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For THE CANADIAN ENGINEER.

WATER, ARTICLE IV.

BY W. M. WATSON.

The readers of the Canadian Engineer would understand the subject discussed in the present paper better if they will refer to the articles published in the issues of June, 1897, and of May and June, 1899. In the articles named, I tried to explain how necessary it is to be careful to lay down water mains straight, parallel, and carefully graded, having cutoff and washout valves properly placed, so that every section can be well controlled and thoroughly emptied and washed out, when required. Also, that the arrangement of street mains should be such, that when all are in full working order, the water the street mains contain is always on the move, and that in no part of the system can the water be motionless for days together.

During the fifteen years I have been in Canada, I have observed that waterworks are usually laid on what European engineers call the temporary system, that is in a zig-zag or snake fashion, laying them over hills and dipping the pipes down under valleys and gullies or culverts, paying no regard whatever to the depressions made in the pipes, that will form receptacles for dirt and poisonous matter, or to the air pockets that will hinder the flow of water and cause water hammer and damaging commotions to exist in the pipes, which start leakages and cause over 100 gallons of water to be pumped per head of population per day in Canadian waterworks, when the quantity actually used does not amount to over 40 gallons per head per day. In fact, as far as I can make out, the health of the public, who have to drink, wash, and cook, with the water carried to them by the street mains, receives very scant consideration, and the fearful cost of repairs and management, after the construction is completed, appears not to weigh one feather weight, I am told on all hands that the country is rich, and can stand it, though I know by experience that my taxes alone are nearly as much as both my taxes and rent were together when living in Great Britain. I also know that the state and local bodies have mortgaged the property so well that our very clothing fits as if they are in the grip of the money-lender, yet money is wasted on public works just as if it were as plentiful as sand. The purest water can be fouled and badly contaminated during its passage through the water mains to the consumer, by allowing it to have a sluggish flow, and stand motionless for long periods in the pipes; also by allowing the minute particles of vegetable or other foreign and objectionable matter to remain in the pipes, and cause to incubate and multiply, at the rate of, often, millions an hour, poisonous microbes, which afterwards find their way to the taps and get mixed with the people's food. Experience has proved that all such objectionable matter lies in deep depressions, or is forced to the dead ends, and such street mains as are extended the furthest from the intake end of the supply. On that account it is absolutely necessary that washout valves be provided at such points of the water mains, so that the pipes can be thoroughly cleaned about once a month, without wasting much water. Some two years since, I saw in the newspaper that the Toronto analyst had been analyzing the city water, drawn from taps near the centre, and he reported the result to be good. On the same day, I was engaged unstopping a blocked water service in one of the side streets, about two miles west of where the analyst got the water he analyzed. On cutting and dividing the pipe, I found a frog's leg, a few small bones of a fish and some vegetable debris. Afterwards I allowed the water to run to clear it, and the quality that the pipe delivered was far from being fit for use for domestic purposes, and the analyst would certainly have said the same had it come under his notice. All the houses in that street are subject to periodical stoppages, on account of the water main in the street being dirty, and no proper means to clean it out being provided. The water at the intake pipe of the city of Toronto is excellent, but the distributing mains appear to have been laid without any thought of cleaning them out.

There has been said sufficient to show how the health of the people largely depends on the laying of the public water mains and service pipes, and may pass on to the costly damages and inconvenience of frozen

water mains and service pipes which are the outcome of poor construction. I have heard people say that freezing of pipes cannot be avoided, but I do not believe such statements, and if reasonable care is observed, there need be no difficulty of that kind. Since 70 per cent. of the water pipes laid never freeze, then why cannot the balance of 30 per cent. be made to resist severe weather. In several newspapers we have read during the last very severe winter that a fire occurred in a town and the firemen were badly hampered because the fire hydrant was frozen. After large sums of money have been spent to ensure security, the article is useless at the very moment its services are necessary. The citizens are living in false security, and their property may be all consumed and even their lives may be sacrificed because it takes time, a long time, to thaw out the fire hydrant before it can be used to quench the fire, and in that case the coroner would say that it was accidental death and no enquiry necessary, when the fact of the case would really be that the person had come by his or her death on account of the carelessness or want of knowledge of the person who set the hydrant. If the party who was responsible for properly fixing the hydrant were committed for manslaughter, there would be very few frozen fire hydrants. Every winter a large number of families suffer, because the private pipe supplying their dwelling is frozen solid, and to relieve them and thaw out their pipes small boilers on wheels are supplied, probably by the ratepayers, and a staff of men takes them from house to house, and thaws the pipes out by dividing the pipe at some convenient point, and working a small copper tube into the interior of the affected pipe, and blowing in steam, until the blockage is removed; but if the pipe fitter has laid the pipe in a snake fashion, and the small tube cannot be forced round the bends, then the services of the steam boilers are useless. We should insist that work be done by persons who thoroughly understand their business, and make them responsible for the work they do, or have a fully-qualified official to inspect the work and pass it, and thus avoid the necessity of thawing appliances, and the heavy expense of repairing damages done by frost to pipes containing water.

Perhaps a few suggestions and some practical examples of how to ensure pipes from freezing and the causes of freezing may be interesting. Water attracts frost, as well as other things, and the slightest dampness will carry a current of frost down to a metal pipe. By placing an open vessel of water in a room it will attract and absorb the frost, and in this way frost can be kept out of cellars.

By keeping this in mind when laying pipes and fixing hydrants, we may prevent the risk of freezing if reasonable judgment and care be afterwards observed in the management. I believe brass and copper will convey and carry frost along quicker than other metals; this is proved, because it is found that in most of the street mains that freeze and crack, the freezing first began at the brass bend, screwed into the crown of the main pipe, and attached to the private service pipe, and when water once begins to crystallize, it increases the crystallization right and left in the main pipe quickly, drawing the frost by way of the brass bend, similar to the tree getting its nourishment through the small rootlets; on this account we should endeavor when fixing water pipes containing water to disconnect the pipe from frost currents in a similar way, that electricians prevent electricity from being wasted or coming in contact with foreign bodies. This may be done in various ways, first by encircling the metal pipe with stagnant air completely void of circulation, because air is an excellent non-conductor; second, by burying in pitch, rosin, brimstone or wax, or covering the pipe with an air-tight stocking of rubber, gutta percha or dry paper with a waterproof coat of varnish on the outside, to prevent it becoming damp. If a pipe is properly insulated it will not freeze. Another important point is not to fix a pipe in a position where a strong current of air, however small the current may be, can strike it direct, especially at a bend or coupling; for instance, a house pipe is often brought up through the kitchen floor from the cold basement; if the hole in the floor is a little larger than the pipe, the chilled air will rush through the aperture round the pipe, and freeze it. Pipes will stand a considerable amount of cold without crystallizing the contents, if the air that surrounds them is nearly motionless. They always freeze first where the currents of air are the most rapid, however small a stream the current may be; so if it is possible to lay a main or a service pipe so that it cannot be approached by dampness, or where a circulation of air cannot come in contact with it, then it must be safe from frost. Some engineers will not allow the filling over a water-pipe to be pounded down solid, except the traffic of the road demands solidity, because the air between the particles of earth placed loosely over the water main forms a non-conductor, and cuts off the current of frost from descending to the pipe. Even in well pounded earth, that covers the water mains, there is some air, and no doubt it prevents the frost from descending to the pipes a little, and together with the heat that is absorbed from the earth that is attacked with frost by the lower stratum immediately under the frosted surface, is no doubt the cause why the dampness in the soil cannot convey the current of frost down to the main water-pipes if laid at a suitable depth.

It is unwise to allow a metal pipe containing water to touch other metal or damp stone or brick, if such metal, stone or brick communicates in any way with the cold atmosphere outside, because such metal will convey the frost similarly to a wire that conveys electricity. I think that the custom of fixing a bent brass union on the crown of a water main, to deliver a private supply, might be done away with, with advantage, and in the place of tapping the pipe at the crown, the pipe main might be tapped on one side, and in place of using copper bends and connections, annealed or malleable iron fittings should be used, because they cannot attract the cold so quickly as brass, and it is often the case that the water in the mains is constantly on the move forward, therefore cannot readily be attacked by frost: while the water in the brass bend and service pipe only moves when water is drawn into the house, and the contents of the pipe being afterwards motionless, is easily crystallized, and then starts the water in the main crystallizing, and in that way great mischief is done. This method would lower the house service connection as much below the crown of the water main, as the brass bend extends above the water main, under the present rule,

which would be right, because the house service needs more protection than the water main. The objection that the services would break away from the main, on account of expansion and contraction, when iron or brass pipes are used for service pipes, can be overcome by using two English slow bends, keeping them sufficiently apart to allow enough movement to take place that will overcome any expansion or sudden jars that might occur. I also consider the custom of putting a separate service pipe to each house, however small that house may be, or however many small houses are grouped together, is unwise. Water rapidly deteriorates when lying idle in pipes; not only do the friendly microbes in the water die off for want of air, but the water sets up a chemical action with the metal of the pipe. The public health demands that water pipes should, wherever possible, be worked to their fullest capacity, on that account the shortest length possible of service pipes should be used between the street main and the house taps, and as many as can conveniently be served from one pipe should be. Water mains are laid down considerably larger than is needed for domestic or trade supply, as a rule, First, because they may be called upon to furnish several streams at any moment to extinguish a fire; second, because a small cast-iron pipe, placed under a road, is easily broken by heavy traffic passing over it. So we see that it is necessary to prevent the water deteriorating or freezing in winter, to so arrange them that the water at all points is kept, if possible, constantly on the move or circulating, besides having plenty of proper provision for emptying and cleaning them out. There is a service pipe made that will resist frost: also preserve the purity of the water it contains, so far as to prevent the water from setting up any chemical action with the metal. It is made of common wrought iron pipe, having a thick, hollow core, or lining, of pure tin, forced into the interior of the iron pipe, and when forcing the tin into the inside of the iron pipe, a thin rubber cloth or other non-conducting material is placed between the two metals, which insulates the pipe, and prevents the frost having any action on the water it contains. Thus, by using that kind of pipe, the purity of the water is maintained, and the chance of freezing is nil, because it is impermeable to frost, on account of the insulator placed between the two metals, and being lined with pure tin, it is impossible for the water to set up any injurious chemical action.

To make the causes of freezing very plain, I will here relate a few of my own personal experiences. Last winter I was obliged to carry a small water pipe over a roof, and I knew the water would only move about twice each day, and there was a great difficulty presented against the pipe being boxed, so I simply insulated it by placing three-ply rubber hose over it, carefully sealed it at both ends to prevent any circulation of air between the iron and the rubber stocking, and the pipe did not freeze last winter, though the weather was severe and the pipe elevated high in the air. Frost will run down a pipe however well insulated, if the end is exposed to the air, because the frost will travel down the metal forward along the inside of the insulated covering. A customer of mine being troubled with mice, that ran along the pipe line of the water pipe placed under the floor boarding, crossing the joints, from the kitchen boiler to his bathroom, took up a board and encircled the lead pipe with a small piece of tin to stop the mice from passing over the joists alongside of the pipes. The house every year was kept so well heated that the pipe had never been known to freeze, but the small piece of tin made it freeze, at the point where the tin touched the lead pipe, because the tin attracted the little frost that was in the air between the floor and the ceiling, and drew it or focused it on to that part of the pipe that the tin touched, and just there I found the stoppage. Some twelve years since, the Grand Trunk Ry. offices, Montreal, were thrown in the dark by a stoppage of their gas supply. I found the defect was caused by the gas being frozen in the ¾" supply main place in the false roof, where the atmosphere never was less than 50 degrees of heat, therefore nowhere near the freezing-point, but a nail had fallen out of a shingle in the roof, and the heat of the false roof being near the seventies, and the outside being about 30 degrees below zero, there was a rapid ingress of cutting cold air through the small nail hole in the roof, into the false roof, which made a bee line to one of the ventilators placed in the ceiling to ventilate the office below, and on its passage forward it struck the gas pipe about the one-eighth of an inch in width, and crystalized the damp gas at that point, cutting off the supply.

There are many waterworks' fittings that have been carelessly constructed, and to rectify the injury done would cost a great deal, therefore if anyone can come forward and show how such badly-laid pipes can be prevented from freezing and bursting, or show us an easy way of thawing them out when they are frozen, they will be public benefactors and deserve commendation. Town councils and private individuals have had to part freely with their money, and suffer much inconvenience on account of shoddy work that could not be prevented freezing in past years. Electricity, which has a close similarity in its actions and methods of travel with frost, is proved by Professors Wood and Jackson to be able to thaw frozen pipes, small or large,

Hundreds of frozen pipes were thawed out last year by the electrical method, both quickly and at a far less cost than when the dirty steam kettle is used, and I cannot do better than repeat the report Mr. Hiem publishes of Messrs. Wood and Jackson's successful work in the thawing out by live electric currents. The attention of Mr. Wood was drawn to a service pipe that could not be thawed out by a steam boiler, nor could the kink in the pipe that was frozen be reached any other way until warmer weather should set in, so Professor Wood consulted with Professor Jackson, and both together they tried to thaw out the obstinate pipe by electricity, and succeeded beyond their expectation, and then they introduced the system generally. Mr. Hiem goes on to say:

"I will now give you the computations Professor Jackson was kind enough to give me, and which have been verified in the different cities where the conditions were proper and the thawing successful. To thaw out lead or iron services up to one and one-half inch, you should use from 200 to 250 amperes; if you are not able to get more than 125 amperes, it will take four times as long. If you use over 250 amperes you are liable to get into trouble by overheating the corporation stop-cock, and all other brass connections. Wrought-

iron pipe must be watched very closely so that the joints do not heat; it has lower resistance, higher conductivity, requiring more current, in order to make more heat, therefore you must watch the unions—that is where the heat occurs. It is necessary to use a source of current which does not affect the electric light lines or other transmission lines; if current is taken from them, danger may result. We have therefore ordinarily used a transformer in the work, but in some cases have used dynamos directly. The source of current should have a pressure of not less than 50 volts. To thaw out 500 feet of a six-inch main in half an hour requires 800 amperes; if you are unable to get more than 400 amperes it will take four times as long, or two hours. Eight hundred amperes will thaw out 500 feet of a 12-inch main in one hour, and a 24-inch main in two hours, etc. The source of current for water mains should have a pressure of not less than 200 volts.

"In preparing to thaw out a water main, connect with two hydrants, winding the wire around the hose nozzle. Screw hydrant nozzle cap up to the wire, making a close connection, commence at open end, where there is no frost, with 800 amperes or less and 200 volts, and thaw say 500 feet at a time. Water should be kept running for at least an hour after the main has been thawed, as it will take that length of time before the water will be slightly warmer. Three-quarter h.p. will thaw a six-inch main in half an hour per foot length; two-tenths h.p. will thaw a one-inch, and one-eighth h.p. will thaw a five-eighths service pipe in half an hour per foot length. There is no danger from electrolysis, on account of the short duration of the thawing process and the ground being frozen. Herewith are the directions for thawing service pipes up to one and a half inches in diameter, which were prepared and sent out by the University of Wisconsin:

"'The current, which is required for thawing service pipes satisfactorily, is from 200 to 300 amperes. The source of current should have a pressure of not less than 50 volts. Where electric light lines carrying alternating currents are available, a transformer or transformers in parallel may be used as a source of current. It is very important that direct connection of pipes to house lines be avoided on account of danger of fire in which the house is placed by such connection. Where alternating currents are not available, continuous current feeder lines may be used, but these should be entirely separated from the distributing net work of conductors. The way in which the appliances should be connected when an alternating current is used with transformers is as follows: The secondary leads from the transformer should be quite large, such as No. 3 B. & S. gauge, or larger. In making connection to the pipes, one of the secondary leads should be taken into the house, to which the frozen service pipe leads, and contact made at that point by some form of metallic clamp or by simply giving the conductor two or three tight twists about the pipe at any point where the pipe is exposed or at a faucet in the house. The other secondary lead should be put in contact with the water system outside of the house and in a similar manner. This contact may be made at a hydrant or at an adjoining service box, or pipes in a neighboring house. When there are two houses near together, each with frozen service pipes, the two secondary leads may be connected to the pipes within these houses and both frozen service pipes thawed out at once. While the thawing process is going on, the faucet should be open in the house to which the service pipe leads. In one of the secondary leads should be inserted a water resistance, which consists, for convenience, of a bucket of water containing a bowlful of salt, and two sheet-iron or copper plates to which the ends of the severed lead are attached. This serves to control the current. In the primary leads from the electric light line to the transformer it is highly desirable to have a fuse in each lead, and an amperemeter. When all connections are made, the plates are placed in the bucket and are then moved towards each other until the amperemeter records a proper current. If the primary pressure is 1,000 volts and the secondary pressure 50 volts, the current should ordinarily approach 15 amperes. If the primary pressure is 2,000 volts, and the secondary pressure is 50 volts, the amperemeter reading should ordinarily approach 7.5 amperes. Water ordinarily begins to flow in a time not much less than ten minutes, or not greater than one hour. If the secondary current is quite close to 300 amperes the period seldom exceeds one-half hour. The frozen pipes are often split by the action of the frozen water, and these at once begin to leak when the ice is thawed away. For this reason it is desirable to have a plumber where he may be readily called to care for the leaky pipe. The electric current when properly used will not damage the pipes. It is desirable to watch brass and iron connections to lead or iron service pipes, as they sometimes heat on account of poor contact. If such heating appears to be excessive, the current may be reduced with a resulting increase in the duration of time for thawing. After the pipe has been thawed it is desirable to let the water run continuously for a considerable time, inasmuch as the ground all round the pipe is frozen, and the pipe is liable to freeze up again unless the water circulates.' In closing this paper let me give you an extract from an insurance paper, as to the financial result of this discovery: 'A slight estimate of the value of the invention of thawing out frozen pipes by electricity to underwriters can be found from the fact that in 1898, insurance companies paid out nearly $300,000 in losses caused by primitive methods of thawing out pipes.'"

SOUTH AFRICA, ITS PEOPLE AND TRADE.

ARTICLE I.

The obduracy of the Transvaal Boers and their president in refusing to concede the common rights of man to citizens not of their own race, is turning the attention of the civilized world to South Africa and its people. That quarter of the world possesses unusual interest to Canadians, not only from the standpoint of imperial politics, but from its commercial development and its possibilities as a field for Canadian trade. As a prelude to a review of the prospects for Canadian manufacturers and exporters, it will be well for the reader to know something of the causes of the present political complications.

The Cape of Good Hope, though discovered by Diaz, a Portuguese navigator, six years before Columbus landed in America, and though used as a port of call by the Portuguese for a century afterwards, it remained for two English captains, in the employ of the

East India Company—Shillinge and Fitzherbert—to make formal claim of sovereignty in the name of England in 1620. After some rivalry between the English and the Dutch East India companies, the latter, realizing the salubrity of the climate and the fine soil, sent out an expedition under Jan Van Riebeek—in whose honor the Hon. Cecil Rhodes has recently had a statue erected in Capetown—to make a permanent settlement, and thus began in 1652 the Dutch occupation of the Cape. Little by little the settlements extended back from the Castle on Table Bay, but the life of the settlers was the life of white slaves. They were not allowd to sell their produce to visiting ships, but could only sell to the company at prices fixed by the company. On the other hand, they were not permitted to purchase goods except from the company and at prices fixed, of course, by the company. They and the artisans of the town were, moreover, bled at every turn by the company's officials, and if they attempted to complain to headquarters in Holland their complaints were either suppressed altogether, or the complainants were imprisoned as treasonable persons or otherwise marked out for persecution. The farmers had no title to the lands they brought under cultivation, and were often ejected after working a lifetime upon their lands. They were plainly told that they held their property by grace of the company. Offences, which now would scarcely come under the criminal code, were visited with death in its most fiendish forms. Crucifixion was a common mode of capital punishment, and another was the tying of the victim with his back on a wheel, where his body was broken, and he was left "a prey to the birds of heaven." The rack and the gallows were the common means of punishing slaves. It is not to be wondered at that the Dutch settlers sought to escape this tyranny, and from time to time, in spite of threats and the company's claim of jurisdiction, many got beyond the reach of the company, risking the enmity of the natives in their migration. Thus began the "trekking" of the Boers, which dates back to 1670, and has been a peculiar characteristic of Dutch colonization down to the present day.

During the upheavals of the French revolution, England felt the necessity of possessing the Cape to save her East Indian trade, and after a feeble resistance the Castle capitulated to Sir James Craig in 1795. At the peace of Amiens in 1803 the Cape was restored to the Dutch, but was finally taken in 1806 by Sir David Baird. The first taste of individual liberty and reasonable government enjoyed by the Cape Dutch was given to them by Great Britain. With the advent of Britain at the Cape, the Dutch farmers got their first clear titles to land, they get district courts, where justice was for the first time administered with fairness and without the corruption which had made their masters so odious. The people got their first regular school system, and their first postal system from their new British rulers, who also did away with the system of punishing offenders by the cross, the wheel, and the rack, those brutal instruments of torture being destroyed at the very outset of the British regime.

Such, in a few words, was the contrast between British and Dutch rule at the Cape. It is not to be denied that between the Home Government and the colonial rulers many mistakes have been made in the subsequent history of British rule in South Africa; but more often than otherwise these errors were made through mistaken leniency or mistaken philanthropy towards Boer and native alternately. Perhaps the most unpardonable grievance nursed by the Boers in the present century was the emancipation of the slaves in the Cape Colony in 1837. Many Boers to the present day believe with apparent honesty that a Kaffir has no soul, and class him with the wild beasts of the veldt. While other nations besides the United States have freed the slaves without compensation to the slave owners, Great Britain voted to the slave holders of the Cape £1,247,000. This was only half the amount of the appraisement, but it must be remembered that the slaves of the West Indies and other parts of the empire had to be freed at the same time at a total cost of £20,000.000 —an enormous sum for those days—and the sublimest exhibition of the awakening of national conscience ever recorded in the history of nations. Though the Boers must have known from the agitation that had been going on in England for the preceding thirty years that the emancipation of slaves must come, there was a great outcry when the amount of compensation was announced, and, to make matters worse, from their standpoint, a horde of self-appointed agents, working on the circumstance that the money had to be paid in London, bought up the claims of the farmers for a mere song in many cases, and the enraged slave-owning farmers trekked into the interior to the number of several thousand, founding what is now the Orange Free State, the Transvaal, and a portion of Natal. British settlers had anticipated them in Natal, and after some bloodshed and a few years' hesitancy on the part of the Home Government, British sovereignty was proclaimed over Natal in 1843. Although the British Government had warned the emigrant Boers that they were still British subjects, those who settled in the Free State and the Transvaal were allowed to rule themselves. The Free State was indeed taken under British rule for a number of years, but that rule was withdrawn under the protest of a large minority of the inhabitants, and the State was left an independent Republic in 1854. Under the wise and common-sense rule of the late Sir John Brand, who was president for twenty-five years, the Free State has had till now the best relations, almost uninterruptedly, with Great Britain and with her colonial neighbors. There was but one serious difficulty and that arose out of the discovery of the diamond fields on the borders of the State in 1867. The land had been owned and was still claimed by a Griqua chief, named Waterboer, and the British Government having bought up his rights, proclaimed the diamond fields British territory in 1871. The Free State, which had claimed a part of these fields, withdrew under protest, but whatever the merits of its claims they were generously compensated by a payment of £90,000, with which the little State was well satisfied, and with which it built its first railway—a road that stands to-day as the best asset possessed by the State. While the Dutch in the Free State and Natal, as well as in the Cape, have settled down to a fairly general friendliness towards the British, the history of the Transvaal Boers has been marred by a strong and persistent hatred of British Government and people. Peopled largely by the irreconcileables, who had left Natal and the Free State on the advent of the

British, and utterly unable or unwilling to understand the British idea of government of the Kaffir tribes, they have become the Ishmaels of South African civilization —their hand forever against the Kaffirs on the one side and against the British on the other. They have so far failed to see the advantages of the golden rule, or to read the signs of the times, that they have perpetuated the same ideas of lordship as those under which their ancestors groaned in the 17th century. In 1877, when the country was in a state of bankruptcy, Sir Theophilus Shepstone annexed the Transvaal to the British Empire, without active opposition. Whatever may be thought of this step, it was taken with the best intentions, and with the desire to save the Boers from the destruction which would have been their fate at the hands of the Zulu King Cetywayo. The step once taken, it is now generally realized that a terrible mistake was made in giving the country back to what has proved a monstrous system of misrule. The British Government, however, gave the Boers just ground of complaint when it left the Transvaal for three years without any representative institutions, and permitted during that time a military aligarchy, composed of men who gave no consideration to the susceptibilities of the Dutch inhabitants, a large part of whom would have been fairly contented under a system which gave them a voice in the affairs of the country. It was unfortunate that just when the British Government began to be awake to the seriousness of Boer discontent, and were actually considering the constitution framed by Sir Bartle Frere, the flames of rebellion broke out, with the result that the British were defeated in three engagements, through the guerilla tactics of the Boer sharpshooters, and then the Gladstone Government restored the republic under that "suzerainty," which has been ever since a source of misapprehension to the Boers.

