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The Canadian Engineer

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For THE CANADIAN ENGINEER.

RAILWAY ENGINEERING.*

BY CECIL B. SMITH, MA. E., MEM. CAN. SOC. C.E., ASSISTANT PROF. OF CIVIL ENGINEERING IN M'GILL UNIVERSITY.

CHAP. V.

ROADBED CONSTRUCTION.

ARTICLE 27.—FOUNDATIONS.

The foundation of a structure is much more important than any other feature of its design, as on its security depends that of the structure itself. We may therefore be justified in examining closely into the bearing power of soils, the various methods of increasing it or distributing the load over greater areas, and the various methods of sinking or making foundations.

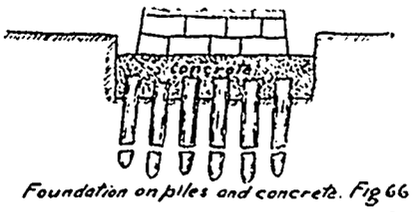
The bearing power of soils varies very much, being least for soft clays and unconfined quicksands, and increasing through sand, gravel, firm clay and hardpan to solid rock; it may be as low as one-half ton per square foot, and as high as 180 tons per square foot, but it is only with the lower values that we need deal. A good clay foundation will bear safely 2½ to 4 tons per square foot, and dry sand or gravel from 5 to 6 tons, while cases have been known of 10 to 11 tons per square foot being carried. In railway work 3 or 4 tons per square foot is usually all that we want to put on to a foundation; consequently, whenever good firm clay (which will not be watersoaked), sand or gravel are reached, the foundation may be considered safe, provided we have sounded several feet, and in case of important structures, many feet below the foundation bed, to see that the substrata are equally firm. Rankine's earthwork formula takes account of the depth of the foundation beneath the ground level, and one rule in use in the Western States is that the safe load per square foot on sand is 2 tons + 1 ton for each 10 feet in depth. No account has been taken of the friction of the soil on the sides of the structure below ground level. This is only of importance where the foundations are sunk by pneumatic caisson or open dredging, in which case it is variously estimated at from 200 to 600 pounds per square foot of surface exposed to side friction. If the caisson is of cast iron, about 300 lbs. for wrought iron, 900 lbs. for masonry, 300 to 600 lbs. for timber, and for piles 500 to 1,000 lbs. per square foot.

FOUNDATIONS ON LAND.

Where a firm foundation is obtainable within a few feet of the surface, all that is necessary is to dig a pit below frost level, or to any required depth and commence stonework at once, or often lay 1 or 2 feet of concrete to get a uniform bed to lay on, if the foundation is bouldery or uneven; but if, on the other hand, the foundation bed shows soft spots or uneven bearing power, the difficulty may be overcome by using a deep bed of concrete which will span over small spots (provided there is no danger of undermining by scour from an adjacent river, liable to change its channel), or by using a grillage of timber instead, in cases where the timber will always remain watersoaked, but not otherwise. Again, the same expedients may answer if the whole foundation is somewhat, but not very, soft, by spreading out over a larger area. When, however, it is found that the foundation is too soft for such methods even if thoroughly drained, and that it will not pay to dig down far enough to reach a firm one, recourse must be had to some artificial method of obtaining greater bearing power, the usual way being to drive piles, although in some cases where cost is no object or the piles would be subject to decay, large platforms formed of cross-layers of steel I beams or rails bedded in concrete (as in Chicago), have been used to great advantage, the transverse strength being such as to enable a very much enlarged area being used. When sufficient piles are driven to carry the load required they may be cut off level and capped by drift-bolting on a double layer of 12 inch by 12-inch timbers, as a base for stonework, or preferably either on the broomed heads of the piles or after sawing them off, a layer of concrete is placed and also rammed around and between the piles, in which case the earth between the piles will take a portion of the load, being much compacted by the driving, indeed, in cases where timber is scarce, a method has been adopted of pulling out piles after driving and immediately filling the holes with well rammed sand, the compacted earth and the sand pillars together carrying the load safely. Cast iron and

*This series of papers will be issued in book form as soon as they have appeared in THE CANADIAN ENGINEER.

wrought iron screw piles are used extensively in ocean jetty, lighthouse, and pier construction, but for foundations to masonry structures on land the wooden pile is in



Foundation on piles and concrete. Fig 66

almost exclusive use; of the various ways of driving piles by steam hammer, drop hammer, water jet, gunpowder explosions or insistent weight, the first three are the only ones worth considering.