Before alluding, in our next article, to the present condition of affairs in South Africa, it is worth while to remember this teaching of the past, that wherever the British and Dutch have co-operated either in colonization, in politics or commerce, they have both prospered. The British possession of the diamond fields was the financial salvation of the Free State; and the British operation of the Transvaal gold fields has lifted that republic from commercial nothingness to a state that has become at once the chief power and the chief danger to the neighboring states and colonies.

HUDSONS BAY.

A. P. Low, of the Geological Survey of Canada, has returned to Ottawa, after fifteen months' exploration of Hudson's Bay. Mr. Low left Ottawa in the spring of 1898 for the Atlantic coast, from whence he went by steamer to the eastern mouth of Hudson's Straits, where he took a yacht and explored the coast down to Great Whale river, a part of the bay not previously explored. Several large rivers were discovered, and great quantities of fish were found, especially in the mouths of the rivers. The fish found were Arctic salmon, whitefish, trout and cod. Mr. Low thinks that they are in sufficient quantities to make fishing for commercial purposes very profitable. The winter of 1898—99 was spent in Great Whale river. Mr. Low and his party living in snow houses. There was not much work done during the winter, as there was barely six hours' sunlight a day: but during the past summer a very large tract of country inland was explored, and some valuable mineral discoveries made, of which details will be given in his report to the Government, which will be made at an early date.

GREEN GRASS GROWS ALL AROUND—PETROLIA.

A wail has gone up from Petrolia, Ont., because the Imperial Oil Co. has removed everything pertaining to the oil industry from Petrolia to Sarnia, Ont. As the mouthpiece of the local sorrow says, the "oil wells are there yet." But that need not comfort the town too much, because these wells can only be pumped when the Imperial Oil Co. requires oil, and when the well-owners are prepared to take the price the company feels prepared to pay. When everything has been got on a business basis, the company will pay only what is good for it, and those who know the Standard Oil Co., know what that is. When the people of Petrolia, Ont., refused to bonus the Bushnell Oil Co., some few years ago, they were unaware that the Standard Oil Company then promised that grass would grow in the streets. They did not know, perhaps, that the Bushnell Oil Co. was then, as the Imperial Oil Co. is now, one of many nice little properties which are owned by the Standard Oil Co. In the meantime the grass is beginning to sprout, and the Standard Oil Company monopolizes the oil business of Canada.

—Occasions have been numerous in Canada where one town has had to call upon another for assistance in fire-fighting, and frequently engines, etc., are sent from one town to another. It has been found that in some such cases the borrowed apparatus was entirely useless because the hose couplings were not of uniform size, and therefore they could not be used in conjunction with the apparatus already on the ground. This should be remedied.

THE COMPRESSIVE STRENGTH OF CONCRETE AS DETERMINED BY TESTS MADE AT MCGILL UNIVERSITY.*

BY W. B. ANDERSON, STUDENT CAN. SOC. C.E.

Concrete, especially in the construction of piers and foundations, is coming every year into more extensive use. It is therefore desirable to determine its strength, and more particularly the resistance to crushing, as it is to a compressive force that it is most often subjected. The results of very few tests with this end in view are given in any of the treatises on concrete or building materials, or in the engineering journals. A few results may be found, but they are scattered and very irregular, and little information can be obtained from them. During the past three years a few tests have been carried on by the students of civil engineering at McGill University. The first series, two years ago, was to determine the effect of different percentages of water upon the strength, and the best percentage to use. This was found to be about 20 per cent. of the sand and cement. Last year tests were made comparing the strengths of concretes made respectively from an English Portland and a German one. This year tests were made upon sand cement in order to compare it with the Portlands, and also to determine the best proportions in which to mix it in making concretes. This cement was "Cathedral" brand sand cement, made by the "St Lawrence Portland Cement Co.," of Montreal. It is made of equal parts of Portland cement and kiln-dried pump sand. These are run together into a revolving cylinder half full of flint pebbles, where they are thoroughly mixed and ground to an impalpable powder.

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

The conditions under which the tests were made this year were the same as those of the first series (published in paper No. 117, Trans. Can. Soc. C.E.), except that the blocks were made 9 x 9 x 12-in. instead of 12-in. cubes, as the cubes were found, in some cases, to be too strong for the testing machine to break. The blocks were tested with their long edges vertical, and rested on a steel plate which was on a ball and socket joint, the plate above the block being fixed. Sheets of rubber were inserted above and below the block to give a more uniform distribution of the load. The blocks were allowed to stand in the moulds for about two days, and were then removed and placed in water, where they were kept until the time of testing. The results of all the tests made in 1898, and the more striking ones of other years, are here presented in tabular form:

RESULTS OF EXPERIMENTS ON THE COMPRESSIVE STRENGTH OF CONCRETE.

		Mixture.					Breaking Loads lbs. per sq. in.					Relative Costs	
No. of Tests.	Date of Test.	Cement.	Sand.	Broken Stone.	Percentage of Water.	Weight in lbs. per cu. ft	One week	Four weeks.	Two months	Proportion of mortar to broken stone.	Relative amounts of cement.	First Assumption.	Second Assumption.
*1	1896	1	2	4	20	139.5	746	626	507	60-80	157	174	126
*2	1896	1	2	5	20	.....	...	703	...	-100	137	152	121
*3	1896	1	2	6	20	.....	...	728	...	-120	122	135	116
*4	1897	1	1	1	22½	142.3	x	x	...	60-30	367	407	206
*5	1897	1	1	2	22½	146.7	1037	x	...	-60	275	305	175
*6	1897	1	1	3	22½	148.0	x	x	...	-90	220	244	156
*7	1897	1	1	4	22½	153.3	x	x	...	-120	183	204	144
*8	1897	1	1	5	22½	151.2	x	x	...	-150	157	174	135
** 9	1897	1	2	2	20	143.5	494	505	...	60-40	220	259	150
**10	1897	1	2	3	20	146.0	611	555	...	-60	183	216	139
**11	1897	1	2	4	20	148.5	810	613	..	-80	157	185	131
**12	1897	1	2	5	20	150.5	581	680	..	-100	137	162	124
**13	1897	1	2	6	20	150.0	500	698	...	-120	122	143	120
**14	1897	1	3	3	20	139.5	333	205	...	60-45	157	185	122
**15	1897	1	3	4	20	139.0	...	366	...	-60	137	162	117
**16	1897	1	3	5	20	145.0	...	386	...	-75	122	143	113
**17	1897	1	3	6	20	147.0	...	357	...	-90	110	129	110
†18	1898	1	3	5	20	146.5	144	274	400	-75	122	122	104
†19	1898	1	3	6	20	146.4	110	182	218	-90	110	110	102
†20	18[illegible]	1	3	7	20	150.3	210	322	...	-105	100	100	100
†21	1898	1	2	4	20	150.6	316	441	...	60-80	157	157	119
†22	1898	1	2	5	22	148.5	275	477	494	-100	137	137	114
†23	1898	1	2	6	20	154.0	521	639	670	-120	122	122	111
†24	1898	1	1½	3	20	149.8	412	490	...	60-72	200	200	134
†25	1898	1	1½	4	20	151.5	446	679	...	-96	169	169	126
†26	1898	1	1½	4½	20	153.5	536	741	...	-108	157	157	123
—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	2	4	5	6	7	8	9	10	11	12	13	14	15

Brand of Cement—*German Portland "Hemmoor" Brand. **English Portland "Anchor" Brand. †Sand Cement "Cathedral" Brand. Blocks marked thus (x) remained unbroken under a load of 1,050 lbs. per square inch.

Column 13 shows the relative quantities of cement in the different mixtures, and some attempt has been made to estimate the cost of the different mixtures on this basis. The relative costs are compared on the following two different assumptions:

First assumption—Column 14 shows the relative costs if it is assumed that the sand and stone can be secured on the spot and their cost ignored. The cost of different brands of cement is taken as below.

Second assumption—Column 15 shows the relative costs of the different mixtures and brands on the following assumed costs per cubic foot of materials

English Portland	53 cents.
German Portland	50 cents.
Sand cement	45 cents.
Broken stone	8 cents.
Sand	2 cents.

The cost of labor is not taken into account, as it will be the same in every case, and these costs can at best be only a rough approximation.

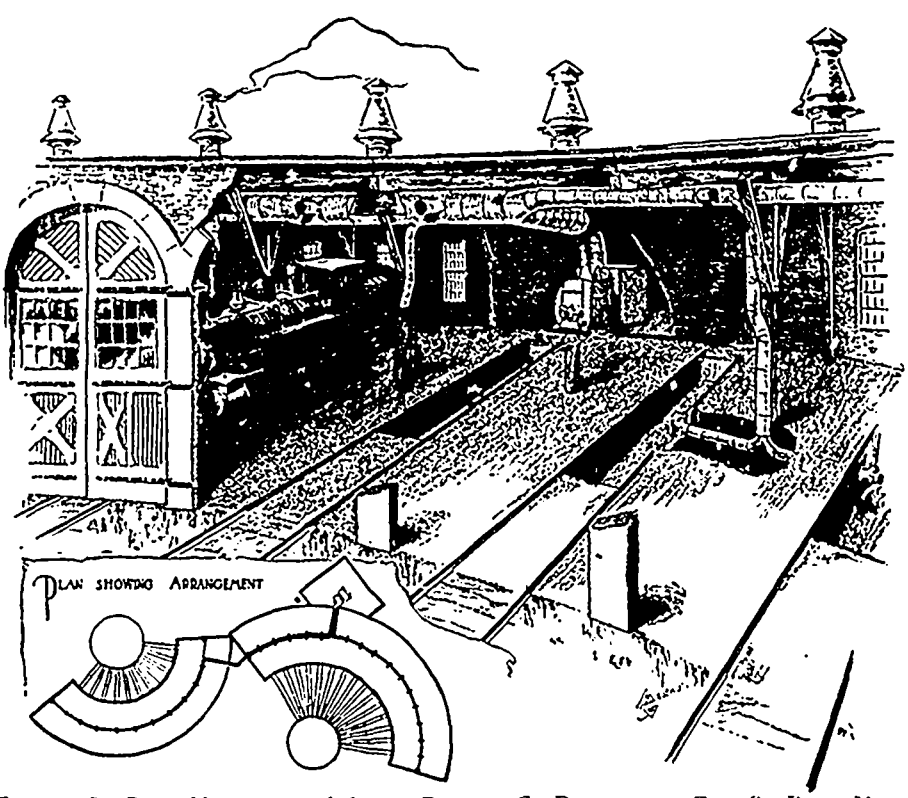
The main requisite for an economic and good concrete is to have just enough cement to completely surround every grain of sand, and just enough of this mortar to fill every interstice between stones. Column 12 gives the proportion of mortar to stone, and it will be seen that with each different mortar the strength increases as the proportion of stone increases, or as the volume of interstices between the stones decreases, because the mortar is not so strong as the stone. The strength also increases with the richness of the mortar in cement, so that the strongest concrete will be one with very little sand and a great deal of stone. Those with the 1-1 mixtures of mortar are very much stronger, though also more expensive than the others. The sand cements are found to be weaker than similar mixtures of Portlands by from 12 per cent. to 40 per cent. The manufacturers claim that with a mortar, such as a 1-10, with a great deal of sand, this cement is stronger than the Portland. This remains to be determined. If the concrete is desired to have very great strength, a Portland cement and a rich mortar might be used, but if weight is the main consideration, with only moderate strength required, a concrete of sand cement will be much cheaper and quite efficient. Of course, much cheaper mixtures than the ones tested can be made, but they will be weaker accordingly after a certain limit is passed, which limit has not been reached in these experiments. One of the cheapest and a fairly strong concrete is No. 23. This mixture would seem the best to use if excessive strength were not required. The loads given in the table are the actual crushing loads. The blocks showed cracks or signs of failure before this load was reached, but it was thought better to make the comparison on this basis. For purposes of comparison it is best to take the results of the four-week tests, as the concretes then show more uniform results than at one week, and the two-month tests are not complete. These tests are still very incomplete, and it might be profitable to make further tests with concretes containing more stone. The strongest of the sand cement mixtures is No. 26, and with this rich mortar it looks as if it would stand a good deal more stone, thus increasing both the strength and weight, and reducing the cost. Tests of this nature will likely be carried out at McGill University in future years.

—S. T. Bastedo, Deputy Minister of Fisheries, and A. M. Wickens, the inspector of boilers, recently made a test of the tug "Gilphie," which the Ontario Government has purchased to be used as a patrol boat in Lake Huron and Georgian Bay waters.

VENTILATING AND HEATING ONE-STORY BUILDINGS.

So far as their construction is concerned, the simplest of all structures requiring ventilation and heating are one-story buildings, such as mills, shops and exhibition buildings. But no other form of building has so large an amount of wall and roof space per cubic foot of enclosed space, or such high and extended rooms; in fact, such a building, as a rule, forms only a single room. As a consequence the most efficient system is necessary. It is not alone sufficient that the apparatus shall be large, to allow for the excessive heat loss from the building, but, above all, the arrangement of the distributing ducts must be such as to most economically utilize the heat supplied; for under-heating at the floor and overheating above is one of the most natural consequences of an imperfect system of distribution. Under such circumstances the apparatus itself is frequently condemned as having insufficient capacity, when the trouble lies entirely in the manner in which the heated air is delivered to the building. In buildings of this type the principal provision is to be made for the heating, for the occupants are generally separated, and the air supplied for heating will answer all the requirements of ventilation. But it is nevertheless necessary that they should be provided with fresh air in sufficient quantity. One of the inherent virtues of this method of heating is that it ensures such supply. As the air provided is generally in excess of that required for ventilation, increased economy can be secured by using over again a portion of the previously heated air. This may be done by arranging dampers or doors so that part of the air entering the heater is drawn from out of doors and part, or, if desirable, the whole from the room. In fact, in the ordinary manufactory the common practice is to nominally take the entire air supply from within the building. This does not result, as might be supposed, in a total lack of ventilation, for a very considerable amount of outward leakage takes place through the walls and around windows and doors. Sufficient, indeed, to cause a similar inward, but imperceptible, leakage at other points in such quantity as to result in a comparatively frequent change of air within the building. One of the greatest difficulties in a building of this character is to heat it rapidly in the morning, after it has cooled during the night. No other system can so completely and rapidly meet this requirement as that here presented. When it is desirable, the engine may be run slowly all night and the building maintained at a moderate temperature. The exhaust from the engine being used in the heater, no expense is entailed for motive power.

Chicago, St. Paul, Minneapolis & Omaha Railway Co., Roundhouse, East St. Paul, Minn., shows that the proper heating of a roundhouse presents a double problem, for not only must its temperature as a whole be kept uniform and sufficiently high, but provision must be made, where heavy snow storms are prevalent, for rapidly melting from the running gear of the locomotive the burden of snow and ice with which it is so frequently encumbered when first returned to the roundhouse from a long run. The general method of solving the problem is made evident in Fig. 58. An overhead system, with hot air discharged toward the walls, serves for the general warming, while special pipes, to be used when desired, conduct large volumes of air to the pits, where it is well distributed beneath the locomotives.



CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA RAILWAY CO. ROUNDHOUSE, EAST ST. PAUL, MIN.

POWER.*

BY P. TROWERN.

At our last meeting I drew attention to the power of the steam boiler, not the engine. The boiler is the place we gather the force, power or energy together, and from thence lead it into the engine, to turn our shafts, pulleys, belts, mills and pumps. I will again repeat what I told you about the steam. It is not the water that gives the power, but the fire gives the heat to the water, which becomes a medium and expands, so that one cubic inch will become one cubic foot, or one cubic inch will expand to 1,728 cubic inches (one rule says 1,680 cubic inches, another says 1,700 cubic inches, and another says one cubic foot or 1,728 cubic inches), at 15 lbs. pressure. It is very clear that the power is in the heat alone, which is embodied in the water we call steam and power in the boiler. I have laid before you some rules. They have been making boilers by them. Yet none seem to be up to the scientific mark nor satisfactory.

I would like some of your readers to take up the subjects I have mentioned in friendly talk. The Centennial Exposition standard is that the evaporation of 30 pounds of water per hour from feed water, having a temperature of 100° F., into steam having a pressure of 70 lbs. per square inch is equal to one horse-power. The American Society of Mechanical Engineers' standard is that the evaporation of 34½ lbs. of water per hour from and at 212° F. is equal to 1 horse-power. With a 60-inch tubular boiler, properly made, well set, and carefully fired, from 8 to 10 lbs. of water to 1 lb. of coal should be made into steam of 60 lbs. per square inch. This would depend on the quality of the coal and the temperature of the feed water. Practically no more coal will be required to convert 1 lb of water into

*From a paper read before the C. A. S. E., No. 18, Toronto.

steam at 80 lbs. than it will at 60 lbs. Theoretically it will require 4-10 of 1 per cent. more.

When setting boilers in brick work the practice is to rake in the side walls to the shell a few inches below the water-line, and thus limit the heating surface. It is customary in calculating the surface of the shell to consider that two-thirds of it is exposed to the action of the heat. In estimating the heating surface of a boiler, take 2-3 of the outer surface of the shell and the whole of the inner surface of the tubes or flues; reduce the whole to square feet, divide by 12 for two flue boiler, and by 15 for multi-tubular boilers, the quotient will be the horse-power; from 14 to 18 square feet per horse-power. Eight months ago I had a new boiler given to me with a shaking grate. It very soon ceased to move, and became expensive to be used, both in labor and coal. I have removed the grate and put in one, cost about one-half, pulled out the brick bridge, filled up a big pit behind called a combustion chamber, and enlarged the ash pit. The new bars are 5 feet long by 6 inches wide, herring bone draught; and instead of the bars dipping behind 3 inches I have raised them ¾ of an inch per foot, and the brick bed behind to the end of the boiler one foot short, with the same grade; or in other words, the front of the boiler is 20 inches above the bars, and the back end of the boiler is 10 inches above the brick bed, or wall. This end I call my bridge, because as the flame passes from the brick bed around the end of the boiler to enter the tubes it drops the ashes and soot into the pit, to be drawn out through the ash door behind. Building the brick work like this gives the inspector an opportunity of seeing the boiler from one end to the other, and also to crawl through to examine the bottom of the boiler from end to end. During my past forty years of building in boilers in this style, I have not had a blister, nor defect in the row of rivets, because the intense heat of the fire is spread from the front end to the back end, much alike, with a better draught. Since I have changed the bars and the bridge we have done the same amount of work with less labor and coal. I have 22 boilers like this one, built in, now in good working order. One of these was made with Low Moor iron by Mr. Currie for me, in the year 1862, and is in good working order now. Some time ago I conceived the idea of knowing the difference of the pressure of the steam on top of the water in the boiler and that below the water. I fitted a pipe to the blow-off pipe at the back end, and put a gauge on it at the same level as the gauge in front, which was pointing to 60 lbs., the one at the back pointed to 52 lbs. I tested both the gauges. I have said the boiler was 5 feet diameter, 14 feet long. I then thought if the exhaust steam could be brought back to the boiler without losing much heat or pressure it might be of great use in saving the use of steam in the future, for it appears other power is going to take its place.

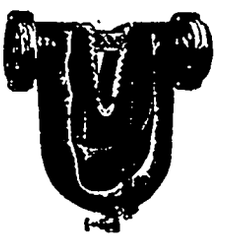
I am now about to ask each one of you to assist me in solving a great question. In almost every country in the world men have been trying to make the most of the heat in the steam by pushing it into a condenser to heat the water, to feed the boiler with it as well as to avoid the pressure of the atmosphere against the exhaust steam when leaving the cylinder. For many years I have been engaged in heating a building with hot water and returning it again to the boiler. This is the question: How can we do it with steam in the boiler at 60 lbs. and cylinder at 50 lbs? What arrangements with valves or any other plan could be adopted to save the heat by getting the steam back again into the boiler without condensation or losing its heat more than in passing from the cylinder to the boiler? I will now turn your attention to liquid air. Liquid air is ordinary air as we breathe it compressed to 1-781 of its normal bulk, or in other words 1,781 feet are pressed into the space of one foot, and reduced to a temperature of 320° below freezing. It has an expansive force of 2,000 pounds to the square inch; it has a latent force of 100 times greater than steam, and as a motive power it is thought that it may be proved to be superior to any known force in or of nature.

—The Rideau Lakes Navigation Co. is a new organization of Ottawa, Kingston and Perth capitalists, who will in the course of a few days make application for letters patent. The capitalization will be $100,000. The company proposes to operate a line of steamers between Ottawa and Kingston by the Rideau River and lakes, and take steps to develop the country as a resort for tourists.

THE AUSTIN STEAM SEPARATORS.

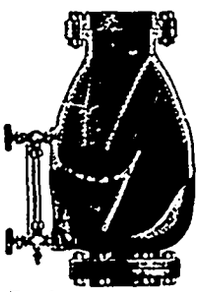
The illustrations accurately detail the construction of the horizontal and vertical separators. By the use of the Austin separators, impurities of whatever nature are, its makers claim, removed from exhaust steam. The steam is immediately given a circular travel (the acknowledged principle for perfect separation) and all impurities or condensation which may escape the corrugations are extracted by centrifugal force aided by gravity, while passing over the separating plate. The steam is in continuous contact with separating surfaces during entire passage through this machine, the makers state. Grooves draining corrugations lead to separating plate, which convey to bottom chamber all impurities, which are discharged through outlet as shown. All practical users of steam power appreciate the importance of condensation being removed from live steam, as when saturated with water there is great danger of cutting the edge of valves and ports, which is not only injurious to the engine, but causing leakage and improper distribution of steam,

"HORIZONTAL"



Can be connected either right or left hand.

"VERTICAL"



Equal results with upward or downward flow of steam.

makes the expense of operation far greater than should be with steam perfectly dry; if there is much condensation in live steam it is apt to cause wreckage of engine by forcing out cylinder head and damaging the working parts. With wet steam proper lubrication of cylinder is not obtained, on account of the hot water neutralizing the action of oil in cylinder and permitting its cutting, practically having the same effect as if no oil was used. Wherever live steam is carried long distances a large element of condensation takes place, which will be entirely eliminated, the makers of the Austin separator believe, by use of their machines, averting all possibility of accident from water in cylinder, the engine working much smoother and greater power obtained. When exhausting into a tank or open heater or where exhaust steam is used for heating purposes and condensation is returned and used as feed water, the oil in exhaust will not only ruin boiler but cause foaming. By using one of these separators in exhaust steam pipe all grease, oil and other impurities will, it is said, be removed. The Austin Separator is manufactured by the Austin Separator Co., 59 Woodbridge street west, Detroit, U.S.

THE CANADIAN ELECTRIC LIGHT CO.'S WORKS ON THE CHAUDIERE RIVER, QUEBEC.

The contract for the works on the Chaudiere River, Quebec, to supply electric power and light to the town of Levis, was signed a short time ago by John Breakey, president of the Canadian Electric Light Company, and C. H. Deans, president of the New York Engineering Contract Company. The works, which are to be in some respects the largest in Canada, to be completed and delivered within six and a half months. The contract calls for the construction of a concrete dam, 900 feet in length, and bulkheads 100 feet long, bringing the total length of the dam to 1,000 feet. Besides the dam the company will build gates, bridges, earthen embankment, boom and piers, pipe supports, power house foundations and tail race, the whole to be completed and in running order by about the 10th of March, 1900. With this dam the company guarantees to supply a minimum of 5,000 h.p., and Levis and surrounding municipalities will be supplied with electric light and power. At the annual meeting of the Canadian Electric Light Company held on the 27th of June last, the directors in their report stated that they had secured exemption from taxation for twenty years in nearly all the municipalities in which the company will work. Besides this a large number of contracts for the lighting of public buildings and residences in Levis and neighborhood, has already

been signed, the Chaudiere Valley Railway Company is to be constructed and operated with the company's power, and the intention is to construct, as they are needed, other electric railways in the counties of Levis, Bellechasse, Dorchester and Lotbiniere. The plans were prepared by the well known engineering firm of T. Pringle & Son, Montreal. A. R. Henry, M.E., is the electrical engineer of the company.

MINERAL INDUSTRIES OF ONTARIO.*

Summary of mineral production in 1898, with quantity and value of mineral production in 1898, with number of workmen employed and amount of wages paid for labor:

Product.	Quantity.	Value	Employees.	Wages.
		$		$
Building stone, rubble, etc	.....	750,000	1,250	520,000
Cement, natural rock barrels	91,528	74,222	85	23,784
Cement, Portland, barrels	153,348	302,096	220	104,350
Lime, bushels	2,620,000	308,000	548	127,000
Drain tile, number.	22,668,000	225,000	2,622	456,000
Common brick No.	170,000,000	914,000		
Pressed brick and terra cotta, No...	8,969,868	100.344	126	42,580
Sewer pipe	.....	93.717	77	26,260
Pottery	.....	155,000	164	61,000
Petroleum, gal.....	26,978,977	.....	....	.....
Illuminating oil, gal	12,281,622	1,243,490		
Lubricating oil, gal	2,043,226	202,150	546	263,455
Benzine, naphtha, gal	1,240,967	121,840		
Gas and fuel oils and tar. gal.....	8,047,441	286,705		
Paraffin wax and candles, lb.....	2,616,086	116,349		
Natural gas	.....	301,600	85	31,457
Carbide of calcium tons[1]	1,040	55.976	35	16,398
Salt, tons[1]	59,385	278,886	191	60,629
Gypsum, tons[1]	3,000	4,000	15	2,000
Graphite, tons[1]	300	6,000	10	1,800
Mica, tons[1]	34	7,500	15	4,500
Iron ore, tons[1].....	27,409	48,875	100	26,700
Pig iron, tons[1].....	48,253	530,789	130	61,476
Nickel, tons[1]	2,283¾	514,220	637	315,501
Copper, tons[1]	4,186¾	268,080		
Gold, ounces	16,261	275,078	580	290,919
Silver, ounces	86,600	51,960	59	28,430
Totals.....	.....	7,235,877	7,495	2,464,239

[1] Net tons of 2,000 lbs.

BUILDING MATERIALS AND CLAY PRODUCTS.

Statistics of building materials were not collected for the year 1897, and for that year they are incomplete. The years of depression had seriously affected the building trade, and production fell off steadily for some time. But with the revival there is a brisker demand for building materials, and it is noticeable also that there is a more generous response to the request for statistics.

The total number of men employed in the production of building materials last year was 4,611, the amount of wages paid for labor was $1,168,240, and the value of materials produced was $2,378,611. In these statistics cement is not included. This industry employed last year 305 men, with wage earnings of $128,134, while the value of the product of their labor was $376,318. The number of workmen employed in brick and tile yards was 2,622, or nearly 800 more than in 1896. Separate statistics are given for pressed brick and terra cotta, and as will be seen there is little sign of revival in the production of these materials. Two or three of the works had been closed down owing to lack of demand for pressed brick, but work has been resumed at one or two of these and it is likely that the output of this year will show an increase. The number of men employed at the quarries last year was 1,250, or 480 more than in 1896. Brick and tile works are correspondingly active, and the output of the yards is but little short of the best year in the decade. The number of men employed at the works last year was 114, being 29 less than in 1897.

The statistics of lime production show an increase in proportion to those of other building materials, and very nearly approach the highest figures of the decade. The number of workmen employed last year was 548, or 118 more than in 1896.

The manufacture of sewer pipe last year gave employment to 77 men, whose aggregate wages were $26,260, as compared with 64 men and $19,600 for labor last year. The value of sewer pipe produced was $93,717, or $20,166 more than last year.

CEMENTS.

Very satisfactory progress continues to be made in the production of cement, but especially the Portland variety of it. There has been substantial improvement in the output of the natural rock cement works during the past four years, but values are not so well maintained as is the case with Portland cement, and the rate of increase is considerably lower in the number of workmen employed, in the amount of wages paid for labor and in the quantities produced. The following table gives the statistics of the industry for the last five years:

Schedule.	1894.	1895.	1896.	1897.	1898.
Natural rock cement—					
Number of works....	5	5	5	4	4
Number of workmen.	63	45	56	70	85
Wages for labor.....	$13,020	$14,166	$15,200	$21,500	$23,784
Product, bbls	55,323	55,219	60,705	84,570	91,528
Value of product.....	$48,774	$45,145	$44,100	$76,123	$74,222
Portland cement—					
Number of works....	3	2	2	2	2
Number of workmen.	105	129	120	161	220
Wages for labor.....	$31,858	$46,000	$48,400	$67,560	$104,350
Product, bbls	30,580	58,699	77,760	96,825	153,348
Value of product.....	$61,060	$114,332	$138,230	$170,302	$302,096

The average rate of wages in natural rock cement works rose from $207 to $315 during the period, and in Portland cement works from $303 to $451, while for both classes of works the aggregate of wages paid for labor grew from $44,878 in the first year to $128,134 in the last, being an increase of 185 per cent. The product of all cement works has grown from 85,903 barrels in 1894, valued at $109,834, to 244,876 barrels in 1898, valued at $376,318, being an increase of 173 per cent. in quantity and of 243 per cent. in value. There has been a slight fall in values per barrel, the average of natural rock being 88 cents in 1894 and 81 cents in 1898, while the average of Portland in 1894 was $2, and in 1898, $1.96. The statistics of Portland cement for 1898, it should be stated, includes 18,400 barrels of Silica Portland, valued at $32,200, which accounts for the apparent fall in value per barrel of Portland. But although the production of cement in Ontario is steadily growing larger, there is no falling off in the quantity of imports for all Canada. The following statistics show for the five years, 1894-8, the values of imports entered for consumption from Great Britain, the United States and other countries:

Year.	G. B.	U. S.	O. C.	Totals.
1894.....	$182,974	$33,263	$ 68,234	$284,471
1895.....	135,693	21,103	95,130	251,926
1896.....	121,125	25,997	107,907	255,029
1897.....	111,551	45,200	104,081	260,84[illegible]
1898.....	106,548	59,855	200,574	366,97[illegible]

It will be noticed that the trade has undergone a marked change in this short period of four years, the imports from Great Britain having fallen off from 64 to 29 per cent. of the whole while those from the United States have increased from 12 to 16 per cent. and from all other countries from 24 to 55 per cent. of the whole. Practically all imports except those from Great Britain and the United States come from Belgium and Germany the former having last year supplied cement to the value of about $150,000, and the latter to the value of about $50,000. The

*From the Report of the Bureau of Mines, Vol. VIII., first part, 1899.

amount of duty paid was $124,868.65, being $121,968.58 on Portland, and $2,900.07 on all other kinds. The total quantity imported last year, including what was not entered for consumption, was 1,153,640 cwt. of Portland, and 11,713 cwt. of other kinds.

POTTERY.

The pottery works of the province gave employment last year to an average of 164 men, whose earnings were $61,000. The value of products was $155,000.

PETROLEUM AND NATURAL GAS.

The total quantity of crude petroleum distilled last year was 26,978,977 imperial gallons, worth at the average price of crude $1,122,801. This was in quantity 1,422,386 gallons, and in value $55,753 more than for the previous year. During the first half of the year six refineries were in operation, owned by five separate companies; but during the second half the business was practically in the hands of two companies, viz., the Imperial of Petrolia, and the Bushnell of Petrolia and Sarnia, and it is now in one. The following table gives the quantities and values of distilled products for the years 1897 and 1898:

Products.	1897.		1898.	
	Gallons.	$	Gallons.	$
Illuminating oil.....	10,891,337	1,131,083	12,281,622	1,243,490
Lubricating oil	1,959,810	199,755	2,043,226	202,150
Benzine and naphtha.	949,341	77,340	1,240,967	121,840
Gas and fuel oils, tar..	8,021,633	281,035	8,047,441	286,705
Paraffin wax, candles..	2,139,278lb	88,378	2,616,086lb	116,349

In 1897 the total value of distilled products was $1,777,591, and in 1898 it was $1,970,534. In 1896 the value of distilled products was $832,187 more than the value of crude, being an appreciation by treatment of 74 per cent. In 1897 the appreciation was $710,463, or 67 per cent., and in 1898 it was $847,733, or 75½ per cent. Last year it was supposed that the lower rate of appreciation in 1897 was a result of tariff changes, but this view is not supported by the statistics of 1898. The average rate of wages was lower last year than in either of the previous years, being $482.68 against $540.83 in 1897, and $541.33 in 1896; but no doubt this is a consequence of a closing down of three of the plants in the latter part of last year. The average number of workmen employed at the refineries was 546, and the amount paid for labor $263,546. In 1897 the number was 364, and the amount paid for wages $196,965.70. The proportion of refined products obtained from the crude is shown in the following table for the seven years 1892-98, and indicates in a general way the progress that has been made in the processes of distillation during that period:

Product	1892. p.c. of crude.	1893. p.c. of crude.	1894. p.c. of crude.	1895. p.c. of crude.	1896. p.c. of crude.	1897. p.c. of crude.	1898. p.c. of crude.
Illuminating oil...	38.67	39.12	41.10	43.31	45.08	42.62	45.52
Lubricating oil....	12.35	12.45	10.91	9.51	9.07	7.67	7.58
All other oils.....	27.34	28.14	30.45	28.07	31.09	35.10	34.42
Totals.....	78.36	79.71	82.46	80.89	85.24	85.39	87.52

In the seven years the increase of all refined products obtained from the crude has been 9.16 per cent., made up of 6.85 per cent. in illuminating oil, and 7.08 per cent. in all other oils except lubricating; in the latter there has been a decrease of 4.77 per cent. The wax product last year was larger than in 1897 by 476,808 lbs., and larger than in 1896 by 1,084,415 lbs. There is perhaps no other industry in the country in which such marked and satisfactory improvement has been made as in the oil industry, and those employed in it deserve great praise for the intelligent methods they have so diligently pursued.

A great deal of exploring and developing was carried on during the year for supplies of crude, and the situation was improved in consequence. A small field north of the London road in Sarnia township has been added to the producing territory. The southern part of the township of Plympton has also given good results, although in these two localities the oil deposit is not quite so uniform as in the old districts of Petrolia and Enniskillen. It was thought last summer that the township of Brooke gave evidence of a good deposit, and quite a number of wells were drilled there; but the supply did not prove to be permanent, and most of the wells have been abandoned. In the township of Zone, near Thamesville, the same experience was realized; several wells yielded liberally when first drilled, but the flow did not last. Bothwell is getting its producing limits as an oil field defined, and during the year its yield was little more than 6,000 barrels monthly. Euphemia and Dawn have each a small field, the area of which is being expanded by exploration. In the old territory, which runs from the southern part of the township of Sarnia in a southeasterly direction through Enniskillen by way of Petrolia, wells may be struck at nearly every attempt. Small detached areas in this region not previously explored give good returns, one of the best being near Oil Springs. It takes time, experience and risk of loss to discover these treasures of Nature's storehouse, but it is not improbable that anywhere throughout the counties of Lambton, Kent and Essex a discovery of oil may be made. A new locality that has recently been attracting attention as an oil field is in the southern part of Dunwich township, in Elgin.

CALCIUM CARBIDE.

For the thirteen months ending December 31, 1897, the product of the Willson Carbide Works Company at Merritton was 574 tons of calcium carbide, valued at $34,440, the average number of workmen employed being 30, and the amount of wages paid for labor, $12,544.62. Last year the product of the works increased to 1,040 tons, valued at $55,976, the average number of men employed was 35 and the amount of wages paid for labor was $16,397.95. The only interruption to operations during the year was caused by a cyclone which swept over the town and destroyed a number of buildings, among them being one of the power-houses of the company. The damage to the power-house was quickly repaired, however, and meantime the mill and furnace were run at a reduced capacity. The demand for calcium carbide continues to be very satisfactory, more indeed than the Merritton factory has been able to supply. But although this is the case the selling price at the works has been reduced by $6 per ton. Further reductions will no doubt be made when larger works are erected, and more experience is gained in processes of manufacture. Important advances are likely to be made during the present year as a result of recent methods and tests.

GRAPHITE AND MICA.

The graphite mine in Brougham township was worked during only six months of last year. In that time 300 tons of ore were raised, valued at $6,000. Ten workmen were employed.

Mica has been discovered at a number of points during the last few years, chiefly in Muskoka and Frontenac. At most of the properties however, operations have not got beyond the development stage, and the returns show that only one of them was a producer last year. The Stoness-Kent mica mine, which is on lot 4 in the thirteenth concession of Bedford township, produced 34 tons of mica, valued at $7,500. From 12 to 18 men were employed. Only small lots were taken out at other locations. Mica for boiler covering is growing actively in demand.

PIG IRON AND IRON ORE.

The following table gives the statistics of the Hamilton blast furnace for the three years it has been in operation:

Schedule.	1896.	1897.	1898.
Ore smelted, tons.....	51,138	37,492	77,023
Scale and mill cinder, tons...	5,883	5,350	8,614
Limestone for flux, tons.....	8,657	9,473	13,799
Coke for fuel, tons.....	30,348	27,810	50,407
Pig iron product, tons.....	28,302	24,011	48,253
Value of product	$353,780	$288,128	$530,789
Wages for labor	$ 47,000	$ 40,000	$ 61,476
Average workmen, No.....	125	130	130

The proportion of Ontario ores used in the furnace last year was 27 per cent. of the whole, being 20,968 tons, whereas in 1897 it was only eight per cent. Two mining companies, whose operations were carried on chiefly in Hastings county, raised during the year 27,400 tons, nearly all of which was shipped to

Hamilton. Its selling price at the mines is given in the returns as $48,875, or $1.78 per ton. At the furnace the value of Ontario ores smelted was $62,904.81, or $3 per ton, which is the same rate as for American ores. The value of mill cinder at the furnace was $17,229.22, of limestone for flux $11,039.44, and of coke for fuel $158,783.22. The total value of raw materials and labor at the furnace was $479,597.64, and the total value of pig iron product $530,789. At the iron mines an average of 100 men were employed whose wage earnings were $26,700, and the value of ore mined, computed at the selling price at the mines, was $48,875.

COPPER AND NICKEL.

There has been a stir in the copper and nickel mines during the past year, and a number of new properties have been developed. Besides the mines in the Sudbury district, several locations north of Lake Huron, in the vicinity of Bruce Mines, have been receiving the attention of prospectors and capitalists. The Joseph Powers Syndicate on the Missisaga river has sunk one or two shafts, the old mines at Bruce Mines have been unwatered with a view to the resuming of operations there, and a new company has been opening up large showings of ore at Rock Lake, in Coffin township (now called Aberdeen). This last venture has been acquired by a syndicate now organized as the Rock Lake Mining Company, with an authorized capital of $1,000,000. The locations are situated about 10 miles north of Bruce Mines station, and comprise an area of 1,400 acres. The vein has been traced on the property for a length of three miles, and samples of float ore may be picked up to the south of it a long distance. Work was commenced in April of last year upon an outcropping of ore about 300 feet above the level of Rock Lake, and two adits 1,200 feet apart have been driven in from opposite sides of the ridge which holds the vein that prove its thickness to be 16 to 17 feet. A shaft is in course of being sunk, and test pits have been dug at various points, which indicate that the vein is well mineralized throughout its whole length. Work has also been resumed on Michipicoten island, where native copper occurs in amygdaloid trap and conglomerate, but although good samples are shown and rich outcroppings have been discovered, enough work has not yet been done for a judgment to be formed of their extent and value. In the township of Garson, about ten miles north of Sudbury, a copper-nickel deposit was opened last year, and a furnace to smelt the ore was in course of construction. North of Markstay station also active development work has been carried on and extensive bodies have been exposed, some of which carry gold as well as copper and nickel. The Canadian Copper Company, however, is the principal operator, and several new mines have been developed by this company. The following table shows for the seven years, 1892-98, the quantities of ore raised and smelted in the Sudbury district, and the per cent. of metallic contents in the ore smelted each year:

Year.	Ore raised. Tons.	Ore smelted. Tons.	Per cent. of metallic contents in ore smelted. Nickel.	Copper.	Cobalt.
1892.....	72,349	61,924	3.36	3.19	.1007
1893.....	64,043	63,944	2.21	2.38	.0800
1894.....	112,037	87,916	2.92	3.14	.1721
1895.....	75,439	86,546	2.67	2.73	.....
1896.....	109,097	73,505	2.67	2.54	.....
1897.....	93,155	96,093	2.08	2.80	.....
1898.....	123,920	121,924	2.28	3.43	.....

The total quantity of ore raised in the seven years was 650,040 tons, and the quantity smelted 591,852 tons. Last year's output alike of the mines and smelters was considerably more than in any previous year. It will be noticed that the increase in ore smelted has been almost steadily continuous from year to year, and while last year's record was more than 25 per cent in excess of the previous year it was nearly 100 per cent more than in 1892. The percentage of nickel contents is fairly well maintained, but the percentage of copper was higher last year than in any one of the seven years.

The total number of workmen employed last year was larger than in any previous year excepting 1892 and 1894, and the amount of wages paid for labor was larger than in any year excepting the first. The aggregate amount of wages paid for labor in the seven years was $1,929,894, or an average of $489.45 per year; for last year the average was $493.74, which is higher than for any of the other years excepting 1893 and 1896. In the seven years the quantity of ore smelted was 591,852 tons, which on being reduced to matte gave 80,929 tons ordinary, and 4,233½ bessemerized matte, or in the proportion of 100 to 14.38. The estimated metallic contents of matte product in the seven years are 14,852½ tons, or 29,705,000 lbs. nickel; 17,285¼ tons, or 34,570,500 lbs. copper, and 30¾ tons, or 61,500 lbs. cobalt. At the selling price of matte at the furnaces, which is the form in which it is exported to the refineries, the total value of nickel product for the seven years has been $3,294,060, of copper $1,302,805, and of cobalt $14,613, or a total of $4,611,478. The selling value of last year's product was $782,300, the estimated quantities being 4,567,500 lbs. nickel and 8,373,500 lbs. copper. Comparative values of the metallic contents of the matte based on the selling price at the works are given for the seven years in the next table:

Year.	Nickel per ton. $	Nickel per lb. cents.	Copper per ton. $	Copper per lb. cents.	Cobalt per ton. $	Cobalt per lb. cents.
1892.....	283.81	14.190	119.90	5.995	436.82	21.841
1893.....	275.08	13.754	80.50	4.025	494.73	24.736
1894.....	238.36	11.918	71.23	3.561	461.54	23.077
1895.....	174.83	8.741	68.02	3.401	.....	.....
1896.....	183.22	9.166	69.94	3.497	.....	.....
1897.....	179.91	8.995	72.75	3.637	.....	.....
1898.....	184.72	9.236	64.02	3.201	.....	.....

These figures show a slight rise in the value of nickel compared with the averages of the previous three years, but a large decrease compared with the first three years of the period. In the case of copper the lowest point of the period was reached last year, although the price of copper had gone up to a point not reached during many years. Obviously the value should be considerably higher than it appears.

GOLD AND SILVER.

Gold was produced last year at 17 locations, but as only four of these have reported an output in excess of $20,000 it will be readily understood that a large majority of them are yet only in the early prospecting stage. The leading ones are the Sultana, the Mikado, the Regina and the Belmont. The Regina however was closed down for five months, during reconstruction of the mill. The Foley was also idle for the greater part of the year, pending a sale of the property in England. In the eastern part of the province the Belmont and Deloro mines promised well at the beginning of the year, but unfortunately the mill of the Deloro was destroyed by fire early in the spring, and a new one erected in its stead was not completed until the close of the year. Both of these mines give assurance of good results for the present year, and in the west the outlook is very hopeful. The following table gives the statistics of gold mines and mills in the province for the five years, 1894-98:

Schedule.	1894.	1895.	1896.	1897.	1898.
Mines worked	4	8	8	9	17
Men above ground	40	126	103	222	296
Men under ground	52	111	86	216	284
Ore treated, tons..	2,428	6,500	13,292	27,589	57,895
Gold product, oz..	2,022½	3,038	7,154	11,412	16,261
Gold value $32,776		$50,781	$121,848	$190,244	$275,078
Labor wages paid.$38,032		$56,234	$91,210	$217,766	$290,919

The total quantity of ore milled during the seven years, 1892-98, has been 116,074 tons, and the value of gold product was $740,587, being an average of $6.33 per ton. This is proof of the low grade character of the ore, but as nearly all of it is free milling, it is high enough to earn a good margin of profit when development is sufficiently advanced to provide an ample quantity to keep the mills running steadily. It will then be possible to select the ore, instead of treating all that comes from the mines. Therefore an increase of average may reasonably enough be looked for, unless, as seems likely, some extensive low grade deposits are worked on a large scale.

THE PRACTICAL MAN.

LUBRICANTS FOR CUTTING TOOLS.

Material.	Turning.	Chucking.	Drilling.	Reaming.	Tapping Milling.
Tool Steel...	Dry or Oil	Oil or Soda Water	Oil	Lard Oil	Oil
Soft Steel...	Dry or Soda Water	Soda Water	Oil or Soda Water	Lard Oil	Oil
Wro'ht Iron	Dry or Soda Water	Soda Water	Oil or Soda Water	Lard Oil	Oil
Cast Iron...	Dry	Dry	Dry	Dry	Dry
Brass	Dry	Dry	Dry	Dry	Dry
Copper	Dry	Dry	Dry	Mixture	Dry
Babbitt	Dry	Dry	Dry	Dry	Dry
Glass.....Turpentine or Kerosene.					

Mixture is one-third crude petroleum and two-thirds lard oil. When two lubricants are mentioned the first is preferable. Oil is sperm or lard; sperm is preferable.

To Harden Cast Iron.—Many times it is very convenient to make an article of cast iron that needs to be finished, and which should be very hard. Cast iron can be hardened as easily as steel, and to such a degree of hardness that a file will not touch it. Take one-half pint vitriol, one peck common salt, one-half pound saltpetre, two pounds alum, one quarter pound prussiate potash, one-quarter pound cyanide potash; dissolve in ten gallons soft water. Be sure that all the articles are dissolved. Heat the iron to a cherry red, and dip it in the solution. If the article needs to be very hard, heat and dip the second and even the third time.

Annealing Cast Iron.—To anneal cast iron, heat it in a slow charcoal fire to a dull red heat; then cover it over about two inches with fine charcoal; then cover with ashes. Let it lie until cold. Hard cast iron can be softened enough in this way to be filed or drilled. This process will be exceedingly useful to iron founders, as by this means there will be a great saving of expense in making new patterns.

To make a casting of precisely the same size of a broken casting without the original patterns.—Put the pieces of broken casting together and mould them, and cast from this mould. Then anneal it as above described; it will expand to the original size of the pattern, and there remain in that expanded state.

How to Anneal Brass or Copper.—In working brass and copper, it will become hard, and if hammered to any great extent will split. To prevent cracking or splitting, the piece must be heated to a dull red heat and plunged in cold water; this will soften it so it can be worked easily. Be careful not to heat brass too hot, or it will fall to pieces. The piece must be annealed frequently during the process of hammering.

The Relative Weight of Different Metals.—The weight of wrought iron being 1, cast iron will be .95, steel 1.02; copper 1.16, brass 1.09, and lead 1.48.

Weight of Castings.—If you have a pattern made of soft pine, put together without nails, an iron casting made from it will weigh sixteen pounds to every pound of the pattern. If the casting is of brass, it will weigh eighteen pounds to every pound of the pattern.

A metal that will expand in cooling is made of 9 parts lead, 2 parts antimony, and 1 part bismuth. This metal will be found very valuable in filling holes in castings.

Lead Explosions.—Many mechanics have had their patience sorely tried when pouring lead around a damp or wet joint to have it explode, blow out or scatter from the effects of steam generated by the heat of the lead. The whole trouble may be avoided by putting a piece of resin, the size of a man's thumb, into the ladle and allowing it to melt before pouring.