The water jet is used economically where water is plentiful, ordinary pile driving inconvenient, and in sandy, quicksandy or silty soils (indeed it is often the only means of driving piles in bad quicksands), the water is carried in a pipe down the side of the pile and is projected in large quantities and considerable pressure just below the point of the pile; this allows the pile, assisted by a dead weight or by light blows from a small hammer, to sink very rapidly, the water rising in a film around the surface of the pile and almost eliminating friction as long as the action continues, but after driving is finished the sand or earth settles around the pile and gives as high a bearing power as with hammer-driven piles.*

The Steam Hammer weighs from 4,000 to 5,000 lbs. and sits on the head of the pile, striking a blow with a piston loaded with about 3,000 lbs., the stroke is 2½ to 3 feet in length and about once per second. This keeps the soil and pile in a continual vibration and effects more than the occasional, though more severe blow of a drop hammer. Although a steam hammer is unable to drive in very hard ground economically, and is not economical where only a few piles are to be driven in a place, as the cost of transportation of hammer, boiler, steam-pipes, etc. is too great, yet wherever a great many piles are to be driven in one locality, as on docks, large foundations, etc., or where the outfit can be economically transported from place to place, it can drive piles much more cheaply and quickly than a drop hammer.

The Drop Hammer is raised either by hand, horse, or steam power, and usually a trip is arranged to free the hammer automatically at the top, the line being brought down again by hand, which takes time. In order to avoid this, sometimes, in driving by steam, the line is permanently attached, and a friction drum is utilized to let it drop without tripping, thereby dragging the line with it and lessening the force of the blow, but economizing time. The chief danger in this method lies in its abuse by dishonest contractors, where the pile-driving is specified for certain maximum penetration at the last blow, in which case, a slight friction on the drum will materially lessen the effect of the blow. The weight of drop hammers varies from 1,200 to 2,000 lbs., and the drop from 15 to 30 feet depending on the hardness of driving and pile head, and length of leads. The drop and steam hammer are in general use, and the load which a pile can safely carry may be approximately estimated by various empyrical formulæ, when the drop, weight of hammer, and penetration at the last blow (with an unbroomed head to the pile) are known, such formulæ are usually on the safe side, because although at least one instance has been given of a pile refusing to drive at all, and yet after a day's rest going five or six inches, yet the usual experience is that piles which will penetrate several inches at a blow, after long continued driving, will penetrate less, or almost refuse to drive after a rest of a day or two allowing the material to settle around the pile.

*See *Engineering News*, Vol. 31, 1894, page 316, for jet pile driver.

The three formulæ looked upon most favorably in America are:—

(*a*) Weisbach's or Sanders—

$$\text{Safe load} = L = f \times \frac{12\,WH}{S} \quad (f = \tfrac{1}{3} \text{ to } \tfrac{1}{8}).$$

(*b*) Trautwine's—

$$\text{Safe load} = L = f \times \frac{46\,W\sqrt[3]{H}}{S+1} \quad (f = \tfrac{1}{3} \text{ to } \tfrac{1}{12}).$$

(*c*) Wellington's—

$$\text{Safe load} = L = \frac{2\,WH}{S+1} \text{ (drop hammer).}$$

$$\text{Safe load} = L = \frac{2\,WH}{S+\frac{1}{10}} \text{ (steam hammer).}$$

(L = safe load in lbs.; W = weight of hammer in lbs.; H = drop of hammer in feet; f = factor of safety; S = penetration, per blow, in inches, for average of last four or five blows.)