Glue.—A little powdered chalk added to common glue makes it much stronger; and a glue that will resist the action of water may be made by using skimmed milk instead of water. A few drops of vinegar put in mucilage will keep it from spoiling.

To Sharpen Reamers.—Hand reamers, when dull through wear, should be stoned first on the face of the flutes, then on top of the flutes. The stone should be always held perfectly flat with the face and clearance that the original shape of the flutes may be preserved. End cutting reamers should be first turned on centres with a wheel, and then recleared to insure reaming a hole the same size of reamer. The Norton Emery Wheel Co. makes an emery stone for the purpose, which is well adapted, and is said to give quicker results than any oil stone. The stone should be kept clean by the use of turpentine.

ICE BREAKING.

There was built last year in the shipyards of Sir W. G. Armstrong, Whitworth & Co., an ice-breaking steamer for the Russian Government, designed by Vice-Admiral Makaroff, and her business is to be to keep some of the principal ports of the Baltic open during the winter. From "Engineering" we take the following account of her first voyage:

Admiral Makaroff first met the ice in the Baltic. It was drift ice, apparently about five feet thick, and judging by the report of Mr. Gulston, of Newcastle, who accompanied Admiral Makaroff on his voyage, there seems not to have been the slightest difficulty in getting the "Ermack" through this obstruction, as she went comparatively easy at nine knots, the engines working slowly. Before going into the ice the engines had been slowed down to ten knots, so as to reserve the powers of the engine-room staff for the harder work which was to come. The worst piece of ice which was encountered was estimated at twenty-five feet thick, and the ship went nearly through this formidable obstruction before she was brought up by it. Accurate measurements were taken as soon as possible and the report reads that the field ice was five feet in thickness, the pack on top was nine feet, and there was ice below the field amounting to eleven feet, so far as could be measured, but there may have been more, as there was no means of measuring further below the bottom of the field. It was evident that a large mass of ice had been washed off a shoal and frozen on the field. The worst field ice that they had much of was apparently four feet thick, with snow on top of it. The snow seems to be the greatest impediment to the vessel's progress, as the designers of the ship had always been led to expect. Mr. Gulston reports that twelve inches of snow was a serious impediment, and eighteen inches almost blocks her. This is, of course, on the top of thick field ice. The ice generally in the Baltic seems to have been much more serious this winter than was expected, and it is said to be beyond 1883, which we gather was a record winter. The "Ermack" did not run continuously, but rested at night and started early in the morning, working with the searchlight. There was apparently no difficulty in starting, although the ship had become fast in the ice. Ice anchors were put out, and the vessel was warped backwards from her berth, after which she started without difficulty. One of the most satisfactory features is that she steers, as Mr. Gulston says, "In any way, at any time, in any ice." This has never been the case with any ice-breakers that have previously been built, and is no doubt due largely to the form of the ship, for there is no flat place on her side, either vertically or horizontally, so that unless absolutely frozen in solid she can be given some movement, and can thus be worked loose by her own propellors and by ice anchors laid out. Her arrival at Cronstadt was evidently an extraordinary sight. The ice was about eighteen inches thick, with a good deal of snow on the top, and the ship steamed through this at six and a half knots up to the sea wall and past the battleships. She swung around on the port hand and entered the harbor through an entrance only ninety-five feet wide; the ship itself is seventy-one feet beam. She swung once in the inside harbor, and one charge astern put her into her berth alongside the coal store. Some manœuvering trials were made in ice of about two feet to three feet in thickness when the turning circle was found to be about six hundred feet, and there was apparently very little difference in which direction the ship was turned. The effect of the bow propellor was most marked, and it seems practically to be that if the bow propellor is stopped, the ship stops, too.

Mr. Gulston examined the ship both inside and outside, as far as he could, and could find absolutely no sign of weakness. The outer skin has been polished bright where the vessel has been running through the ice; but there is no sign of breakage anywhere. The ice varied enormously in quality. Drift ice was passed through, and appeared to offer practically no impediment; pieces described as quite two to three acres in extent were pushed aside, the ship moving through quite easily. Pack ice with eighteen inches of snow on top, seems to have been the greatest difficulty.

The " Ermack " is 305 feet long, 71 feet beam, and 42 feet 6 inches deep. She is capable of developing 12,000 horse-power, and of making 16 knots an hour. She has four screws, all four-bladed, and varying in diameter from 13 feet to 14 feet 6 inches. The blades are enormously thick, and made of very strong cast-steel, are calculated to be brought up by the ice when the vessel is running at full speed without breaking. The draught of the vessel is calculated to be 19 feet, in fresh water, and 25 feet when working in the Kara Sea, with 3,000 tons of deadweight. The screws are arranged, three at the stern and one at the bow.

Reference should be made to the arrangements for coupling up this ship with another or others, in order to make a train of ships for more effectively dealing with thick ice. Although the " Ermack " is so big and strong a ship, there is, of course, a limit to her capacity of breaking up ice, and to the speed with which she could perform the operation. A vessel pushing astern of her would supply additional power to do the work. Forward the stem is set at an angle of seventy degrees from the vertical. So in going through the ice she would slide up, raising her bow, and this would cause the ice to break down. She might, of course, mount the ice until her forward propeller came into contact with it; but, as has been said, this is made of sufficient strength to stand the shock. That, however, is not what is expected generally to occur, as the form of the bow is designed to keep breaking down the ice continuously. Of course this would absorb an enormous amount of power; but if another vessel, either an ice-breaker or an ordinary steamer, were pushing astern, naturally the speed would be increased. Moreover, a vessel not so strongly built as the " Ermack " would be protected by following close behind her. For this reason a recess has been built into the counter of the ship. This recess is designed to take the stem of the following vessel, arrangements being made for lashing the latter in firm contact with the leading craft. It may be mentioned that the " Ermack " has also a specially strong towing windlass abaft.

ACCIDENTS OF THE MONTH.

An explosion occurred in the Blockhouse, N.S., gold mines, Sept. 13th, resulting in the death of one man and the serious injury of another.

S. Gagnon, a young apprentice in Gilmour & Hughson's sawmill at Ottawa, was killed while attempting a horizontal bar act on a fast revolving shaft which turns beneath the mill.

H. Dooley, Division street, Ottawa, 25 years of age, a mill-hand at J. R. Booth's sawmills, while at work, Sept. 14th, was caught between two rolls six inches apart and drawn in front of a five-foot circular saw, and was mangled in such a way as to die shortly afterwards.

J. Benoit, about forty years of age, living at 18a Soulanges street, Point St. Charles, Montreal, was killed instantly at the G.T.R. shops, a short time ago. He was struck violently on the chin and side of the head by some machinery operated by shafting, and his brains scattered.

W. A. M. Pollock, electrician, in the employment of the Almonte, Ont., Electric Light Company, met with a fatal accident, Sept. 18th. While working with a large driving belt he was caught and drawn into the wheels. One arm was torn from his body at the elbow, and he was hurt internally. He died two hours later. It took over an hour to extricate him.

TORONTO EXHIBITION NOTES.

D. K. McLaren, leather belting and mill supplies, Montreal and Toronto, had a fine exhibit of various kinds of belting, and a great variety of textile and other mill supplies.

The Still Motor Co., successors to the Canadian Motor Syndicate, had two storage battery vehicles in the Machinery Hall, and one in constant operation through the grounds.

The Royal Electric Co., Montreal and Toronto, had the whole of the eastern end of the central tier of exhibits, where a great aggregation of motors, transformers, dynamos, meters and switch-boards were shown. Among these was a 3,000-light machine and a 2,000-light and 1,500-light machine, all of which were sold. It was the most comprehensive exhibit in the fair in the electric line.

The Northey Mnfg. Co. had a small building all to themselves, near the western entrance to Machinery Hall, where several of their well-known Imperial gas engines were in operation, and attracted a large number of investigators.

The Robb Engineering Co. had an exhibit of the celebrated Robb-Armstrong engines, which are now known not only all over Canada, but in many foreign countries, where they have gained acceptance in competition with the best makers in the world.

The Dodge Mnfg. Co., manufacturers of pulleys, had an imposing trophy formed of their celebrated wood split pulleys, which were also to be seen in actual use on many other exhibits. This company are the largest manufacturers of wood pulleys under the British flag.

A. W. Spooner, of Port Hope, " the handsomest town in Canada, and the only place in the world where Spooner's copperine is made," had a striking display of copperine. The genial owner of this metal reports that it continues to grow in popularity among engineers.

The Northey Mnfg. Co., are showing gas and gasoline engines in great variety. Machinery Hall exhibit contained a combination gasoline or gas engine, which is used for operating a pump. To the right of the western entrance they had a building in which the bulk of their exhibit commanded much attention from the visitors.

Cowan & Co., of Galt, only showed wood working tools although they manufacture the Corliss pattern of engine. They publish a very complete catalogue showing the different styles made by them. Their exhibit comprised 12-in. moulders, planers and matchers, band saw filers and " Clark " pattern band saw set, and one power feed rip saw. The Cowan people are advocates of the fast gear type of machine gearing, and their arguments are interesting and instructive.

Just outside the east end of Machinery Hall was a complete exhibit of road-making machinery shown by the Good Roads Machinery Co., of Hamilton. It consisted of a Champion rock crusher, a road roller, a mud scraper, a road grader and road ploughs. Mr. Challen, the manager, was always surrounded by an interested crowd of enquirers. He reported that the Government of New Brunswick had adopted the Good Roads Machinery Co.'s system, their latest order being a No. 4 mounted crusher, a 12-ton steam roller, a McAdam spreading wagon, and other machinery.

One of the most attractive exhibits was that of the Jones & Moore Electric Co., of Toronto. They exhibited a complete line of electric motors up to 40 h.p., as well as several direct current dynamos, enclosed arc lamps, telephones for private lines, etc. This firm make a specialty of lighting and power plants for factories and mills. Some of the plants on order and installed are: D. S. Perrin & Co., London, 400 light dynamo; A. R. Williams Co., Montreal, 80 light dynamo; Gadsby & McCann, Toronto, 20 h.p. motor; Massey-Harris Co., Toronto, 20 h.p. motor; Meaford Woolen Mills, 80 light dynamo; Toronto Grain and Seed Cleaner Co., Toronto, 20 h.p. motor; McFarland, Gray & Southgate, Toronto, 8 h.p. motor. They now have over 500 machines in daily operation.

In Machinery Hall this year power was supplied to the line shafting and individual machines by different makes of engines. The Corliss type, the well known Wheelock and the Ideal; one of the Wheelock 100 h.p. being the purchase of the Industrial Fair for Machinery Hall. The Still Motor Company exhibited one of their motor carriages, and the company have, owing to the great number of orders, been unable to spend time in preparing exhibition goods. One of the features of Machinery Hall was the Hardill tandem compound engine exhibit. This new engine was patented in Canada in January, 1899. A company has been formed in Mitchell, Ont., to manufacture them. The engine exhibited was 5-in. H.P. and 8½-in. L.P. cylinders, and 7-in. stroke. In January and February of this year Prof. J. T. Nicolson, of McGill University, tested the economy of this engine and made a report on April 14th, 1899, a copy of which can be procured upon request. According to the report the engine showed 21½ i. h.p. working double acting. Prof. Nicolson says: " I am surprised at the economy shown by so small an engine. It is accounted for by the **compounding of the expansion** and the high speed."

At the close of the Exhibition a number of the exhibitors in the machinery hall met and presented Thomas Eversfield, the chief engineer, with a handsome bedroom suite in oak. The gift was accompanied with an address expressing the donors' appreciation of Mr. Eversfield's attention to the exhibits during the fair.

Rice Lewis & Son, Ltd., of Toronto, are to be complimented on the large and artistic display of parlor mantels, grates, tilings, railings and other interior house fittings. A tiled bath-room and two or three parlors were represented, and each exhibit was in excellent taste. The rooms were filled with an admiring crowd each day, and the display was voted the best of the kind in the Exhibition.

The Mica Boiler Covering Co., not content with having a boiler and a range of piping covered with their mica covering in the Machinery Hall, had their covering placed on several engines in other parts of the grounds where engineers could test for themselves the remarkable properties of mica for this purpose. All the pipes connected with the motive power in the Machinery Hall were covered with this material, which received much favorable comment.

The Luxfer Prism Co had a long dark gallery built, in one end of which was a swinging window fitted with Luxfer prisms. It was a source of never ceasing wonder to the thousands of visitors here that when the window was closed the whole gallery was lighted from end to end with a soft light, in which the colors of every object could be distinguished; but when the window was opened to the full light of the sky there was comparative darkness through the gallery, and no colors could be made out in the placards on the rear wall. As a means of shedding light in dark places everybody admitted that Luxfer prisms were a remarkable discovery.

LITERARY NOTES

The Daily Review is a new paper, which reaches us from St. John's, Newfoundland. This will be a welcome addition to the journalism of Great Britain's oldest colony in America.

Glaziers' diamonds of every known style and type are illustrated in the catalogue of A. Rudd & Co., St. Helens, Lancashire, Eng. This concern also makes nippers, vises, atmospheric soldering irons, and other tools for the manipulation of sheet, plate and stained glass work. Messrs. W. J. Woodburn & Sons, Montreal, are Canadian representatives.

The interesting history of the "Beginnings of the St. Lawrence Route." by Arthur Weir, B.Ap.Sc., Montreal, which recently appeared in The Canadian Engineer, has been reprinted in pamphlet form. Mr. Weir has gathered a great amount of hitherto unpublished matter in this essay, and has presented it in such an attractive form that many will be glad to have it in this convenient form for future reference. Although the edition is a very limited one the price is only 10 cents per copy.

The Quebec and Lake St. John Railway have published some books descriptive of the scenery on the line of their well known road, which also contain many good illustrations of the sportsman's variety. The names of the books are as follows: "Guide to the Lake St. John and its Tributary Waters;" "Ye Ancient Quebec," and "A Tale of Lake St. John." Any or all of these will be sent to any person interested. Their time tables are original in design, and much more complete in information and description than the ordinary run of railway folders.

Few people, except those who have made a special study of Canadian books, would believe that a mere catalogue of Canadian poets and their works would make a volume of 72 pages, and contain about 500 names. Such, however, is the array of Canadian versifiers presented by C. C. James, the Deputy Minister of Agriculture for Ontario, in a work just compiled by him for the Victoria University Library. Mr. James recently presented the University with what is probably the largest library of Canadian books of poetry yet collected, and this bibliography is his crowning tribute to the poetical literature of the country. It is from the press of William Briggs.

—A steel bridge will be erected over the Pembina River near Riviere, Man., to cost about $3,000. Another steel bridge will be built over the same river 20 miles south of Manitou.

QUEBEC ARCHITECTS' ASSOCIATION.

The annual meeting of the Provincial Architects' Association was held in Quebec city, Sept. 23. A. Raza, president, was in the chair, and presented the annual report, which states that the association now numbers 139 active members, of whom ten joined during the year. The meeting elected the following officers for the ensuing year: President, S. H. Capper; vice-president, G. E. Tanguay; second vice-president, Joseph Venne; secretary, G. O Monette; treasurer, W. A. Doran; council, Messrs. A. Raza, J. S. Archibald, E. Maxwell, A. Chausse, H. Staveley and A. H. Lapierre. The next meeting of the association will be held in Montreal in September, 1900.

THE GREAT LAKES COPPER CO.

Much interest is being taken by everyone realizing the value of the mineral industries to Canada in the plant now being established at Sudbury for treating the nickel-copper ores of that district by the Great Lakes Copper Co., of Sudbury, Ont. The president of the company is Jno. McKinley, 60 State street, Boston, and the superintendent is C. M. Boss. The plant is now in process of construction, and is to a certain extent experimental. The process is being patented in Canada, and when the necessary formalities have been completed this journal will publish a more extended notice of it. The great advantage attained by the use of the process of the Great Lakes Copper Co. is a reduction in the time of ore treatment. In fact it is said that instead of weeks only three days is required to produce nickel of 60 per cent. fineness from the ore.

GOOD WORK APPRECIATED.

The Canadian Engineer has a splendid report in this week's issue of the C.A.S.E. convention held in Berlin in August. The report is very full and accurate, and every engineer should obtain a copy. Mr. Smith, The Canadian Engineer's representative at the convention, deserves credit for the manner in which he looked after C.A.S.E. interests.—The News-Record, Berlin, Ont.

METAL IMPORTS FROM GREAT BRITAIN.

The following are the sterling values of the imports from Great Britain of interest to the metal trades in August, 1898-99, and the eight months ending August, 1898 and 1899:—

	Month of August.		Eight Months ending August.	
	1898.	1899.	1898.	1899.
Hardware	£2,115	£2,025	£14,617	£13,170
Cutlery	5,043	4,149	35,841	33,766
Pig iron	1,007	1,743	8,113	8,815
Bar, etc.	229	2,880	6,271	10,969
Railroad	—	1,363	6,972	58,591
Hoops, sheets, etc.	12,095	12,852	36,122	68,307
Galvanized sheets	7,270	4,643	39,341	40,117
Tin plates	12,571	20,175	96,169	118,266
Cast, wrought, etc., iron	1,454	7,903	16,662	32,315
Old (for re-manufacture)	—	421	3,574	2,424
Steel	2,542	9,134	35,185	52,760
Lead	3,668	5,111	19,726	32,440
Tin, unwrought	652	1,773	11,875	14,215
Alkali	3,139	2,850	27,558	21,508
Cement	2,671	2,700	14,824	18,939

—A Washington special to The Detroit Free Press says the United States War Department has referred the protests of their Lake Carriers' Association against the construction of the canal through Kent county, Ontario, connecting Lake St. Clair with Lake Erie, to Col. Leydecker, with the request for a full investigation and a report. Col. Leydecker will report both as to the probability that the project will find adequate financial support, and as to its effect upon the level of the lakes, should it be carried out. It seems probable that if it is found that the Canadian project is being seriously considered with any prospect of its being actively entered upon in the near future, the State Department will take the matter up with the Canadian Government on the basis of a proposition to appoint a commission, which was earnestly advocated by Col. Leydecker and his colleagues in their report on the Sault power canal.

NICKEL EXTRACTION BY THE MOND PROCESS.*

BY SIR. WILLIAM CHANDLER ROBERTS-AUSTEN.

The rules of the institution provide that an associate shall submit a paper within a year of his election. In complying with this direction, the author was satisfied that no better subject could be selected for consideration than the interesting process which marks an entirely new departure, in metallurgical practice, from the principles which have hitherto guided it. This process depends on the remarkable property possessed by nickel of forming a volatile compound with carbonic oxide, or, as it is called in modern chemical nomenclature, carbon-monoxide. When this gaseous compound is heated to 180° C. nickel is released in the metallic form.

The author was much impressed during a recent visit to Canada with the imperial importance of the great nickeliferous district of Sudbury, Ontario. In view of the magnitude of this deposit, the annual production of metallic nickel in Canada seems inadequate, as it has hitherto not exceeded 2,750 tons. The description therefore of any new process which affords a hope of hastening the development of this remarkable district should prove to be interesting. The deposit itself presents many points of interest. According to Professor Coleman, of Toronto, the nickel ores of Ontario resemble the gold ores of Rossland in British Columbia, as they consist of a mixture of pyrrhotite (magnetic pyrites) and copper pyrites. These sulphides form enormous masses near the margin of large areas of diorite, or weathered gabbro of Huronian age, the amount of nickel contained in the ore averaging between 2½ per cent. and 10 per cent., the lower proportion being the more common. It is worthy of note that pyrrhotine from other parts of the country, found in association with Laurentian rocks, is almost barren of nickel. The importance of the nickel deposits of Ontario may be judged from the fact that, until the mines in the Sudbury region were worked, the world's supply of the metal was drawn chiefly from the mines of New Caledonia, an island in the Southern Pacific, supplemented by the Gap mine in Pennsylvania, and a few isolated mines in Norway and Hungary. The extent of the Sudbury deposits is greater than any of these, and New Caledonia, which belongs to France, is virtually the only rival of Ontario in the production of nickel.

The ore at Sudbury is smelted into a regulus, or matte, which contains between 12 per cent. and 20 per cent. of nickel, and about the same amount of copper, although usually there is rather more copper than nickel. This matte may be enriched by suitable treatment, and is "bessemerized" into a regulus which contains about 40 per cent. of nickel, and is especially free from iron, as the following analyses show:

	I.	II.
	Per cent.	Per cent.
Nickel	40.938	31.35
Copper	45.714	48.86
Iron and (Al_2O_3)	0.405	0.81
Cobalt	0.136	.....
Sulphur	11.960	...

It is unnecessary to give a history of the metallurgy of nickel, but it may be well to state that Chronstet isolated the metal in the year 1751, and that Bergman confirmed his discovery in 1774. The methods hitherto employed for extracting the metal from its ores are very complicated; they have involved concentrating the nickel either as a sulphide (matte or regulus), or as arsenide (speise) followed by either "dry" or "wet" treatment. In the case of certain ores, wet methods only have been employed. The metallic nickel has always to be subjected to a process of refining, mainly, as in the case of cast iron, with a view to separate it from associated carbon.

As regards the process which forms the subject of this paper a few brief historical details may be offered. In 1889 Dr. Ludwig Mond, F.R.S., in collaboration with Dr Carl Langer was engaged in working out a method for eliminating the carbon-monoxide from gases containing hydrogen[1] which they wanted for use in their gas battery[2]. In attempting to effect this, they were guided by the observation they had previously made that finely divided nickel has the remarkable property of removing carbon from carbon-monoxide at a temperature of 350 C., converting it into carbon-dioxide, while the dissociation of carbon monoxide by heat alone, according to Victor Meyer and Carl Langer, remains incomplete at the high temperature of 1,690° C. In the course of these experiments, which they carried out in conjunction with Dr. Friedrich Quincke[3], finely divided nickel formed by reducing nickel oxide at 350° C., by hydrogen, was treated with pure carbonmonoxide in a glass tube at varying temperatures. In order to keep the poisonous carbon-monoxide out of the atmosphere of the laboratory the gas escaping from the apparatus was ignited. They found to their surprise that while the tube containing the nickel was cooling, the flame of the escaping gas became luminous and increased in luminosity as the temperature sank below 100° C. Metallic spots were, moreover, deposited on a cold plate of porcelain held in this luminous flame, just as spots of arsenic are obtained in applying the Marsh test for that metal. It was also observed that on heating the tube through which the gas was escaping, a metallic mirror was obtained, while the luminosity of the flame disappeared. On examination these metallic deposits were found to be pure nickel. The next step was to endeavor to isolate this curious and interesting nickeliferous compound, by preparing nickel with great care at the lowest possible temperature, and treating it with carbon-monoxide at about 50° C. The amount of the volatile nickel compound in the gases passing through the apparatus was thus gradually increased. The gases issuing from the apparatus were treated with a solution of cuprous chloride to absorb the excess of carbon-monoxide, and in this way a residue of several cubic centimetres of a colorless gas was obtained, containing the volatile nickel compound. By passing this gas through a heated tube the nickel and carbon-monoxide were again separated, and the volume of the carbon-monoxide thus set free was found to correspond to about four equivalents of carbon-monoxide to one equivalent of nickel. By further improving the method of preparing the finely divided nickel, and by passing the resulting gases through a refrigerator cooled by snow and salt, the investigators at last succeeded in obtaining the new compound in a liquid state, and were able to produce it with facility in any desired quantity.

Nickel carbonyl in its pure state is a colorless liquid boiling at 43° C.; it has a specific gravity of 1.3185 at 17° C., and solidifies at—25° C. into needle-shaped crystals. It is soluble in alcohol, petroleum and chloroform; and it is not acted upon by dilute acids or alkalies. It can be readily distilled without decomposition, but on heating the vapor to 150° C., it is completely dissociated into its components, pure carbon-monoxide being obtained, while the nickel is deposited in a dense metallic film upon the sides of the vessel in which the compound is heated.

After the production of nickel carbonyl had become easy, Drs. Mond, Langer and Quincke directed their attention to the action of carbon-monoxide on other metals. A series of experiments was made with a view to obtain a similar compound with cobalt, which in its chemical and physical behavior so much resembles nickel. The experiments gave, however, the unexpected result that, unlike nickel, cobalt will not combine with carbon-monoxide. Experiments were then made with iron and indications were soon obtained of the existence of a volatile compound of iron and carbon-monoxide; a long time elapsed before this new compound was obtained in a pure state. It was finally isolated in a way similar to that by which the nickel carbonyl had been prepared, and proved to be a somewhat viscous liquid of pale yellow color[4]. Its specific gravity at 18° C. is 1.4664; and it distils completely without decomposition at 102.8° C. under a pressure of 749 millimetres of mercury. When cooled to —21° C. it solidifies into a mass of yellowish needle-shaped crystals. Its chemical composition is somewhat different from the nickel carbonyl, as it contains five equivalents of carbon-monoxide to one of iron. The liquid compound, to which the name of iron penta-carbonyl was given, undergoes no change when protected from the action of light, but exposure to daylight for several hours in a sealed tube is attended with the formation of gold-colored, tabular crystals, and carbon-monoxide is evolved, so that the pressure in the tube rises con-

*This paper on the Mond Process by Sir. W. C. Roberts-Austen, D.C.L., F.R.S. was read before the Institution of Civil Engineers, London, England, on 8th Nov. 1898.

[1]Ludwig Mond and C. Langer. "Improvements in obtaining Hydrogen," British Patent No. 12,608, 1888.

[2]Ludwig Mond and C. Langer. "A new form of gas battery." Proceedings of the Royal Society, vol. xlvi. p. 296

[3]Ludwig Mond, C. Langer, and F Quincke. Journal of the Chemical Society. vol. lvii., p 749.

[4]Ludwig Mond and Carl Langer on "Iron Carbonyls." Journal of the Chemica Society, vol. lix. p. 1090

siderably. The crystals have, when dried, a metallic lustre, and resemble flakes of gold; they contain two equivalents of iron to seven equivalents of carbon-monoxide. None of the other metals which were submitted to investigation showed indications of combining directly with carbon-monoxide.

The discovery that in a mixture of metals only nickel and iron would form volatile compounds with carbon-monoxide, and that they could, therefore, be separated from the other metals, was sufficiently important to induce Dr. Mond to arrange laboratory experiments with ores containing nickel, cobalt, iron, copper, etc., such as "kupfer-nickel" and "pyrrhotite." The experiments afforded such promising results, that apparatus of considerable size, though still well within the limits of the resources of a laboratory, was set up, and in it several pounds of ore could be treated with carbon-monoxide.* A patent was also applied for on the 12th August, 1890, which describes the way in which such ores may be treated. It is pointed out that the principal nickel ores which are metallurgically treated contain the nickel in combination with arsenic and sulphur besides other metals and gangue. These ores have first to be submitted to the process of calcination, in order that the nickel may be present in the form of oxide, and to drive off, as far as is practicable, the arsenic, sulphur, and other volatile bodies. The resulting oxide of nickel is treated with reducing gases, such as water-gas or producer-gas, in order to convert the oxide of nickel into finely divided metallic nickel; the material containing it then is cooled to about 50° C., and is treated with carbon-monoxide. In dealing with nickel ores which contain

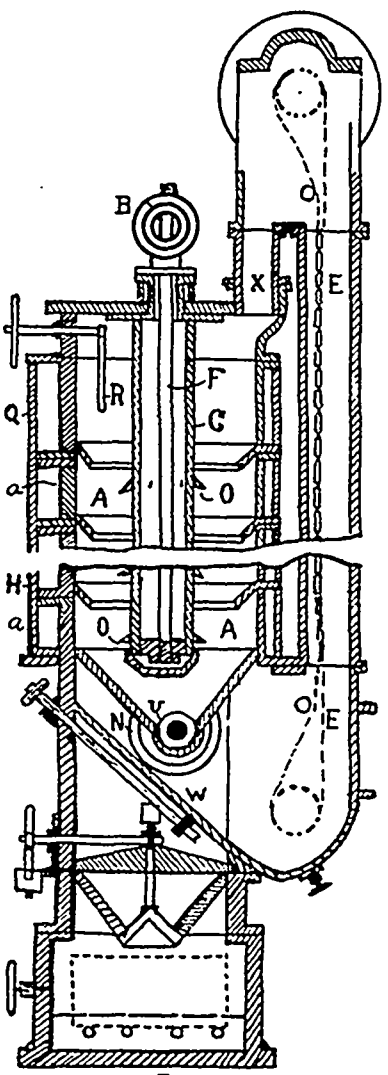


FIG. 1.

nickel oxide in chemical combination with silicic acid, arsenic acid, or other substances which cannot be removed by calcination, the ores are so treated as to convert the nickel into nickel speise or nickel matte, which is then subjected to calcination.

In 1892 an experimental plant on a large scale was erected at Smethwick, near Birmingham. After some years of patient work, during which the plant had several times to be reconstructed, in order to meet all the conditions of this somewhat delicate process, the plant gradually assumed the shape shown in Figs. 1. Before describing it in detail it will be well to give a brief account of the operations involved in the process, which are the outcome of many years of practical experience.

The process is more especially suitable for the extraction of nickel from ores which contain copper in addition to nickel and iron. These ores, which have on an average between 2 per cent. and 6 per cent. of nickel and about the same amount of copper, are first subjected to "heap roasting," to eliminate the greater part of the sulphur, and to convert the iron which forms their chief constituent into oxide. The roasting is necessary to enable the iron in the following operation of smelting to combine with the silica present in the ore to form a slag, and thus to effect the separation of the iron from the nickel and copper which unite with the remainder of the sulphur to form a regulus or matte. This matte contains the nickel and copper in a more concentrated form, the amount of each metal being usually 15 per cent. to 20 per cent., the residue consisting mainly of sulphur and iron. To concentrate the nickel and copper still further, the matte is "bessemerized." A sample of such "bessemerized" matte is exhibited; it contains 31.37 per cent. of nickel, 48.62 per cent. of copper and 0.70 per cent. of iron. It was prepared by the Canadian Copper Company, Sudbury, Ontario, from their ores, which contain an average of 4 per cent. of nickel and 4 per cent. of copper. This "bessemerized" matte is crushed, ground, and subjected to a calcining operation so as to convert the sulphides into oxides, and it is then passed through a mill and dresser. This calcined bessemer matte then consists practically of nickel oxide and copper oxide in varying quantities. It has been found in the practical working of the process to be advantageous to further concentrate the nickel by extracting part of the copper at this stage by treating the mixtures of oxides with dilute sulphuric acid, which dissolves about two-fifths of the copper present without taking up more than 1 per cent. to 2 per cent. of the nickel. The copper thus dissolved is in the form of copper sulphate and is obtained in a marketable form by crystallization. The undissolved residue from this operation contains between 45 per cent. and 60 per cent. of nickel, and after drying it is subjected to a carefully regulated reducing process by means of water-gas, after which it is treated with carbon-monoxide to extract part of the nickel present. In this first treatment with carbon-monoxide about two-thirds of the nickel can be easily extracted; after this amount is volatilized the extraction becomes much slower, so that it has been found advantageous to recalcine the residues and repeat the copper extraction, the reduction, and the nickel extraction.

The five operations involved are diagrammatically illustrated in Fig. 2. The process begins, as will be seen, at one end with the material to be treated, "bessemerized" matte; it ends with the market product nickel. The "bessemerized" matte proceeds, as the arrow indicates, to the first operation (1) of dead roasting, and for this purpose any suitable furnace may be employed. After roasting, the matte contains 35 per cent. of nickel, 42 per cent. of copper, and about 2 per cent. of iron.* It then passes to the second operation (2) for the extraction of part of the copper (about two-thirds) by sulphuric acid, the copper being sold as crystallized sulphate of copper. The residue from this process contains about 51 per cent. of nickel and 21 per cent. of copper, and passes to the third operation (3) for reducing the nickel and incidentally the remaining copper, to the metallic state, care being taken to avoid reducing the iron. This is effected in a tower provided with shelves, over which mechanical rabbles pass, the reducing agent being the hydrogen contained in water-gas. The temperature does not exceed 300° C., and should be kept lower when much iron is present. From this tower the ore is conveyed continuously to the fourth operation (4) of volatilization, in which part of the nickel is taken away by carbon-monoxide and forms the compound nickel carbonyl. The formation of this volatile compound is effected in a tower similar to the reducing tower, but the temperature is much lower, and does not exceed 100° C. From the volatilizer, the ore is returned to the reducer (3), and it continues to circulate between stages (3) and (4) for a period varying between 7 days and 15 days, until about 60 per cent. of the nickel has been removed as nickel carbonyl. The residue from this operation, amounting to about one-third of the original calcined matte, and not differing much from it in composition, is returned to the first operation and then naturally follows the same course

*Ludwig Mond on "Metallic Carbonyls," Proceedings of the Royal Institution, vol. xiii., p. 668.

as before. The nickel carbonyl, produced in the fourth operation, passes to the decomposer (5) This appliance is either a tower or a horizontal retort, which is heated to a temperature of 180° C., so as to decompose the nickel carbonyl and release the nickel in the metallic form, either on thin sheets of iron or, preferably,

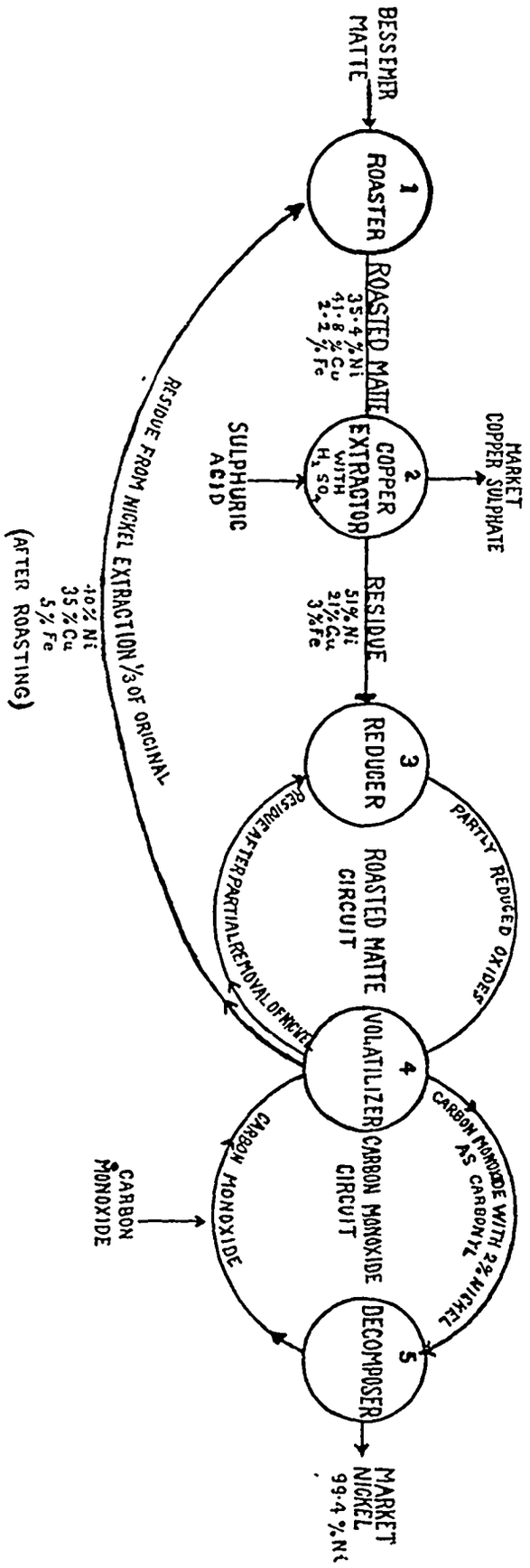


FIG. 2.

on granules of ordinary commercial nickel. Carbon-monoxide is also released, and is returned to the volatilizer to take up a fresh charge of nickel. It will be evident that, when the operation is in progress, the gaseous carbon-monoxide and the partially reduced oxides of nickel and copper are continuously revolving in two separate circuits which join and cross each other in the volatilizer (4). The commercial product contains between 99.4 per cent. and 99.8 per cent. of nickel.

It will now be possible to proceed to a description of the working as the author saw it in full operation in Smethwick a few months ago. The material under treatment during the author's visit was of Canadian origin, and had been received as calcined bessemer matte containing 35.4 per cent. of nickel, 41.8 per cent. of copper, and about 2 per cent. of iron. This material was first passed through a ball mill and dresser with a sixty-mesh riddle, and was then treated in quantities of 3 cwt. in a small lead-lined mixer with 200 lb. of ordinary sulphuric acid, which had previously been diluted with about 20 cubic feet of mother liquor from previous operations. These appliances are shown in the right hand portion of the plan and elevation, Fig. 1. The temperature of the mixture soon rises by the action between the copper oxide and the sulphuric acid, and is kept, by means of a steam-jet, at a temperature of about 85° C. for ½ hour. From this mixer, the charge is run out into a centrifugal hydro-extractor, provided with a filtering cloth, in which the solution of copper sulphate is separated from the solid residue containing the nickel. After the filtration of the charge is finished, the speed of the hydro-extractor is increased, and the residue is thus rendered sufficiently free from the liquor.

The solution containing the extracted copper runs from the hydro-extractor into a well, from which it is pumped into the crystallizing vats shown in the Figs. After a period of about eight days to ten days, the crystals of copper sulphate are taken out of the vats and the mother liquor is mixed with fresh acid and is again used for the extraction of copper. As already mentioned, a small amount of nickel and a little iron are also dissolved in the sulphuric acid during the copper extraction, so that the mother liquor from which the copper sulphate has crystallized becomes gradually contaminated with these two metals. It is therefore necessary to replace some of the mother liquor from time to time by fresh water, and to recover the nickel from the solution. The simplest method is to evaporate the solution to dryness and to roast the nickel and copper sulphates so obtained. The oxidized material is again introduced into the main process. The copper sulphate crystals from the crystallizing vats are charged into a second hydro-extractor, where they are washed with a little clean water to remove all acidity; they are then dried and are ready for packing. The copper sulphate thus obtained is sufficiently pure for the market, as it contains only 0.05 per cent. of nickel and 0.048 per cent. of iron.

The residue from the copper extraction is taken from the hydro-extractor and stored in a bin until a sufficient quantity has been collected to make up a charge of five to six tons for the nickel extracting plant. It now contains 52.5 per cent. of nickel, 20.6 per cent. of copper, and 2.6 per cent. of iron. The material is charged by hand at the rate of ½ ton per hour into a feeding-hopper described as the matte inlet in the lower part of the plan, figs. 1, plate 1, which communicates, through a rotary valve, with the conveyor, consisting of a tube enclosing a revolving spiral, which transports the material to an elevator. This lifts the material to the top of the reducing tower, and discharges it through another rotary valve into this reducing tower.

The reducer and the volatilizer (shown in the centre of Figs. 1), in which the treatment with carbon-monoxide takes place are fully described in Dr. Mond's patent (No. 23,665 of December 10th, 1895). The reducer consists of a vertical tower about 25 feet high, containing a series of shelves, which are hollow so as to admit of their being raised to a temperature of 250° C. by producer gas. The roasted matte falling on these shelves from above is stirred and made to descend from one shelf to that below it by rabbles actuated by a central vertical shaft. Water-gas passes up the tower to effect the reduction of the material. There are about fourteen of these shelves or trays in the tower. The five lower shelves are not heated by producer gas, but are cooled by a stream of water in order to reduce the temperature of the roasted and reduced matte to the temperature at which the volatilizer is worked.

The volatilizing tower resembles the reducer, but the shelves are not hollow, as there is no necessity to heat them. The reduced nickel requires a temperature of only 50° C. to enable it to combine with carbon monoxide and form a volatile compound, and the matte and gas are sufficiently hot to main-

*Average results are given in the Figure, rather than the best which have been obtained.

tain this temperature. In the plant at Smethwick the volatilizer was made the same size as the reducer, but in the new plant it is somewhat smaller.

The decomposer has been devised with much care, and has, in its present form, only recently been patented. The nickel is deposited in it, from its gaseous compound with carbon mon oxide, on granules of ordinary commercial metal. The arrangements by which this is effected are very ingenious, and may be described almost in the words of Dr. Mond's latest patent. The object is to obtain metallic nickel from nickel carbonyl in the form of pellets, which are specially suitable for the production of nickel alloys. For this purpose gases containing nickel carbonyl are passed through granulated nickel, which is kept at the temperature required for the decomposition of the carbonyl —about 200° C. The nickel which thus separates from the carbonyl becomes deposited on the granulated nickel, which consequently increases in size. In order to prevent cohesion of the granulated nickel, it is kept in motion. When a number of the pellets have attained a convenient size, they are separated by sifting without interrupting the depositing operation, the smaller granules being returned to receive a further deposit from the nickel carbonyl. A convenient form of apparatus for effecting the process described is shown in Figures 3, which represent vertical sections of the apparatus on planes at right angles to each other. A is a cylindrical vessel, preferably built up of short cylinders, *a a*, bolted together; it contains a central tube, C, provided with gas outlet holes, O, through which the gas containing nickel carbonyl, entering at the gas inlet, B, passes into the vessel which is filled with shot, or small granules, of nickel. The gas permeates through the interstices between these granules, and is brought into intimate contact with them, and when the nickel carbonyl is decomposed the nickel is deposited on the granules. The gases finally escape through the outlets, L, into the gas-exit pipe, M. In order to prevent the granules from cohering, they are kept slowly moving by continuously withdrawing some of the granules from the bottom of the cylindrical vessel, A, by means of a right and left-handed worm conveyor, U, which delivers the granules into two sifting-drums, N. The smaller granules fall on to the inclined plane, W, and collect at the base of the elevator, E, which conveys them again to the top of the cylinder, A, and feeds them through the feeding hole, X. In order to avoid the deposition of nickel from the nickel carbonyl in the central tube, C, it is kept cool by causing water to circulate down the tube, F, and up through passages F^1, formed in the central tube, to the water outlet, F^2. The cylindrical vessel, A, is surrounded by a wrought-iron casing, Q, which forms heating spaces, H, communicating with heating-flues, P, which are so arranged that the temperature of each cylinder can be separately regulated by dampers, so as to maintain the temperature of the granules of nickel contained in the vessel, A, at about 200° C., at which temperature the nickel carbonyl is decomposed. With a view to ascertain whether the cylinder, A, is full of granules, a rod, R, is fixed to the spindle of an external handle, which can be turned partly round, so that if the operator feels resistance to the motion of the R, it is certain that the granules extend to that height. The appliance used for depositing the nickel originally consisted of a series of retorts lined with thin steel sheets, on which the nickel was deposited in layers. It was found, however, that the metal so obtained was very difficult to cut, and the apparatus above described was accordingly devised.

A magnified section of a granule of nickel shows that there is a core of nickel which under higher magnification shows a crystalline and convoluted structure, and this core is surrounded by concentric layers. The central core is ordinary commercial nickel, and the layers are nickel deposited from its carbonyl. In some cases granules of deposited nickel are found without any central core. These have grown from minute fragments of deposited nickel which have become detached during the course of deposition.

The water-gas used in the reducer is generated in gas-producers. Anthracite is used to decompose the steam, and the water-gas is collected in a gas-holder, whence it is taken to the reducing tower, to which reference has just been made. This gas contains, on entering the reducer, about 60 per cent. of hydrogen. The reducing operation is so regulated that only a small quantity of hydrogen remains in the escaping gas, as a rule not more than 5 per cent. to 10 per cent. This waste gas is subjected to the action of a fine water-spray, which condenses the steam generated by the combustion of the hydrogen in the water-gas. Part of this waste gas is used for making the carbon-monoxide required in the volatilizer, by passing it through the C O retort charged with incandescent charcoal, which reduces the carbon dioxide contained in the waste gas, and this increases the amount of carbon-mononoxide in it. The gas issuing from this retort contains about 80 per cent. of carbon-monoxide, and is stored in another gasholder, which communicates with the main circuit of carbon-monoxide gas. The main circuit of the carbon-monoxide passes through the volatilizer already referred to, where the nickel is taken up. The carbon-monoxide, now charged with nickel, passes through a filter to separate the fine particles of matte-dust from the gases, then through an apparatus called the decomposer, and so described in the Figure. In this decomposer the nickel taken up in the volatilizer is deposited. The gas now deprived of its nickel passes to the C O blower, Figure 1, which sends the carbon-monoxide to the volatilizer in order that it may take up a fresh charge of nickel.

The solid material from which the nickel is being extracted is kept circulating through the reducer and volatilizer for a period varying between seven days and 15 days, during which time the oxides are gradually reduced to the metallic state and the nickel volatilized. When the material originally charged in has had the bulk of its nickel extracted it is run out through a rotary calciner roaster, Fig. 1, which converts the metals into oxides, so that they may be treated for the second time with sulphuric acid and carbon-monoxide. The ratio between the nickel and copper in the residues from the nickel extraction is practically the same as in the calcined Bessemer matte, with which the operations were started, but the amount of iron has increased by the removal of the copper and nickel, as the following figures show: Original matte contains, nickel, 35.27 per cent.; copper, 41.87 per cent.; iron, 2.13 per cent. After the first treatment of copper and nickel extraction, the quantities are, nickel, 35.48 per cent.; copper, 38.63 per cent.; iron, 4.58 per cent., and after the second copper and nickel extraction, nickel, 35.83 per cent.; copper, 35.56 per cent., and iron, 7.82 per cent. The amount of nickel extracted in these two cases was, after the first treatment 61 per cent., and after the second treatment 80 per cent. of the nickel present in the original matte. It must be remembered, however, that in the second treatment only one-third of the original amount remains to be treated, while the final residue is only one-tenth. To avoid the formation of iron carbonyl, the temperature in the reducer has to be kept very low, and if this is done the nickel extracted from a matte originally containing as much as between six per cent. and ten per cent. of iron will not contain more than 0.5 per cent. of iron. If the amount of iron in the residues rises above this percentage, the extraction of the nickel is very much delayed, on account of the low temperature which must be maintained in the reducer. It is necessary, in such a case, to re-smelt the residues before proceeding with the extraction of the nickel and copper. The following are analyses of the deposited nickel:

	I.	II.
	Per cent.	Per cent.
Nickel	99.82	99.43
Iron and (Al_2O_3)	0.10	0.43
Sulphur	0.0068	0.0099
Carbon	0.07	0.087
Insoluble residue	....	0.026

The experimental plant at Smethwick has been working for some time, and about 80 tons of nickel have already been extracted in it from different kinds of matte. The results obtained were quite satisfactory, and they point to the conclusion that the process is fully able to compete with any other process at present in use for the production of metallic nickel.

PARSONS' STEAM TURBINE DIRECT-CONNECTED.*

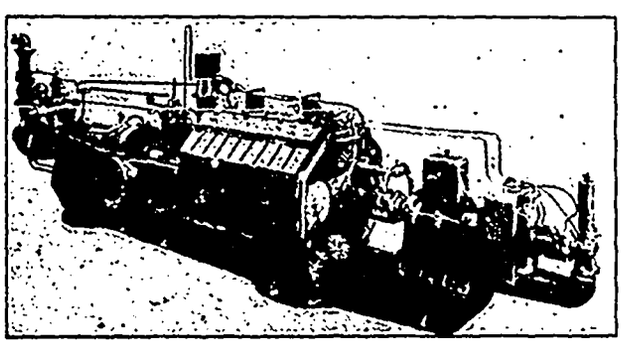
With the steam turbine the conditions are favorable to the larger machines for obtaining the best results, and the increase in the sizes manufactured has been rapid, the average at present being about 300 h.p., and we understand that turbo-plants of 4,000 k.w. output are being designed under the Parsons patents, for the generation of electrical energy from steam at a very low

*Reprinted from Engineering, London, England.

cost to compete with water power. In the turbine engine, as in the compound triple or quadruple reciprocating engine with which we are more familiar, it is essential for the most economical results, that the capacities of the cylinders should be proportioned to the various stages of the expansion of the steam between the boiler and the condenser. In the ordinary triple-expansion engine this is very incompletely obtained. In the mercantile marine, the ratio of expansion seldom exceeds 10-fold, and in war vessels 9-fold. In the compound turbine any ratio of expansion can be obtained without a material increase in weight or bulk, and in the larger condensing turbine motors, being constructed for driving dynamos, or for marine propulsion, the ratio of effective expansion within the engine is between 100 and 200-fold. It is to this exceptional ratio of expansion, and the economy of the engines themselves, that the satisfactory results which have been obtained in the larger engines are attributed. In the steam turbine the advantages of working expansively are obtained by increasing the length of the blades and diameter of the turbines; and therefore, of course, increasing the area acted on by the steam In this way, what corresponds in some degree to compounding in a reciprocating engine is obtained, though of course there is not the need to divide the expansion up into stages, as in a reciprocating engine, the expansion being continuous and gradual. So long as the initial pressure is kept constant, the temperature of any one ring of blades will not vary.