Where penetrations are as much as two inches or over there is not much to choose between all these formulæ; but for small penetrations the 1st one is evidently inapplicable, giving abnormally high results; on the other hand, the third formula is conservative under all conditions, simple in use, and admits of a modification for steam hammer driving, in which *stiction** is not an element to be considered. It is also applicable down to zero penetrations for ordinary weight of hammer, drop and length of pile, as $L = 2\,WH$ is about what a pillar 12 or 15 inches in diameter and, say, 20 feet long will safely stand (taking W = 2,000, H = 25).

These formulæ neglect many small losses of energy in driving, and are, therefore, only empyrical; but the results accord fairly well with the few facts known regarding the safe loads on piles. Evidently in ordinary soils, the skin friction is the important element in their sustaining power, as the load carried on the point of even a blunt ended pile would not be very great unless on solid rock.

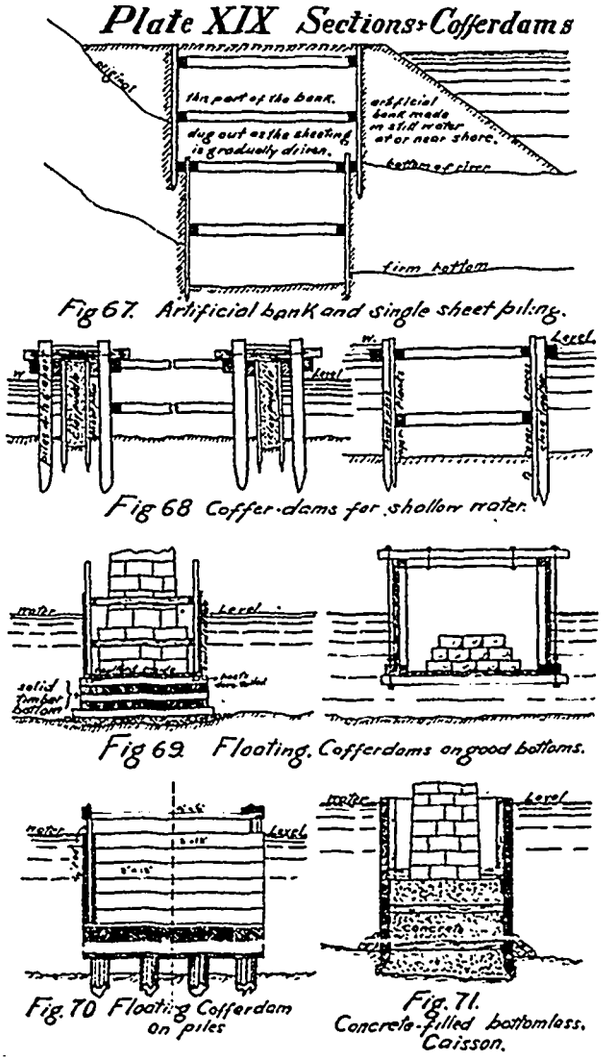
Of the ordinary losses of energy in pile-driving, the only important one (neglecting the friction of the leads, the compressing of the pile, the bouncing of the hammer, which latter can be remedied by lessening the drop, or getting a heavier hammer), is the brooming of the head and point under hard driving. To prevent the former, a hea[illegible]on band about three inches by one inch should be fitted around the head, and when brooming does occur, it should be sawed off at once. While in hard or bouldery ground the point should be shod with straps of iron and made rather blunt—in fact some drive with piles almost without a point, claiming that brooming is thus prevented—in quicksand, a pile turned butt downward will often be the only means of keeping it down during driving, and in all cases where piles are subject to severe vibration they will take a much less load than where it is a quiescent one. This is not included in the formulæ and must be provided for in the design.