The plants, when completed in the machine and erecting shops, are transferred to the testing shop, where they are put under steam, and undergo the usual tests of full and emergency load; the steam consumption being accurately measured. At present the boiler and condenser capacity of the shop is sufficient for prolonged tests up to 500-k w. output, but this will shortly be increased to 2,000 k.w., when plants up to this size will undergo a full series of tests before being sent out from the works. New large machine-shops, erecting-shops, pattern-shop and offices are at present in course of erection, and will be specially equipped for the production of the larger turbine plants of standard sizes and design for continuous current and single, two, or three-phase alternating current.

We do not propose in these articles entering into the construction of various types of generators made by Messrs. Parsons, as that would take us too far afield, but any description of the works would hardly be complete without some notice of the product. There are thirteen 350 k.w. turbo-alternators now in use for lighting London at the Metropolitan Company's stations at Manchester square and Sardinia street. In the illustration we show a 75-k.w. turbo-generator of another type, four of which have been installed at the Hotel Cecil, London.



STEAM TURBINE.

The central station of the Newcastle and District Electric Company at Forth Banks, is one of the most important installations undertaken by the Heaton works. A 500 k.w. turbo-alternator has been more recently erected in the same station.

This company obtained powers to supply energy in 1889, and on January 10, 1890, the works were opened with three Parsons turbo-electro generators of 75 k.w. capacity each. The company has been a success in every respect from the first, paying a dividend which has increased every year from 2 per cent. in the first to 8½ per cent. in the last year of working.

The small cost per unit for repairs and renewals—and this figure includes all plant, cables, buildings, etc.—is worth noting; as also is the moderate figure which represents the amount required per unit sold to pay interest on capital at 5 per cent. This is important in view of the results obtained. The works are near the River Tyne, from which water is drawn for condensing purposes. The water pipes are laid in a brick lined tunnel about 100 yards long, and terminate in a condenser chamber sunk to mean tide level. There are two sets of plant, one for surface condensation, dealing with light loads, the other for jet condensation, and capable of condensing 48,000 lbs. of steam per hour. The works are peculiarly formed, being placed on the side of a hill, and the various rooms are as it were terraced out. The place originally formed part of Messrs. R. and W. Hawthorn, Leslie and Co.'s marine engine works, and at present is bounded on one side by that company's locomotive shops. As is well known, Messrs. Hawthorn's marine engine department was, some time back, transferred to St. Peter's, lower down the Tyne, and the electric light company thus were able to find a site well suited for its purpose. Advantage could hardly have been taken of the position, however, had it not been that the Parsons steam turbo-generator occupies so small an amount of space, and also on account of the absence of vibration, no foundation being required for the machinery. With regard to the latter feature, it is of interest to point out that Messrs. Hawthorn's drawing office wall forms a continuation of the engine room retaining wall of the electric lighting station; a fact which, in itself, would prohibit the use of ordinary reciprocating engines. The total area of the engine room is only 400 square yards, and in that space there are at present fixed turbo-generators representing nearly 1,720 k.w., with provision for a total of 3,200 k.w.

The use of the steam turbine for actuating electric generators has hitherto created the chief demand for this motor, but there are some other applications of the steam turbine; amongst these that to fan and pump machinery is of considerable importance. It has been found that a centrifugal pump when somewhat modified, is equally efficient whether it is run at 1,200 revolutions, as it generally is, or at 3,200 revolutions. An ordinary 6-inch pump at 1,200 revolutions will give a lift of about 40 feet, but we learn experiment has shown that the modified pump running at 3,200 revolutions will give a lift of about 200 feet, with proportionately greater output. This equals a discharge of about 1,000 gallons per minute, and gives about 60 water h.p. When this is combined with a 100 h.p. turbine, a very compact arrangement is obtained, suitable for mining purposes. A plant was recently erected at Messrs. Storey Brothers', Lancaster, for 850 gallons per minute, at 160-ft. lift, when run at about 3,200 revolutions per minute, and is reported to have given exceedingly good results. For low lifts, the centrifugal turbine pump is not so suitable, and propeller pumps with screws, somewhat like those of a ship's propeller, are adopted. These are suitable for lifts of from 10 to 40 feet.

Another department of these works is devoted to the manufacture of fans for ventilating purposes, and also for induced and forced draught. For the last three years, a fan 3 feet in diameter has been running at Mr. Cookson's works, Howdon-on-Tyne, drawing hot gases, and exerting a pressure of 7-inch water gauge with 2,000 revolutions per minute. It has practically run day and night since the start. Fans have also been made at the Heaton works for forced draught on board ship, and for land purposes. At the time of our visit one was being erected to give induced draught at 3-inch water gauge to two marine boilers capable of evaporating 25,000 lbs. per hour.

Another application of the fans is for colliery ventilation. Engineering describes a 5-foot fan which has now been running for nearly three years at the Clara Pit, Wylam-on-Tyne, a large colliery in the Tyne district exhausting 120,000 cubic feet per minute at 2½-inch water gauge; and another fan has just been erected at the Tredegar Coal Company's pit in South Wales for 300,000 cubic feet of air per minute at 3 inch water gauge.

Both fans and pumps are reported to have given good results for economy. One advantage is that practically no foundations are required; in one case the total cost of fan, brickwork and foundations amounted to one-third that needed for an ordinary slow-speed fan. This was largely on account of the small quantity of brickwork and foundations which were necessary. Although we are not entering into many details of construction reference may with advantage be made to the interesting feature of the governing of turbines. It may be effected by an electrical governor, or by a centrifugal governor, as may be found most suitable for the special work. If constant speed is required, as in alternators which have to run in parallel with

others, the centrifugal governor type is adopted; if, however, constant voltage is desired, the electrical governor is used. In the latter the voltage is automatically controlled by the governor, and so accurately can this be done that any desired voltage can be obtained at either full load or no load to within 1 per cent. without altering the governor. Thus, if 5 per cent. rise of voltage is desired at full load in a 100-volt machine, the governor can be adjusted to give 100 volts at no load, and 105 volts at full load. The governor is exceedingly prompt in its action, and large variations of load cause little variation of voltage, thus making the turbine specially suitable for traction purposes.

In both types of governor, one end of a lever is moved up and down either by the centrifugal governor or by a core controlled by a spring, and actuated by a solenoid in shunt with the terminals of the machine. This lever actuates a small valve, which is further moved to a small degree up and down at equal intervals. This small valve, by a steam relay arrangement, actuates the piston, which, in turn, actuates the main admission valve. The result is that at small loads the steam is admitted in a series of equal puffs, thus getting the advantage of the high-pressure steam, and securing great economy at small loads. As the load increases these puffs get longer and longer, until at full load the admission of steam is continuous. The puffs are at such rapid intervals that there is no perceptible variation of the speed of the turbine between each puff. Another advantage of the movement of the valve up and down is that everything is kept in a state of movement, and therefore there is no liability to stick, and all hunting is avoided.

SAND FILTRATION OF PUBLIC WATER SUPPLIES.*

BY R. S. LEA, ASSOC. M. CAN. SOC. C. E.

(Continued from last issue).

The operations which have been described in the foregoing pages are those connected with the carrying on of what is known as continuous sand filtration; and in determining what methods produce the best results, our only test has been the degree of bacterial purification effected. The reason of this is, as we have already seen, that in waters at all likely to be used as public supplies, the actual amount of organic matter is relatively so small as to be of little sanitary significance. Nevertheless, there is a certain degree of chemical purification effected by this process. Analyses of the effluents show a reduction of the dissolved organic matter of from 30 to 60 per cent. This is brought about by the action of the bacteria, which, though existing under adverse conditions, are yet capable of producing this result in the presence of the free oxygen in the water, the amount of which is usually quite sufficient for the purpose. Now, in the case of sewage, which is only very highly polluted water, the amount of free oxygen is very small in comparison with the organic matter present. And it was found, in making experiments on the purification of sewage by passing it through beds of sand, that if air were artificially introduced a very complete reduction of the organic matter would be effected by the bacteria. This was accomplished by working the bed intermittently; that is to say, at regular intervals of time—say 24 hours—the bed was allowed to drain, and fill its pores with the air drawn in after the sewage. After taking this breath the bed rested for a day; then the sewage was again turned on to the surface, preventing the escape of the air which was necessary to provide oxygen for the next 24 hours' purification. The same method used in connection with water is what is termed intermittent filtration. The first filter of the kind was built at Lawrence, Mass., by H. F. Mills, C.E., member of the State Board of Health. Since then, small plants on the same principle have been built at Mt. Vernon, N.Y., and Grand Falls, North Dakota. The results do not seem to indicate any necessity for their use, not being at all superior to those of continuous filters, while the method of operation is not suited to cold climates, and either requires a greater area of bed or a higher rate of filtration. A description of the Lawrence filter may be found in Trans. Am. Soc. C.E., 1893, p. 350.

From what has been said, it will be evident that where the water is at any time liable to turbidity, a settling basin, capable of holding from 12 to 24 hours' supply at least, must be provided Also, in order that the filter may be able to work continuously at a uniform rate, a clear water basin will be necessary of a capacity sufficient to cover the maximum fluctuations in the consumption. If the supply is from a storage reservoir, the filters are placed below the dam, and are, of course, supplied by gravity. But even when the supply is from a river or lake, the topography of the ground often admits of the same economical arrangement. If this is not possible, the water must be pumped into the settling basin by a separate pump of the low lift variety. The extra expense of two pumpings may be almost eliminated if the same station, boiler plant, etc., can be made to serve for both pumps. The total area of filter beds required depends in the first place upon the maximum rate adopted; and, second, upon the area out of use while being scraped and refilled. The higher the rate of filtration the less the total area, and therefore the first cost of the plant. The principal item of expense connected with the operation of this plant is that for scraping; and it is found that the amount scraped for any given quantity of water filtered is independent of the rate. Also, the allowance for the area out of use will not vary with the rate to any extent. Hence an increase in the rate will not by any means produce a proportionate reduction in the cost of filtration. A rate of 3,000,000 gallons per acre of bed in use will give results entirely satisfactory from the standpoint of efficiency, and at a cost which is usually by no means excessive.

The size of the individual beds will depend in part upon the extent of the total area, the smaller plants having necessarily to use smaller beds. A large bed costs less per unit of area than a small one, on account of the proportionately greater length of wall in the latter case. With a large bed it is, however, probably more difficult to obtain a uniform rate of filtration over the whole area. During the winter of cold climates the cost of maintenance is considerably increased by the expense of removing the ice which forms in the bed. It is also difficult to avoid injuriously disturbing the surface of the sand. Beside this, when the water is drawn down the surface sometimes freezes before it can be scraped. On account of such disadvantages as these filter beds should be covered in all cold climates. The best method of constructing these roofs has already been referred to. The proper number, shape, and area of the beds of a system can only be determined for any particular case by careful study of the local conditions, and by making comparative estimates of the different items of cost of construction, maintenance, etc. There will be opportunities for the exercise of considerable ingenuity in the general laying out of the system, the relative placing of its parts, the arrangement of the piping, drains, etc., in order that convenience and economy may be happily combined.

The cost of construction will of course depend on the local circumstances and the kind of materials used. As in all hydraulic work, great care is required in the construction, and the best quality of materials must be used. In the main, it is the same class of work as is required in the building of distributing reservoirs. The following table gives the cost of construction for several European and American filters:

Place.	Cost per Acre.	
	Covered.	Open.
London		$24,000—$40,000
Berlin (1884-87)	$66,000—$70,000	
Hamburg (1893)		30,500
Warsaw (1885)	78,000	
Zurich (1885)	86,000	
Nantucket, Mass. (1892) ..		45,500
Hudson, N.Y. (1874-88)...		73,000
Ilion (1893)		96,700
Ashland, Wis., (1897).....	80,000	
Somersworth, N.H. (1898)	64,000	
Poughkeepsie, N.Y. (1872)		90,000
Poughkeepsie, N.Y. (1896)		41,000

Lindley gives the general cost of continental filters as $45,000 per acre for open, and $68,000 for covered. The following figures, giving in detail the bids received February 15th, 1898, for constructing the water filtration plant now in process of construction at Albany, N.Y., will be of more interest. When completed it will be by far the largest plant yet built in America; and in general design and completeness of equipment it will be second to none.. It will consist of a settling basin of 16,000,000 gallons capacity, eight covered filter beds, each with 7-10 of an

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

acre of sand surface, and a clear water reservoir with a capacity of 600,000 gallons. There will also be provided an office building containing fully equipped chemical and bacteriological laboratories. The price for the sand and gravel included the necessary screening, washing and putting in place. The sand washer is of the ejector type. The bids are as follows:

Material.	Quantities.	Prices of Successful Bidder.	Prices of Other Bidders.	Engineer's estimates.
Shale rock excavation	5,000 cubic yards	$ 1.20	$ 0.30 to $ 1.50	$ 0.80
Earth excavation (above grade)	60,000 cubic yards	.27	.13¾ to .476	.20
Earth excavation (below grade)	3,000 cubic yards	.30	.20 to .60	.40
Rolled clay and gravel embankments	21,000 cubic yards	.52	.45 to .90	.50
Silt and loam filling	23,000 cubic yards	.15	.15 to .50	.20
General filling (rolled)	18,000 cubic yards	.18	.07 to .40	.20
Puddle in place	13,000 cubic yards	71½	.67 to 1.07	1.00
Broken stone or gravel for lining	1,900 cubic yards	.85	.99 to 1.40	1.25
Sodding	3,000 square yards	.15	.15 to .60	.15
Seeding	8 acres	25.00	12.50 to 70.00	50.00
Gravel in roadway rolled	800 cubic yards	.60	1.00 to 1.50	1.00
Vitrified brick laid as paving	120 M	20 00	18.00 to 30.00	20.00
Stone curbing	800 lineal feet	.60	.75 to 1.50	.50
*Concrete in floors	11,000 cubic yards	2.31	2.34 to 3.50	3.00
*Concrete in vaulting	7,000 cubic yards	3.85	3.90 to 7.50	5.00
Other concrete	3,000 cubic yards	2.13	2.50 to 4.30	3.00
*Brick work	4,500 cubic yards	8.12½	7.00 to 10.00	6.00
Imported Portland cement	500 bbls.	3.12½	2.35 to 3.00	2.75
American Portland cement	14,000 bbls.	2.14½	1.90 to 2.21	2.15
Rosendale cement	1,500 bbls.	.97½	.85 to 1.95	1.00
Furnishing and placing 2-inch drain pipe in piers		525.00	300.00 to 1,318.00	700.00
2-inch agricultural drain pipe	2,000 lineal feet	.04	.05 to .10	.05
6-inch drain pipe, open joints	16,000 lineal feet	.11	.10 to .12½	.10
Furnishing and laying all vitrified pipe cement joints		5,337.00	3,850.00 to 5,933.00	6,000.00
*Placing all gates, etc., furnished by board		1,140.00	700.00 to 2,000.00	470.00
*Furnishing and placing all cast-iron pipe and specials		20,701.25	14,750.00 to 20,000.00	15,000.00
*Iron filter covers	672 each	4.40	5.00 to 6.50	5.00
*Sand washing apparatus	2 sets	393.00	250.00 to 1,000.00	800.00
*Sand run fixtures	8 each	407.50	100.00 to 511.00	200.00
*Regulator houses	8 each	862.24	175.00 to 900.00	500.00
*Office and laboratory building		4,881.00	2,700.00 to 10,200.00	3,000.00
*Filter gravel in place	7,000 cubic yards	1.05	1.00 to 2.00	1.50
*Filter sand in place	36,000 cubic yards	1.00	.90 to 1.78	1.25
Split stone lining	2,000 square yards	.82	1.03 to 3.60	2.00
Rough stone paving	200 square yards	.82	.93 to 2.50	.80
Fasteners furnished and placed in concrete vaulting	3,000	200.00	150.00 to 225.00	100.00
Iron fence	850 lineal feet	2.00	1.00 to 2.00	1.00
Connection with pump-well and closing old intake		3,000.00	1,000.00 to 4,000.00	3,500.00
Total		$309.866.00	$322,358.00 to $387,345.00	$322,440.00

The items of special interest are marked thus *

It will thus be seen that a covered filter plant of this area (5.6 acres) with settling basin, clear water basin, and all other appurtenances complete can be built for less than $56,000 per acre. For further details and information concerning this plant see Engineering News, Feb. 10th and Oct. 20th, 1898.

The total cost of maintenance of a filtration plant is made up of the operating expenses, and the interest and sinking fund charges. The former—the operating expenses—comprise: (a) The cost of superintendence, and of attendants to look after the regulation, etc.; (b) the cost of scraping and removing the sand; (c) the cost of washing the sand; (d) the cost of replacing the washed sand when renewal of the bed becomes necessary.

It is only in very large plants that a special superintendent is required, so that the expense for that purpose would not form a very large part of the total cost. The proper handling of the gates, and the running of the plant in general requires a degree of intelligence considerably above that of the ordinary laborer. The wages of the gatemen therefore will be from $2 to $3 per day. Scraping and removing the sand by wheelbarrows seems to cost, under ordinary circumstances, between $40 and $50 per acre, depending upon the wages paid. At Mount Vernon, N.Y., the shovellers and barrow wheelers are paid $1.10 per day, and the scrapers $1.25. Chas. Fowler, for many years in charge of the filters in Poughkeepsie, N.Y., says that one man working one hour is required for every 150 square foot of surface cleaned and removed. This would cost at $1.50 per day, about $43.50 per acre. Lindley gives 30 days at 10 hours each for every acre, which at the same rate is $45 per acre. In the small plants at Ilion, N.Y., and Ashland, Wisconsin, the cost is at the rate of about $50 per acre. The cost of sand washing varies with the method employed. In Poughkeepsie, when they used a simple inclined trough and water jet, it cost as high as $1.50 per yard. By improving their methods they reduced this cost, till to-day it is only 27 cents per yard. In Hudson, the cost is 20 cents per yard, and in Ilion 18 cents. In Germany it varies from 14 to 20 cents per yard.

The periodical replacing of the sand in the bed must be done carefully of course, but should not cost, including whatever is necessary to be done to the permanent layer, more than 40 cents per cubic yard The cost of these various operations will of course depend upon the scale on which they are carried on. It will obviously be easier to keep the price low with a large plant than a small one. In the case of the former a force of gatemen and laborers can be permanently employed. In the smaller plants the operations of scraping and sand washing only take place at intervals, and are performed by laborers hired temporarily for the purpose, or by employees from other parts

of the water system. In using the above data to make an estimate of the total operating expenses, we shall employ as a unit the cost per million gallons of water filtered. Assuming an average yield of 50 million gallons per acre between scrapings, the total cost would be as follows:

Scraping and removing at $45 per acre	$0.90 per mill. gals. filt.
Washing 100 cu. yds. sand at 25c. yd	0 50 per mill. gals. filt.
Replacing, etc., at 40c. yd	0.80 per mill. gals. filt.
Superintendence, etc	0.25 per mill. gals. filt.
Total	$2.45 per mill. gals. filt

To this should be added the cost of bacterial analyses of the effluents which should be made as frequently as possible in order to test the working of the filters. In many of the European plants a fully equipped laboratory is included in the equipment; and some of the superintendents, like Pieike, chief engineer of the Berlin works, are also expert bacteriologists. The actual cost of the operations discussed above for some American filters is as follows:

Poughkeepsie, N.Y., for 20 years aver.	$2.90 per mill. gals. filt.
Hudson, N.Y., is given as	1.38 per mill. gals. filt.
Mount Vernon, N.Y., a little less than	2.00 per mill. gals. filt.
Ashland, Wisconsin, estimated to cost	2.25 per mill. gals. filt.

The following table furnished by W. B. Bryan, Esq., chief engineer, East London Water Co., gives the yearly cost of filtration of the London Water Companies from 1890 to 1895:

COST PER MILLION U.S. GALLONS.

Name of Company.	1890-1	1891-2	1892-3	1893-4	1894-5
Chelsea	$ .72	$ .75	$ .62	$1.16	$ .60
East London	1.42	1.54	1.42	2.63	1.69
Grand Junction	1.33	1.24	1.30	2.00	1.68
Lambeth	.86	1.01	1.20	1.46	2.54
New River	1.02	.93	1.17	1.43	1.03
Southwark and Vauxhall	$1.17	$1.15	$1.26	$1.53	$1.34
West Middlesex	1.01	.97	1.42	.95	.96

To get the total cost of maintenance, we must include with the operating expenses the charges for interest and sinking funds. This will of course depend upon the cost of construction; and the latter will vary with the maximum rate of filtration adopted, and the proportion of the total area to be out of use while being cleaned. These being decided upon, it will then be easy to calculate the first cost per million gallons of daily yield. For example, if, with the rate chosen, the daily yield of the plant will be 2,000,000 gallons per acre of the total area of beds, the first cost per million gallons will be half the cost of construction per acre, and so on. The diagram gives the cost per million gallons filtered, corresponding to different construction costs, which will pay the interest and sinking fund charges necessary to cancel the whole first cost with interest at the end of 40 years. For example, with a first cost of $60,000 per acre, and a net yield of 2,000,000 gallons per acre of total area, the cost per million gallons with interest at 4 per cent. would be $4.15. With interest at 4½ per cent., and a first cost of $80,000 per acre, first cost would amount to about $6. Add to this $2.50, for the expense of operation, and we should have $8.50 as the total cost of filtering 1,000,000 gallons of water, or 1,000 gallons for less than 9-10 of a cent.

Having now discussed the method and cost of sand filtration, the next and last question to be considered is the nature of the results which this process can be depended upon to produce. There can be no question as to its efficiency from an aesthetic point of view. The complete removal of even the most minute particles in suspension, together with a large part of the dissolved organic matter, ensures the entire elimination of any characteristics the water may possess which would be disagreeable to sight, taste or smell. Yet it is because of the effectiveness of the purification from a sanitary standpoint that this system is especially noted. This is due to its destructive effect upon the bacteria, which is almost sufficient to cause their disappearance during the passage of the water through the filter. The average reduction in a well designed and well managed plant will be as great as 98 or 99 per cent., as shown by comparing the number of germs in the effluent with that in the applied water. But in reality it is even greater than this. For it has been shown that of the few bacteria which are present in the effluent, a certain number come from the underdrains, and have therefore not passed through the filter at all. These belong to some of the species of water bacteria, and, consequently, will be quite harmless. From tests made on the experimental filters at Lawrence with an easily recognized and hardy species, the actual reduction was found to be from 99.9 to 100 per cent. Now, when it is considered the filter is capable of producing such effects upon bacteria which exist normally in water, it will be evident that the effect upon the pathogenic or disease germs which are out of their natural habitat and in a decidedly unfavorable environment will be much greater. Thus what may be called the "hygienic efficiency" of this system must be remarkably high. The process is comparable to nature's method of purifying the surface water which furnishes the underground supplies; and if properly carried out, the water produced is probably of almost equal wholesomeness. The continued experience of places where sand filtration plants have been in operation for some time only goes to strengthen this conclusion.

In America the method is only just beginning to be employed. Up to the year 1892 there were but two plants of this description in the country, viz., those at Hudson and Poughkeepsie, which have been already referred to. Since that time 14 new ones have been completed, and three others are under construction, the latter including the large plant at Albany. The experience to be derived from these plants is too limited to be of much value for some time to come; but the officials connected with the majority of them have invariably expressed their entire satisfaction with the method of working and with the results obtained.

(To be continued).

Industrial Notes.

The Calgary Milling Co. will build an elevator.

At Truro, N.S., T. G. McMullen is completing a pulp mill.

Goderich, Ont., has voted a bonus of $10,000 to the Kensington Furniture Co.

Windsor, Ont., is buying a site for a drill shed to be built there by the Dominion Government.

The contract for the new public works office at Regina, Assa., has been let to Willoughby & Mallard.

G. H. Hopkins and J. D. Flavelle have bought the Lindsay, Ont., waterworks. F. K. Begbie will be manager.

The ratepayers of Woodstock, N.B., will vote on a bylaw to give a $50,000 bonus to a pulp mill on October 16th.

Kamloops, B.C., has voted $27,000 to improve the waterworks, and $15,000 to extend the electric light plant.

An addition will be erected to the John H. Stratford Hospital, Brantford. An isolation hospital may also be built.

The overhead bridge across the M.C.R. near Kingsmill, Ont., which was recently burned, is being replaced by a new one.

H. M. Whitney, Boston, president of the Dominion Iron and Steel Co., has given $25,000 to build an hospital in Sydney, Cape Breton.

The Canadian Rubber Co., Montreal, has ordered a 100 h.p. Mumford Improved boiler from the Robb Engineering Co., Amherst, N.S.

Joseph Black, Toronto, has been continued as editor of The Iron Moulders' Journal by the Iron Moulders' Association of North America.

The boiler inspectors in Montreal are enforcing the city by-laws requiring the use of smoke consumers, and heavy fines are being imposed.

The L.E. & D.R.R. is pulling down its grain elevator at Port Stanley, Ont., which was built four years ago, and removing it to Sarnia.

Smith's Falls, Ont., has appropriated $150,000 to put in a system of water supply and sewage. Willis Chipman, C.E., has prepared the plans.

Graham Moon, of the Postoffice Department, Ottawa, is said to have invented a roller boat, which it is claimed is better than Knapp's failure.

The Kingston School of Mines is trying to secure $6,000 to equip a new laboratory. The expenses last year were $2,070 in excess of the receipts.

The contractors have commenced work on the Hoepfner Refining Co.'s nickel works at Hamilton.

John Dittrick's bolt and nut factory at Perth, Ont., is nearly completed and will soon be in working order.

The annual convention of the International Building Inspectors' Association took place a month ago in Quebec.

Brantford, Ont., will build a new Isolation Hospital, and make a large addition to the John H. Stratford Hospital.

The scale manufacturers of the United States are, it is said, to form a trust which will combine most of the leading makers.

W. J. Hamilton, Peterborough, Ont., has invented an improvement in gasoline engines, which is attracting some attention.

Robt. Cameron, contractor, Almonte, Ont., has a contract for building a new wing to Rideau Hall, the official residence of the Governor-General, Ottawa.

The Lillie foundry, Perth, Ont., has passed into the hands of a new firm, The James Bros. Foundry Co., which will operate it on a large scale, it is said.

A bylaw granting W. W. Ogilvie, of Montreal, exemption and free site for his flour mill and elevator at Fort William, Ont., was carried Sept. 11th.

J. E. Asquith and others of Ottawa, Ont., propose to put in waterworks and sewage in Arnprior, Ont. They would also take over the electric light plant.

The Mattawan Iron Co. is in correspondence with the town of Fort William over the $50,000 bonus for a smelter, which that town has been offering for some time.

A steam plough has been successfully tested at Morris, Man. It will plough 18 acres per day with ease, according to the testimony of the mechanic who made the test.

The contract for raising the piers of the Edmonton, N.W.T., bridge has been let to the Dominion Bridge Co. It has been decided to add eight feet to the present height.

The acetylene gas apparatus in T. Ivory & Co.'s store, Omemee, Ont., exploded, September 26th. The generator was wrecked, but no considerable damage was done the building or contents.

The William Kennedy & Sons, Ltd., Owen Sound, is building an extension to its foundry. The addition, which will be used for the manufacture of steel castings, will give employment to between twenty-five and thirty men.

The following were elected officers at the convention of the United Brotherhood of Railway Trackmen in Ottawa: President, J. Logan, Ottawa East; vice-president, J. Hogan, Ottawa; secretary, H. McKenny, Ottawa; treasurer, A. Thompson, Ottawa.

St. Henri, Que., council has granted a tax exemption to the Merchants' Cotton Company to erect a factory in the municipality. The following proviso was made: "The company will have to agree to employ three hundred persons, to whom a yearly sum of $50,000 will have to be paid as salary."

The Nova Scotia Steel Company is making preparations for building another smelting furnace. The large steel building will be extended some eighty feet to cover the new furnace, and bring the steel travelling crane in connection with it. The furnace will produce 100 tons of steel a day.

The large iron works of Carrier, Laine & Co., Levis, Que., are crowded with orders. The establishment employs about 425 hands, and all are busy. Within the last three months a general increase in the wages has taken place, and the men are now receiving about fifteen per cent. more than formerly.

McLachlin Bros., Arnprior, lumbermen and sawmill owners, chartered two C P R trains and gave a free trip to the Ottawa Exhibition to their employees, and paid not only the fare of the excursionists, but their entrance fee to the Exhibition. Thirteen hundred men, women and children were thus entertained.

A. S. Chrystal is giving up his business as steam boiler manufacturer here, and will remove to London, to enter the London Engine Supplies Co. The company will manufacture steam boilers and steam heating appliances, will sell engines, boilers, etc., and will conduct a repair shop for engines and other machinery.—Goderich Signal.

The Simcoe Peat Fuel Company, Barrie, Ont., commenced operations a short time ago, and this industry promises to give employment to a large number of men.

Frank White, representing the Canadian Peat Fuel Co., Toronto, has gone to Tullamore, Ireland, where he is going to install a plant for the Canadian Peat Fuel Co.

H. E. Hill, of Halifax, N.S., has ordered a 100 h.p. steam plant from the Robb Engineering Company, Ltd., Amherst, N.S., for the new works of the Maritime Explosives Company.

The Good Roads Machinery Co., of Hamilton, has taken action against the Sawyer-Massey Co., of the same city, to restrain it from using the phrase, "good roads" in connection with its business.

Notice is given of application for the incorporating of the Aroostook Power Company to erect mills and plant for the manufacture of lumber, pulp and paper at Aroostook Falls in Victoria county, New Brunswick.

J. W. Wilson, Ottawa, has bought two marine type 3 h.p. gasoline engines from the McLachlan Electric and Gasoline Motor Co., Toronto. One of these Mr. McLachlan states is for export to the United States, having been bought for a summer visitor by Mr. Wilson.

The W. R. Brock Quarry Co., Toronto, has bought the Mount Dimson Granite Quarry Works from J. M. Hazel & Co., and has also purchased the Stanstead, Que., granite quarries, including the rights and plant of the Morr Granite Co., with three miles of railway track.

As mentioned last month the business of Tingley & Stewart Mnfg. Co., makers of rubber stamps, etc., Toronto, has been bought by Bernard Cairns, whose familiarity with every detail of the business and exact knowledge and careful methods of carrying it on ensure all patrons that their work will be turned out promptly and as ordered.

The Georgian Bay Portland Cement Company, Ltd., is a new industry established this year in Owen Sound, Ont. Buildings are now practically completed, and manufacturing operations commenced. Seventy-five men will be given employment, and the wages will amount to between $2,500 and $3,000 a month. The output will be 400 barrels per day, and it is expected this will be doubled in the next two years.

The British Government, after careful tests of every known material used for boiler covering, has selected mica covering for Her Majesty's new yacht. After looking into the qualities of mica as a pipe and boiler covering a number of English capitalists have formed a strong company to manufacture boiler covering under the patents of the Mica Boiler Covering Co., of Toronto.

R. H. A. Hunter, W. Hunter, A. Malcolm, G. M. Mackendrick, J. L. Murray, D.D., W. C. Loscombe, J. Boyer, DeW. H. Martyn, M.D., J. Ruettel, G. Wood and J. B. Watson, Kincardine, Ont., and J. Warren, C.E., Walkerton, Ont., have been incorporated as the Hunter Bridge and Boiler Company of Kincardine, Ltd.; capital, $25,000; to carry on the business of Hunter Bros., Kincardine, Ont.

P. Lyall & Sons, Montreal, have installed a large diamond saw, electrically driven, in their stone cutting yard. This saw is a part of the $20,000 electric plant recently purchased by the firm, and includes a travelling derrick and two planers, one of the largest capacity yet made, and the second of smaller size. There are but four of the derricks in use in the stone yards of the United States, and no other in Canada.

E. Leonard & Son made a very fine display of their engines, etc., at the Exhibition recently held in St. John, N.B. Among those who have bought their engines recently from this firm are, W. H. Fowler, of the West End, a 250 h.p. engine to be used in his flour mill. J. W. & W. A. Hutchinson, of Berwick, N.S., have bought the large engine exhibited in the booth. The Acadia Electric Co., of Wolfville, N.S., have sent in an order for one of this firm's 120 h.p. peerless self-oiling engines. J. R. Caulder & Son, of Pepperville, N.S., have ordered a 60 h.p. outfit; E. H. Pickett, of Bridgetown, N.S., a 35 h.p. engine; M. Graves, of Annapolis, N.S., a high-speed engine, and Charles H. Brown, who is starting in operation his new flour mill at Gagetown, has ordered a steam outfit.

A. O. Norton, manufacturer of ball bearing jacks at Coaticooke, Que., has just shipped a large order to Denmark. Several other important orders for export to India, Australia and South Africa have just been received.

Hon. George G. King, Chipman, B.C.; Hon. Ambrose D. Richard, Dorchester; Henry C. Read, Sackville; M. Lodge, Moncton; E. Hutchinson, Douglastown; W. Kitchen, Fredericton, and W. Frank Taylor, Hillsboro, are to be the provisional directors of the New Brunswick Petroleum Co., Ltd., for which a charter has now been applied for. The company will bore for oil; its chief place of business is to be Moncton, N.B., and its capital $1,000,000.

The Owen Sound, Ont., Iron Works Company, Ltd., have revived the business of the old Corbett foundry firm, which closed up during the hard times of a few years ago. They commenced operations last January, and give employment to twenty-five men. The company contemplates enlarging its foundry, increasing its staff and going extensively into the manufacture of propeller wheels, according to a recent report in The Toronto Globe.

The following tenders for the construction of the new drainage system for Lachine, Que., were received: Albert Dini, $209,129.74; Rheaume & Dansereau, $144,816.90; Leopold Leger, $163,230; Chartier & Rebin, $174,095; Martineau, Son & Lemoine, $185,000; Bastien, Valiquette & Parker, $152,523.15; O. L. Hainault & Co., $149,552; Amyot, Lemay & Gauthier, $141,518.88. The contract was awarded to Bastien, Valiquette & Parker, whose tender, though not the lowest, was deemed to offer the best guarantees for the satisfactory execution of this important public work.

Harding & Leathorn, London, Ont., have the contract for building the waterworks at St. Mary's, the figures being $10,081. The specifications call for: All labor in laying the cast-iron pipe distribution system, comprising 1,000 feet of 10-inch pipe; 4,000 feet of 8-inch pipe; 10,600 feet of 6-inch, and 8,000 feet of 4-inch; setting 52 fire hydrants; setting 34 valves; furnishing material for and building 17 valve chambers and setting 17 valve boxes. The contractor also furnishes all materials required except the cast-iron pipes, the pipe specials, the fire hydrants and the valves.

The Canadian Hardware Association at its annual convention in Hamilton, Ont., last month, elected these officers for the ensuing year: President, T. H. Newman of Caverhill, Learmont & Co., Montreal; vice-president, Peleg Howland of Howland, Sons & Co., Toronto; secretary-treasurer, R. and T. Jenkins, Toronto; Executive Committee, Thomas Lee of Rice Lewis & Son, Toronto; R. Angers of Frothingham & Workman, Montreal; E. Jeanotte of L. H. Herbert & Co., Montreal; William Vallance of Wood, Vallance & Co., Hamilton, Ont.; John Bowman of Bowman Hardware Co., London, Ont.

For purposes of record and identification, the Detroit Lubricator Co., Detroit, Mich., has numbered its sight feed lubricators consecutively from No. 1 upwards, so that the number appearing on any lubricator shows how many had been manufactured up to its time. On Sept. 15, 1899, there was completed lubricator No. 460,000. When it is considered that as a rule only one lubricator is used on an engine this figure gives eloquent testimony to the very general use of the Detroit lubricators. The present output of sight feed lubricators alone, of this company, amounts to over 5,500 per month. The Detroit Lubricator Co. also reports a rapidly growing trade in its new style glass oilers and oil pumps.

The F. D. Cummer & Son Co., Cleveland, Ohio, the manufacturer of the well-known Cummer Mechanical Dryers, reports the following sales and shipments for the past two months: Laflin & Rand Powder Co., Pleasant Prairie, Wis., one special dryer to dry 1½ tons of nitrate of soda per hour; United States Navy, Indian Head, Md., one special dryer to dry 1 ton of nitrate of soda per hour; Trent Valley Peat Fuel Co., Peterborough, Ont., one No. 00 "Salamander" dryer to evaporate 2½ tons of water per hour from peat fuel; Warren-Burnham Portland Cement Co., Craigsville, Va., one No. 8 style "F." dryer to dry 2½ tons of slack coal per hour; Peerless Portland Cement Co., Union City, Mich., one No. 00 "Salamander" dryer, to evaporate 2 tons of water per hour, from marl; John McGillen, Chicago, one Cummer portable railroad asphalt paving plant, guaranteed to lay 2,000 yards of 2-inch topping per day of ten hours; Societe Anonyme de Ciments de Vise, Brussels, Belgium, one No. 000 size "Salamander" dryer to dry 15 tons of chalk per hour, and one No. 2 size "Salamander" dryer to dry four tons of clay per hour; T. Herbert Wymonds, Vancouver, B.C., one No. 00 style "F." dryer, to dry 50 tons of fish scrap per day; Pennsylvania Salt Mnfg. Co., Natrona, Pa., one 3 tunnel, 6 track tunnel system complete, for drying iron ore briquettes; Vulcanite Portland Cement Co., Phillipsburg, N.J., one No. 0 style "F." dryer for drying 75 tons of slack coal per day; Wm. Krause & Sons Cement Co., Martins Creek, Pa., one No. 8, style "F." dryer for drying 2½ tons of coal per hour; Premier Tripolite Co., North Sydney, N.S., one special dryer for drying tripoli.

Electric Flashes.

The Montague, P.E.I., Electric Light Co., is making preparations for lighting the village.

Nelson, B.C., is installing additional power for its lighting service, and will shortly be able to supply 4,500 16-c.p. lamps.

The village of Weston, Ont., intends to buy the water-power on the River Humber, and run its proposed electric light plant.

It has been stated recently that the street railway, gas and electric light and power companies in Brantford, Ont., were to be combined.

At the annual meeting of the Quebec Electric Railway, Light and Power Company, A. Thomson was elected president in place of H. J. Beemer.

A project for the construction of an electric railway from St. Catharines to Wellandport, Ont., traversing Fonthill and Pelham, is under consideration.

W. W. Brown, in charge of the lighting plant at Petrolia, Ont., since its establishment, has gone to Camp McKinney, B.C., to take charge of the plant of the Minnehaha Mining Co.

The transfer of the Hamilton and Dundas Railway to the Cataract Power Company was completed Sept. 17th. The company paid $110,000 cash besides assuming bonds amounting to $90,000.

Application is to be made for a charter for an electric or steam railway from Ottawa to Brockville, Ont., with power to operate a ferry on the St. Lawrence, between Brockville and Morristown, N.Y.

The Brantford Electric and Operating Co., Brantford, Ont., is rapidly increasing its power business. The Keys Somerville Printing Co. has installed a 3 h.p., two-phase S.K.C. induction motor with which to operate its new printing presses.

E. H. Caughell, Mary L. Caughell, A. E. Marlatt, Emma L. Marlatt and W. T. Williams, St. Thomas, Ont., have been incorporated as the Port Stanley Electric Railway Co., to build an electric railway from St. Thomas to Port Stanley; capital, $40,000.

Liverpool, N.S., has taken up the municipal electric lighting business, and placed an order with the Royal Electric Co. for a 75 k.w. two-phase S.K.C. generator, as well as the full complement of transformers, and other apparatus. The plant is to be in operation by November 1st.

The Royal Electric Co., Montreal, was awarded the contract for installing the new electric light plant to be added to the plant of the corporation of Picton, Ont. The new plant is to consist of one 120 k.w. S.K.C. two-phase generator, with the full complement of transformers, lamps, etc.

An electric railway between Port Stanley, St. Thomas and London, Ont., the track to be laid along the gravel road connecting those places, is now talked of. A company has been incorporated to build the road, which if successful is to be followed, it is said, by an electric road to Aylmer, Ont.

The corporation of the city of Winnipeg through its Water and Light Commissioners has awarded the contract for the incandescent electric lighting plant to the Royal Electric Co., Montreal. The plant is to consist of a 60 k.w., S.K.C. two-phase alternating generator, with the necessary transformers, etc. The order for the arc apparatus was placed with the Western Electric Co., Chicago, Ill.

The capital of the Citizens' Telephone and Electric Co., Ltd., Rat Portage, Ont., is to be increased from $40,000 to $90,000.

The Mineral Springs Furniture Co., of Preston, Ont., has installed a dynamo and electric lighting plant in its factory.

J. H. Jones has completed the plans and specifications for the Sarnia, Ont., Street Railway Company's proposed new electric line.

The St. Hyacinthe Electric Railway Co. is applying for a Quebec charter to build an electric railway in the counties of St. Hyacinthe and Bagot.

The Hamilton Electric Light and Cataract Power Co. has had certain changes made in its charter enabling it to take over the management of companies of whose stock it has acquired at least two-thirds.

The Robb Engineering Co., Amherst, N.S., is supplying the town of Neepawa, Manitoba, with the steam plant for its new electric lighting system; a 100 h.p. compound engine and two 75 h.p. Mumford improved boilers.

The Royal Electric Co., Montreal, announced a cut of 30 per cent. in electric light rates on Sept. 15th, and the Lachine Rapids Land and Hydraulic Co. has followed with a reduction of 40 per cent., taking effect October 1st.

W. H. Pearson, W. H. Pearson, jr., W. E. H. Massey, J. W. Flavelle, Toronto, and R. Weddell, Trenton, Ont., have been incorporated as the Trenton Electric and Water Co., Ltd., capital, $400,000; head office, Toronto.

The Ottawa Electric Railway Company has let a contract to Heney & Smith, of Ottawa, for the construction of an electric radial line from Ottawa to Britannia, on Lake Dechene, seven miles. The road is to be completed by November 1st.

J. Playfair, Geo. Chew, D. L. White, jr., and P. Potvin, Midland, Ont., W. J. Sheppard, W. H. F. Russell, W. J. Lovering, of the township of Tay, county of Simcoe, Ont.; J. J. Drummond, Radnor Forges, Que., have been incorporated as the Midland Power Co.; capital, $90,000; to supply heat, light and power.

At a meeting of the shareholders of the Royal Electric Company, R. Forget, president, in the chair, the bylaw giving power to increase the capital stock of the company by $750,000 was submitted and approved. The stock, it was decided, would be issued on a basis of one to two, so that present holders of two shares would be entitled to one in the new stock.

Hon. S. W. Parent has announced that the English and United States company, which has applied for certain water powers on the upper waters of the Saguenay River, Que., for the purpose of establishing calcium carbide works, will spend over a million dollars there if they obtain the privileges. His engineer is engaged in preparing a report for him on the matter.

The Canadian Niagara Power Company, which obtained a new franchise from the Ontario Government under which, according to the statement of Wallace Nesbitt, the company's counsel, it is expected that power will be available for transmission to Toronto, has given a contract for boring test holes along the line of the tunnel it contemplates building on the Canadian side of the Niagara River.

H. Alabaster, Gatehouse & Co., 4 Ludgate Hill, London, E.C., proprietors also of The Electrical Review, announce that the 1900 edition of the Universal Electrical Directory is in course of preparation for its 19th annual issue in January next. This book is of great value, and those wishing to secure the insertion of their names in the forthcoming edition should not lose any time in communicating with the publishers.

In connection with the destruction of water mains by electrolysis the Engineering News, New York, recently recommends the use of wood in joining water mains instead of lead. In St. John, N.B., it has been the practice for nearly half a century to close the joints in city water pipes, not with melted lead, as in most other places, but with pine plugs. The experiment was tried in 1851, and again in 1857. On both occasions it worked so well that the same policy was pursued two years ago. The object in view was economy.

The proposed bylaw to raise $25,000 to establish a municipal electric light plant in Almonte, Ont., was defeated, Sept. 26th, by 38 votes.

The first meeting of the new directors of the Radial Electric Railway since the Cataract Power Company syndicate secured control of the road, was held Sept. 9th, and officers were elected as follows: President, John Patterson; vice-president, Hon. J. M. Gibson; treasurer, John Moodie; secretary, S. E. Malloch.

The Nova Scotia Electric Co. has been organized to supply electricity for lighting and power purposes for the whole of the Annapolis Valley, Nova Scotia. The following officers have been elected: President, Hon. F. W. Borden; secretary-treasurer, J. W. Beckwith, who with Captain H. H. Norwood, C. O. Foss, F. W. Clark, F. B. Wade and Allen Healy will constitute the board of directors.

The St. Catharines Cold Storage and Forwarding Co., Ltd., is replacing its direct current power service now in use in the warehouse, with a 15 h.p. two-phase S.K.C. induction motor. The current for this machine is supplied by the St. Catharines Electric Light & Power Co., which has recently installed in its power house a 200 k.w. two-phase S.K.C. generator for both lighting and power purposes.

At a meeting of the creditors of the Kay Electric Company, Hamilton, Ont., it was decided to wind up the estate, and Mr. Weyler, of the Packard Electric Co., St. Catharines, E. Brown and James Dickson, Hamilton, were appointed inspectors. The nominal assets are $2,312.24, made up of stock and book debts, and the liabilities $1,721.03, of which $637 are preferred claims. The unsecured creditors, it is believed, will get a very small dividend.

Brewder & McNaughton, contractors, have issued a writ in the High Court of Justice against the Metropolitan Electric Co., Ottawa, claiming $50,000 damages for alleged breach of contract and for wrongful deprivation of plant, materials and other goods and chattels. The writ is also for an injunction restraining the company from further use of the said plant. This is the outcome of the dispute which has been going on between the contractors and company which ended in the company taking away the contract from Brewder & McNaughton.

Guglielmo Marconi, the exponent of wireless telegraphy, who is now in New York, said to an interviewer: "The outlook for wireless telegraphy is bright, and the system is constantly being perfected. Messages have been flashed eighty miles, but I do not care to say what has been the greatest distance reached. The experiments have proved that the curvature of the earth is overcome, for in sending the message between stations 80 miles apart the earth curvature, which is over 1,000 feet, has been overcome. The station from which the message was sent was 70 feet high."

A syndicate has bought the Chats Falls at Fitz Roy Harbor, on the Ottawa River, on behalf of the Pontiac Mining Company. The falls are about 35 miles from Ottawa, and a minimum of 141,000 h.p. can be developed at low water and 600,000 h.p. at high water. The purchase was carried through by T. C. Bate, N. A. Belcourt, M.P., W. J. Poupore, M.P., P. Clark, Ottawa; Denis Ryan, St. Paul, Minn., and T. A. Darby, of North Carolina. These gentlemen bought the property as individuals, and are turning it over to the company. The falls, as mentioned some months ago in The Canadian Engineer, are in the middle of a highly mineralized country, and near two lines of railways.

At the annual general meeting of the shareholders of the Great Northwestern Telegraph Company the old board of directors and officers were re-elected, viz.: President, H. P. Dwight, Toronto; vice-president, Adam Brown, Hamilton; directors, H. N. Baird, James Hedley, A. S. Irving, W. C. Matthews, Toronto; Richard Fuller, Hamilton; Hon. William McDougall, Ottawa; and Charles A. Tinker, New York; secretary and auditor, George D. Perry; treasurer, Arthur Cox. The financial statements presented showed a marked improvement in the revenue of the company over the previous year, and it was stated that the outlook for the coming year was still more hopeful.

Marine News.

Smith Bros., Quoddy, N.S., are building a steam boat 68 feet long for Wm. Butler, Yarmouth, N.S., to be completed November 1st.

Sheet piling is to be driven on both sides of the Burlington Beach canal, Hamilton, Ont., to such a depth that it may be dredged to a depth of 20 feet.

Isaac Radford, Buffalo, is arranging with J. Gaskin, Kingston, Ont., for boats from the latter for transferring a large quantity of iron ore from Three Rivers, Que., to Buffalo.

The Quebec, Hamilton & Fort William Navigation Co., which was incorporated a short time ago, has sent A. B. McKay to Great Britain to buy two 3,000-ton steel freight steamers for the lake trade.