For permanent piling in fresh water districts such woods as cedar, oak, yellow pine, rock elm, spruce and tamarac are in common use, being given somewhat in order of merit for durability, while any good wood may be used for temporary work. The cost for ordinary lengths will vary from five cents to eight cents per foot in favorable localities, to twelve cents or fifteen cents for oak piles at a greater distance, and even twenty-five cents or

*Stiction is that excess of frictional resistance offered, when a body is started from rest, over the continuous frictional resistance offered to a body while in motion, under the same conditions of surrounding material. C. B. S.

thirty cents per foot for the same in great lengths of fifty or sixty feet; driving will vary from two cents or three cents per foot in situations where great quantities are driven by steam hammer, to four cents or five cents per foot where driven by a track pile driver on cars; but for ordinary railway construction work, scattered and in small quantities, eight cents to twelve cents per foot is not out of the way. An ordinary price on railway construction is about thirty cents per foot for good piles, 12 inches in diameter at the small end, in place in the work, and fifteen cents per foot for all cut-off ends, this includes all labor of driving and cutting off to the exact height if on land, but cutting off under water is extra, and sometimes a matter of considerable expense.

Deep Foundations on Land. — Where foundations require to be carried down for any considerable depth, it is more economical to timber and sink vertically than to put earth slopes on the foundation pit, such timber will, in general, consist of vertical hand-driven sheet piles and horizontal rings of timbers and braces to sustain them at five or six foot intervals, as shown Fig. 67, Plate XIX.,



and in planning such work it is well to remember: (1) To allow for extra room more than is apparently required, in order to give freedom of movement, extra timbers, etc.; (2) To be sure to find out how deep it is to good bottom before digging is begun, in order to see whether piling might not be less expensive, and chiefly so as to be able to say definitely how many rings of timber there will be, and how much extra room will, therefore, be needed to step in all around about 15 inches every 10 or 12 feet in depth; this is a very important consideration. See Fig 67.

FOUNDATIONS IN WATER.

When masonry work is to be built in water, the considerations which determine the method to be adopted are: (1) The depth of water and its fluctuation in level. (2) The depth of soft material underlying the water which must be penetrated to secure good foundation. (3) The velocity of the current. (4) The money and materials available.

Of these considerations Nos. 1 and 2 are most important, and the total depth from water surface to bottom of structure will determine whether the foundation should be obtained by:

(*A*) Fixed cofferdams; (*B*), floating cofferdams, with solid timber bottoms; (*C*), bottomless cofferdams or caissons; (*D*), compressed air; (*E*), open dredging.

Fixed Cofferdams.—These are used where there is shallow water, at most only a moderate current, and where the bottom is of such a nature as to admit of sheet piles being driven in and the foundation suitably excavated to a firm foundation bed. This may be accomplished in various ways. Where the structure is near shore and waste excavation is available, it will pay to make an embankment above water level, and carry down hand-driven sheet piles kept in position by rings of timber, the excavation being always kept about level with the bottom of the sheet piles. This method is illustrated in Fig. 67. If, however, the structure is not thus situated, the sheet piles are either driven in a double layer, as in Fig. 68, or a single row of Wakefield sheet piling is used (this is an artificially made sheet pile composed of three planks spiked together to form a tongue and groove). If any of these methods are employed, a centrifugal pump will be kept busy keeping down the water while the foundation courses are being laid, but in case such pumping power is not advisable or available a more expensive form of cofferdam can be used, as in Fig. 68. Rows of guide piles are driven at considerable distances apart, then walings are bolted on, and a double row of sheet piles is driven around the area to be unwatered, between which is rammed clay puddle, making a very watertight, but expensive, cofferdam. This is generally employed in extensive works where the area is to be unwatered for some length of time.

Floating Cofferdams with Solid Timber Bottoms — It is moderately certain that as long as timber is covered with running fresh water it will never decay, and it is even contended that in any fresh water it is practically safe also; this has led to the adoption of methods of foundation building which do not involve the unwatering of the bottom. If the bottom is bare and moderately level, or can be dredged to a good bottom and levelled up with broken stone, it is manifestly easy to build a watertight box with either a solid timber (Fig. 69) or stone-filled crib, or only a plank layer, as a bottom (Fig. 69), and, after floating it into position, sink it, by building in it or by external loading, and after the structure has been built up above water level tear off the sides of the watertight box, leaving the bottom as a permanent part of the structure. If, on the other hand, the foundation is soft and good bottom can be reached by piling, the piles are driven to a firm bearing, sawed off under water close to the bed of the river, and the same operation as just described is gone through, the structure being landed on top of the piles as a foundation, as in Fig. 70. These methods are cheap and satisfactory in situations where the current is not excessive, but in very swift currents such constructions are not as manageable as the bottomless cofferdams to be described, and even where used, it is

found advisable to build the timber work and footing courses of masonry considerably (1 to 2 feet) larger than the neat work, which is laid out after the crib is in its final position. This provides for some permissible inaccuracy in sinking. The cribs are well drift-bolted together and the boxes caulked with oakum and dove-tailed or bolted down to the bottom, so as to prevent them lifting when the sinking process is going on.

Bottomless Caissons or Cofferdams.—Where no timber is desired under the masonry, or where the current is very swift, the method shown in Fig. 71 has been found best, but is only admissible where good foundations are easily obtainable. The bottomless box is floated into place, loaded until it sinks to the bottom, and then is either unwatered by having a large canvas flap around the outside of the bottom, held down by bags of concrete, thus nearly sealing the bottom, the caisson being then pumped out and the bottom excavated or levelled off with concrete, or else, if the bottom is already firm, as is usually the case in swift currents, there is no necessity for unwatering until a great depth of concrete has been put in, forming a watertight bottom; in the latter case, if there is an irregular rock bottom, the caisson cannot be made to fit it, and in order to keep the undertow from carrying away the concrete as fast as deposited, or even dissolving out the cement, it is found necessary to fasten a canvas flap around the inside of the bottom and load it down with bags of concrete, pea straw, etc., until a bottom has been formed And in depositing the concrete it is done by lowering an iron box, with a hinged bottom, containing about one cubic yard down to the bottom; the box is tripped, allowing the concrete to slide gently out, whereas it would become dissolved if allowed to fall any distance through water. After such a bed of concrete has been formed as is considered sufficient, the caisson may be pumped out and construction continued in open air.

Compressed Air.—Where a great depth of water and soft foundations are encountered the methods previously described must be abandoned. Early in this century the vacuum air process was tried, by which the excess of outside pressure forced soft materials up inside a vacuum chamber, this material being excavated, air was again extracted, and each time the hollow chamber of wood or iron sank down by its own or added weight; but this method was found uncertain in its means of directing the sinking, was capable of only limited application and failed entirely on encountering stiff clay or boulders, besides it did not enable the bottom to be personally examined and properly prepared for the foundation layers.

Very soon the plenum or compressed air process was tried, and to-day it is recognized as being in every way most satisfactory until greater depths than about 100 feet below water level are to be obtained, when open dredging through wells must be resorted to. Figs. 72, 73 and 74 show common forms of the same process. The drawings are almost self-explanatory, the pressure of air in the working chamber is constantly maintained, and the extent of the pressure must always be sufficient to keep out water; the tendency being for compressed air to be continually escaping around the working edges, and bubbling up to the surface outside the chamber. Where pneumatic cylinders are used, they are in pairs, sometimes braced together, the two supporting one end of a truss, and being completely filled with concrete after bottom is reached. See Plate XVI. One larger cylinder, as in the Hawkesbury bridge, with elliptical ends will, however, be much more stable.