The Richelieu & Ontario Navigation Co. will make a very interesting exhibit at the coming Paris Exhibition. Photographs of the fleet and the various hotels of the company, together with views of the scenery of the route will form part of the exhibit.

The record from Liverpool to Quebec was made by the "Canada" of the Dominion Line, which sailed from Liverpool 5 p.m., Thursday, October 29th, 1896, arrived Quebec 11.20 a.m., Thursday, November 5th. This still remains by almost 20 hours the fastest trip of any steamer to St. Lawrence ports.

The steamer "Delta," employed in carrying coal between Louisburg, C.B., and St. John's, Nfld., was reported wrecked at St. Mary's Bay, Nfld., Sept. 14th. She formerly belonged to the Cunard Steamship Company, and was 550 tons register. She was the second steamer to cross the Atlantic between England and Halifax.

The returns of the traffic through the Sault Ste. Marie canal from the opening of navigation on April 26th until Sept. 24th, show a considerable falling off. For the present year the number of vessels which have passed through the locks is 2,725, with a tonnage of 2,092,701, and a freight tonnage of 2,114,984. For the corresponding period of last year the number of vessels was 3,048, tonnage 2,211,899, and a freight tonnage of 2,463,058.

A new tug, "Robert Mackay," has been built for the Harbor Commissioners, of Montreal, by Carrier, Laine & Co., Point Levis, Que. The new vessel is a powerful looking craft, and has a speed of over eleven miles an hour. Her dimensions are as follows: Length between perpendiculars, 71 feet; length over all, 81 feet 9 inches; breadth, moulded, 17 feet 6 inches; depth, moulded, amidships, 11 feet 5 inches; draught forward 8 feet, draft aft 9 feet 6 inches. The tug is built of steel. The cost was about $8,000.

"Success has attended every service this season," said C. S. Gildersleeve, manager of the Richelieu & Ontario Navigation Company, in a recent interview published in a contemporary, "and the earnings are over $100,000 net, in excess of those of last year." He stated further that so encouraged was the company that other new steamers would be added to the western service, and to that between Quebec and Montreal. At present the boat-builders were congested, and it would take a year to get one new boat ready. During the coming winter the steamer 'Longueuil,' would be rebuilt, and the ferry service perfected as far as possible. The new steamer 'Toronto' had helped to swell the earnings, and only proved that the public appreciated first-class accommodation. The hotel department of the company promised to expand, as it, too, had proved highly successful. The new hotel at Murray Bay was 'under way,' and would, he expected, be ready by June 15, 1900."

Objection has been made by United States vesselmen to paying fees for the inspection of United States vessels running to Canadian ports, though the Canadian officials have been carrying out the law of Canada, whereby Canadian vessels were charged inspection fees. American vessels were treated in exactly the same way. For the past ten or more years the American Government has been in the habit of inspecting Canadian vessels running to American ports. The Canadian Government has repeatedly requested the American Government to accept the Canadian inspection in American waters in lieu of the United States inspection being accepted in Canadian waters, but this reciprocity had not met with favor. The margin of safety under the Canadian law is said to be much greater than that under the United States law. In the first place the steam boilers of Canadian vessels are not allowed to use within 25 per cent. so high a steam pressure as is permitted under the American inspection.

Mining Matters.

Geo. McIlraith's iron pyrites mine in Darling township, Lanark county, Ont., is now being worked.

Work at the Ostram nickel mine on the Calumet Island, Que., has been resumed by the English-Canadian Mining Co.

Gold has been found on the farm of Robert Grier, 4th line, Ramsay, Lanark county, Ont. An assay is said to show gold amounting to $8 per ton.

The mica mine discovered on the property of Robert Schnider, 7th concession, Sydenham township, Frontenac county, Ont., has been bought by G. Moriel, Kingston, Ont., who will work it.

The richest mica mine so far discovered in the Gatineau district, that of Father Guay at Gracefield, Que., has been sold to W. H. Sills, Chicago. A complete equipment of the newest machinery will be installed.

The Sailor mine, Camp McKinney, B.C., is sinking a vertical shaft by contract for 100 feet, and when that depth is reached a hoisting plant, which was recently ordered in this city from the Jenckes Machine Company, will be installed.

The first discovery of coal in the Boundary district of British Columbia, it is claimed, has been made by Robert Clark. The seam is said to average 25 feet in width, and is on the north fork of Kettle river. Jay P. Graves has bought a half interest, and will develop the property at once.

On the Minnehaha mine, Camp McKinney, B.C., a five-drill Ingersoll Sergeant compressor and an 80-h.p. boiler have just been installed. The plant is to be used to extract ore in sufficient quantities to run a 10-stamp mill which the company has ordered. There is considerable high grade ore in sight in the mine.

The Dunnville, Ont., Natural Gas Co. has been incorporated with a capital of $20,000. The provisional directors of the company to be J. Taylor, F. J. Ramsey, W. W. Krick, J. Norris, W. Shirton, W. D. Swayze, J. Parry, C. Shirton, T. Rice, L. Masseear, W. Bullock, J. E. Griffin and R. Bradford, of Dunnville, Ont.

J. Johnston, manager of the Crow's Nest Coal Co., Fernie, B.C., stated recently that 500 men were now engaged in the company's mines, that the mines were lighted by electricity, and the coal was hauled to the pit's head by electric motors. The company can produce 1,000 tons of coal every 24 hours, and when the coke ovens now being constructed are completed it will supply 300 tons per day.

Telephone connections have been made from Mine Centre, Ont., to all the mines of the Bad Vermilion Lake group, including the Golden Star, Decca, Manhattan, Olive, Lucky Coon, Aria, Alice A., and many others. The Manhattan Gold Mining Company is installing a compressor plant, and fifteen additional stamps are being installed at the Olive mine.

The Iron Mask Gold Mining Co., Rossland, B.C., is enlarging its electric hoist and air compressor, and has placed an order with the Royal Electric Co. for a 120 k.w. S.K.C. synchronous motor. The first order received by the above company from the Iron Mask was for a 75 k.w. S.K.C. motor. This was found not large enough for the requirements.

W. R. Arnold, of the Valley Worsted Mills, Providence, R.I., and David Sherwood, Rhode Island, were recently in St. John, N.B. They are interested in the Intercolonial Copper Mining Co., whose property is situated near Dorchester, N.B. The mine has been idle for 15 years, but the company intends to resume operations next summer. About $125,000 will, it is said, be invested in new machinery and buildings.

It is said the Dominion Coal Company will mine 400,000 tons this winter.

J. L. Bell, advocate, Quebec, has accepted the position of assistant gold commissioner in Yukon at a salary of $4,000.

G. W. Mitchell has just returned from the Peel River. He has made a good map of the river courses in the hitherto unexplored country lying between the Mackenzie and the Yukon rivers.

D. H. Beaton, Fort William, Ont., reports that the Johnson Nickel Mining Co., St. Paul, U.S., are doing extensive prospecting for iron with a diamond drill on the Canadian border near Gun Flint Lake.

George C. Hinton & Co., Vancouver, B.C., have placed an order with the Royal Electric Co. for a 10 k.w. multipolar generator, and the necessary wiring of lamps for one of their mining camps on Vancouver Island.

A fine strike of nickel ore is said to have been made in the Fort Steele district of East Kootenay. The claim is four miles from Fort Steele on Wild Horse creek. A wagon road runs from Fort Steele directly to the property.

An immense copper belt is said to extend from White Horse Rapids, on the Yukon River, to a point on the Dalton trail, forty miles from the Lynn Canal. It is over fifty miles in extent, and lies in British territory. In places vast masses of ore yielding $60 in copper to the ton are exposed.

W. H. and J. W. Wylie, Almonte, Ont., have a gang of men taking out hematite iron ore between White Lake and Calabogie, Renfrew county, Ont. Several car-loads will be shipped to the smelting works at Deseronto for test, and if found desirable the mine will be extensively worked.

Lord Ernest Hamilton is said to have bought the Florman quartz claims at Atlin for a quarter of a million dollars. The agreement binds the company which Lord Hamilton will organize, to put up a stamp mill of large size. The group is called the Anaconda group and embraces four ledge claims, aggregating 216 acres.

J. J. Durage, Duluth, Minn., has surveyed the water power of the Seine river, Ont., from Sturgeon Falls to McManus Falls, a distance of eight miles. There is a total fall in this distance of nearly 100 feet, of which 74 feet are in eight falls. It is feasible to construct power plants for the generation of nearly 3,000 h.p. Power might be furnished for the operation of the Alice A., Gold Bug, Emma Abbot and a number of other mines near by.

The iron mine at Ironsides, Que., on the Gatineau River, four miles from the centre of Ottawa city, and known as the Haycock mine, has been sold to J. O. Hibbert, until lately of the New York and Ottawa railway. The mine has an area of 300 acres, and the ore is of the best hematite. It was operated twenty-five years ago when smelting on a small scale was carried on, and extensive shipments were made, but the price having fallen operations were suspended.

The uncovering of a solid mountain of native ferro-nickel manganese at Durango iron mountain, Mexico, has created great excitement throughout the Republic, according to the statement of Harvey Kline. Tradition has it that this enormous mass of native metal is an aerolite that fell from the sky centuries ago. It is more than 300 feet high, half a mile wide and more than a mile in length, and is estimated to contain more than 500,000,000 tons above ground. It is worth $485 a ton. A rolling mill with two large blast furnaces is now nearly completed to work on this mass of native metal, and already five cars of ferro-nickel manganese have been shipped daily from Durango to the United States and Europe.

The announcement has been made that the Dominion Coal Company has made voluntary provision for sufferers through the late disaster at Caledonia as follows: For each widow a month's pay for the first year, and after that during her life, or while she remains a widow, $12 a month. Two dollars a month for children until they are each 13 years, and after that $4 a month for the boys until they attain 14 years, and $4 a month for the girls until they attain 16 years. In cases of single men who were supporting aged or infirm parents the latter are to receive $8 per month during life. Parents who were partially dependent upon their son for support will receive $4 each per month. The payments are to date from July 1 last and continue as above.

The statement of laboratory work done at the Ontario Government Assay Office, located at Belleville, which is conducted by the Bureau of Mines as an aid to the discovery and the development of the mineral resources of Ontario, shows that 277 determinations or assays were made during the month of August. These consisted of 232 gold assays, 14 for gold and silver, 19 for copper, 7 for nickel and 2 iron ores for partial analysis. Of these 168 determinations were done for the Bureau of Mines on which no fees were collected, while 109 were for the public on which fees aggregating $130.65 were collected. As the fees are about one-half the regular rates this statement shows that the prospectors and mining men engaged in development of properties are now aware of the advantages which the office affords. The office also reported on 30 samples sent in for identification, which consists of a description of the samples with the probable metallic contents and commercial value. The samples came from all parts of the province, the gold ores from the Seine River and North Hastings districts, while the copper and nickel ores were sent from the Sudbury and Parry Sound districts.

Dr. A. P. Coleman describes a specimen of hematite iron ore, which was taken from a deposit on the claim of E. V. Clergue of Sault Ste. Marie, which is about ten miles north of Michipicoten Post. It contains 60 per cent. of iron. The deposit, according to Dr. Coleman, has an area of 350 feet by 450 feet, although late exploration shows the length to be not less than 550 feet. The deposit rises to a height of 90 feet above the level of Lake Boya, into the waters of which it dips. So far as can be seen, Dr. Coleman says, most of the deposit is high grade ore. It possesses all the characteristics of hard brown hematite, many of the specimens obtained in it showing botryoidac forms, and a variety of beautiful colors. While the percentage of iron is high, there are only traces of sulphur and phosphorus. If the hill in which it appears is solid ore, which is almost certain, the quantity in sight above the ground line would be about 1,680,000 short tons, and if it goes to any distance below the ground line the quantity would be much more. The ore in sight alone, however, should produce 1,000,000 tons of pig iron, worth, at the present United States price, $15,000,000. Dr. Coleman says none of the adjoining locations have any important ore bodies in sight, but the same formation runs through them as in the Clergue mine, to a greater or lesser extent. Mr. Healy, of Duluth, who recently acquired these properties adjoining the Clergue mine, thinks the prospects are very good. To give an idea of the importance of the Clergue mine, it is sufficient to say that a blast furnace capable of smelting 200 tons per day, and working 300 days in the year, would occupy 28 years in smelting the ore in sight. As far as Director Blue of the Bureau of Mines is aware, it is the only important deposit of hard brown hematite in the country, and it very closely resembles the rich hematite ores supplied by Malta and Cuba. The deposit is so situated that the ore can be mined very cheaply—in fact it can be mined as an open quarry, and very easily and cheaply handled. The distance from the mine to the water's edge at Michipicoten harbor is only twelve miles, and docks are to be constructed at the latter point, where it can be put on board and delivered to the furnaces at Midland, Hamilton or Deseronto. A railway is now in course of construction from Michipicoten harbor to the mines, which is expected to be completed in time to ship out a quantity of ore this season. A quantity of ore will be sent to the new blast furnace at Midland, and Mr. Clergue is preparing plans for a new blast furnace at Sault Ste. Marie.

Personal

T. H. Wiggins, C.E., has tendered his resignation as town engineer of Cornwall, Ont.

H. Townsend, contractor for the Coast Railway construction, died of cancer at his home in New Glasgow, N.S., Sept. 8.

P. S. Gibson, Willowdale, engineer for York township, has been appointed to a similar position by King township council, York county, Ont.

Mrs. Margaret Gartshore, widow of the late John Gartshore, the pioneer manufacturer of Dundas, Ont., died at her residence in Hamilton, Ont., Sept. 2nd. Mrs. Gartshore was 90 years of age.

Capt. Lesslie, assistant instructor of engineering in the Royal Military College, Kingston, has gone to India to rejoin his regiment. He is a graduate of the Royal Military College, Kingston, Ont.

Matthew Neilson, C.E., manager of the electric railway system of St. John, N.B., visited his Almonte, Ont., relatives when taking part in the Dominion Rifle Association matches, where he showed himself an able marksman.

Fred. T. Greene, Butte, Montana, has been appointed mining engineer of the War Eagle Gold Mining and Development Co. Rossland, B.C. Mr. Greene is a Canadian, being the son of W. A. Greene, of the W.G. & R. Co., Berlin, Ont.

Thomas R. Secord died at his residence, Port Colborne, Ont., Sept. 6th. Mr. Secord was inspector on the Welland Railway during its construction, but in April, 1861, he was appointed deputy superintendent of the Welland canal, which position he held until about two years ago.

E. Andrews, M.E., a graduate of the School of Practical Science, Toronto, who has been on the assay staff of the War Eagle Mining Co. at Rossland, B.C., for the past year, has gone to McGill University for post-graduate work in mineralogy, the facilities offered for study there under Profs. Harrington and Adams being unequalled elsewhere in Canada.

Canada can claim a share in the praise that is being given the steamship "Oceanic," as its designer, the Right Hon. W. J. Pirrie, is a native of Canada, having been born in the city of Quebec in 1847. After completing his education at the Royal Belfast Academical Institution, he devoted himself to engineering and shipbuilding. He is now chairman and principal of Harland & Wolfe, Ltd., and has designed and built some of the largest and fastest steamers afloat, including the "Majestic," "Teutonic," "Canada," "Cymric" and "Pennsylvania."

John W. Bell, B.A.Sc., lecturer on mining and metallurgy in the Faculty of Applied Science, McGill University, has resigned, and accepted a position with a large mining concern in British Columbia. His resignation is a loss to McGill, from which university he graduated in 1897, and with which he has since been connected in the capacity of demonstrator and lecturer.

Jas. Poole, chief accountant of the Goold Bicycle Co., Brantford, Ont., has received a similar position with the Canada Cycle and Motor Co., and a short time after the appointment received by express a very handsome and costly silver service, without any intimation as to who the donors were, although it is presumed it came from the employees of the Goold Bicycle Company.

The Fairbanks Co., Montreal, has made a contract with the Foster Engineering Co., Newark, N.J., for control for the Canadian market of their product, consisting of pressure regulating or reducing valves and pump governors. Howard C. Foster, a son of the manufacturer of these goods, has taken a position as salesman with the Fairbanks Co., and will give his time to these goods in connection with the Fairbanks steam specialties, which are already so widely known.

Surg.-Lieut. Bertram, whose fine work at the Bisley ranges was commented upon in the last issue of The Canadian Engineer, was given a royal reception on his return to the town of Dundas, Ont., Sept. 6th. There was a torch-light procession with several bands, and an open air meeting, at which addresses were read on behalf of the town council and of the officers of the 77th Battalion, who also presented a silver tea service, as did also the Victoria Rifle Club, Hamilton. The citizens of Dundas, Ont., presented a purse containing $400.

W. A. Carlyle, superintendent of the Le Roi mine, is said to have accepted the managership of the Rio Pinto mines in Spain, with a salary of $25,000 yearly, which is very much greater than his former salary in Rossland, B.C. Mr. Carlyle is a Canadian, being a native of Oxford county, and a nephew of the great Thos. Carlyle. At the time of his birth his father, Wm. Carlyle, now public school inspector for Oxford county, was principal of the Central school, Galt, Ont. Mr. Carlyle, who is a distinguished graduate of McGill University, was formerly inspector of mines for the Government of British Columbia.

Railway Matters.

The G.T.R. is building a new double track bridge over the Magog at Sherbrooke, Que.

There is a strong agitation in the northern part of Quebec to secure the extension of the Lake St. John Railway to James' Bay.

A charter is to be applied for for a new line of railway between Ottawa and Brockville as an independent direct connection with Brockville and with the Grand Trunk system.

R. A. Hazlewood, C.E., has surveyed the connection between the C.A. and O.A. & P.S. Railway, and the C.P.R. at Parry Sound. The distance is almost five miles, and the link will form part of the James' Bay Railway.

A bylaw to provide for the granting of a $20,000 bonus to the Lake Erie, Tilsonburg and Port Burwell Railroad for an extension for the road from Tilsonburg to Ingersoll, was carried by a large majority in Ingersoll, Ont., Sept. 20th.

After many months of surveying and the expenditure of much money, the C.P.R. engineers have at last discovered a feasible route for a railway over the divide between the Kettle and Okanagan River valleys to the south of Camp McKinney.

The Midland Railway contractors in Nova Scotia are pushing their work, says The Truro News. The rails are now laid up to the Shubenacadie river, and ballasting is going on day and night. An electric light plant has been installed in the ballast pit at Stanley, so that night work can be pushed with redoubled vigor.

The Jenckes Machine Co., of Sherbrooke, Que., have built one of the George E. Smith power rail bending machines for Ross, Barry & McCrea, contractors, for use on the construction of the Great Northern Railway. The machine will be driven by a 10-h.p. Dake engine, the steam being taken direct from the locomotive.

The Algoma Central Railway has 500 men employed in the construction of a twelve-mile section of the line from Michipicoten Harbor to the iron mines owned by the company. The exceptional activity of the company, despite the scarcity of labor, is explained by the fact that a contract has been entered into with the Midland smelter for the supply of iron ore this fall. The rails will, it is said, be laid by November 1.

The Canadian Pacific Railway Company has received advices to the effect that the work of construction on the Columbia and Western Railway is now almost completed, and it is expected that trains will be running into Midway before winter. This road, which has been constructed by the Canadian Pacific Railway Company, opens up the famous Boundary Creek mining country. It runs from Robson, on the Columbia River, to Midway, on the Kettle River, a distance of 100 miles. T. G. Shaughnessy, president of the Canadian Pacific Railway, said recently: "The grading of the road into Midway has been completed, and there remains only some twenty-five miles of iron to be laid before we shall have our trains running into the town of Midway. The work on the big tunnel, 30 miles west of Robson, where we have pierced for 3,000 feet the side of a mountain, is not quite completed, but the completion of the work there will not prevent the running of trains from Robson to Midway this autumn. In addition to the main line, we have constructed some thirty miles of sidings along the line into mining camps, where the development has been sufficient to warrant us in going to that expense. This road is, by all means, the most expensive the Canadian Pacific has ever constructed. The country throughout the entire distance is exceedingly difficult, and the engineering difficulties very great. The entire line has cost the company in the neighborhood of $40,000 a mile, or a total expenditure of nearly $4,000,000 for 100 miles of line. The company received no subsidy. The Boundary Creek country promises to be one of the richest mining countries in British Columbia, and though the road has cost the Canadian Pacific a very large amount of money, there is no doubt that the business over the road, as soon as the mining properties along the line are opened up and developed, will be very large."

The Rainy River Railway will open up a great extent of rich mineral country. Commencing at Stanley, up to which point it has running powers over the Port Arthur, Duluth & Western Railway, the line runs close to Kakabeka Falls, a vast water power, and proceeds through the east end of the Matawin iron range, which is twenty miles long, of which two-thirds is soft hematite, and the remainder, at the western end, magnetic. Skirting the Shebandowan and Kashabowie lakes, the line then passes through a copper region, the most known mine in which is the "Tip Top," having a vein of a hundred feet wide; thence it runs close to Moss township, where there are several gold locations, not at present being developed. The line next passes close to Lac des Mille Lacs and Partridge Lake, twelve miles to the south of the Saw Bill mining region, running nearly parallel to the Ati-Kokan iron ranges, a distance of twenty miles. It is stated upon excellent authority that here is the largest iron deposit in the world, there being in one place 2,000,000 tons of iron ore in sight on a plot of 160 acres. The Seine River waters are next reached, which will give ready access to the mines, and here there are many valuable water powers. Running along the Seine River valley, the line goes near to Bad Vermilion and Little Turtle lakes, where it will cheapen supplies for more than a hundred prospects and mines, the principal of the latter at present being the Golden Star and the Olive. It next runs along Rainy Lake, crossing the western arm of the same on a succession of six islands, two miles west of Pither's Point, necessitating the building of five bridges. Between Pither's Point and Fort Frances is an excellent site and prospect for a large city, the Couchiching Falls being estimated to supply a water power of fully 50,000. From Fort Frances the line runs along the Rainy River, where there is a large area of fine agricultural lands, and reaches Hungry Hall, at the river's mouth. Here the line leaves Canadian territory until it reaches Buffalo Bay, a distance of 35 miles, and enters Manitoba at the latter point. The land is well wooded from Buffalo Bay to Winnipeg, and considerable revenue has been derived from this source to assist the 60 miles of railway already constructed. Besides the subsidy proposed for this Rainy River Railway, the Government has included a subsidy in the estimates for 40 miles of the 160 miles of the proposed Central Algoma Railway, and if these two lines should be built, as now seems almost certain, they will not only help to develop the interior of New Ontario rapidly, but may be expected to act as great feeders to the St. Lawrence route.

THE STOKER CASE.

Our readers will remember an action taken by the General Engineering Company, of Toronto, against the American Stoker Company, of New York, and the Dominion Cotton Mills Company, of Montreal, which has been pending in the Canadian Courts for more than a year past. This was a suit brought by the plaintiffs against the two defendant companies for damages for infringement of the Jones-Underfeed Stoker patents, and for an injunction to restrain the defendants from using these stokers in Canada. The case was regarded as a very important one to manufacturers, and both parties to the suit had retained eminent counsel. J. L. Ross, of Rowan & Ross, Toronto, and C. A. Duclos, of Atwater & Duclos, Montreal, appeared for the plaintiffs, while Donald McMaster, Q.C., of Montreal, and Gifford and Bull, of New York, represented the defendants. The trial lasted four days. The action was a test case, the object of which was to determine the validity of the Jones' patents, not only in Canada, but for the whole continent of America. The judgment of the Exchequer Court, in which it was brought, was a very strong one, and Mr. Justice Burbridge upheld the validity of the Jones patents, and granted the injunction asked for, with damages. These damages were not fixed at the time, but would depend on the number of the defendant's stokers set up in Canada. The total damages would probably reach $10,000, or over. The defendant's, however, are continuing the litigation in another form on a point raised by them since the previous action was decided, and have obtained a stay of proceedings in the main action by putting up a bond in the American Surety Company for $5,000. The result of the action will be of considerable interest to owners of Canadian patents in general. Up to the present the General Engineering Company have succeeded at every stage of the legal contest.

—One of the oldest bridges in Europe is soon to disappear, under the demand for better navigation of the river it spans. This is the stone bridge, with fifteen arches and a total length of 994 feet, built across the Danube at Regensburg (Ratisbon), in Bavaria, by Duke Henry the Superb, in 1135-1146.