Where large timber working chambers are used they must be very strong, as the whole weight of the pier will be carried on their backs until the working chamber is filled in, which is not until firm bottom is reached. It may be shod with iron or merely with timber, depending on the materials to be met with, and on top of this chamber may first be constructed a timber crib as in Fig. 74, extending up to the ground surface and filled with alternate pockets of concrete or broken stone sufficient to sink the chamber, which crib is built up gradually as the process goes on. Or, if advisable, the masonry may be commenced immediately on top of the working chamber as in Fig. 73, this will usually be done where the foundation is not a very deep one. The support which a deep caisson sunk by this method, or by open dredging gives to a pier and bridge, is partly by the bearing on the bottom and partly by friction on the sides, which is estimated at from 300 to 600 lbs. per square foot of surface, and is an enormous item in such a structure as that of Fig. 74, amounting to 2,000 or 3,000 tons. Of course, this resistance is not all to be overcome while sinking, for the continual movement and escape of a film of compressed air tends to aid sinking by lessening friction.

The material to be excavated is forced out of the discharge pipes by the compressed air, if it is finely divisible, by opening valves at the mouths of flexible pipes, but boulders, gravel, logs, etc., must be laboriously taken out of the air lock in small quantities, making the operation costly. The air shaft and lock form the means of ingress and egress, and it is a question whether it is safer and more convenient to have the air lock near the top or bottom of the shaft, the former, however, being safer for the men. The process of working the lock is to open one door, pass in, close the door, open a valve so as to raise or lower the pressure as the case may be, and then open the other door and pass on, some time being necessary to prevent injury to the lungs and ear drums; men can work in about

Plate XX

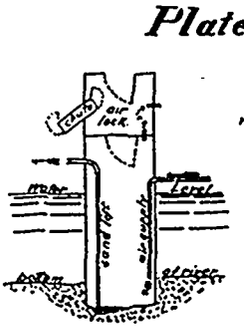


Fig 72 Pneumatic Pile

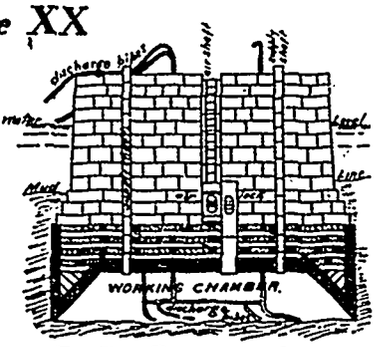


Fig. 73 Pneumatic Caisson.

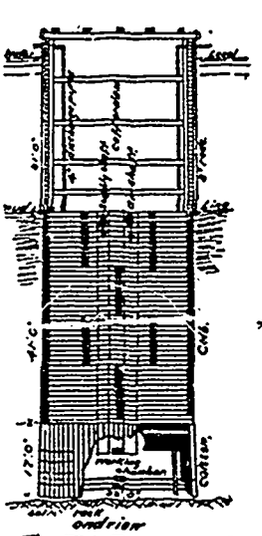


Fig. 74 Pneumatic Caisson with Crib and Cofferdam

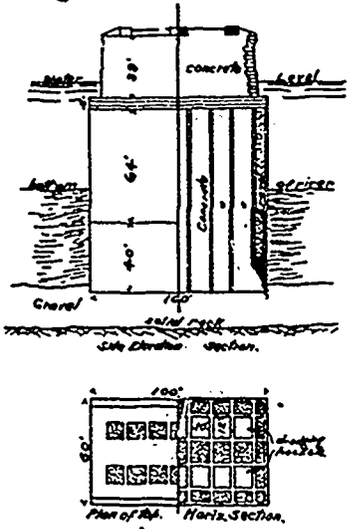


Fig 75 Open Dredging Caisson for Pier

4 atmospheres pressure as a safe maximum, and then only for three or four hours for healthy men; with less pressure the period of labor may be lengthened, but on coming out to the open air the depressing effect of a lowered pressure must be counteracted by a strong stimulant like coffee, to prevent injurious consequences; and for reasons of safety the compressed air is taken from a receiver and not direct from the compressor. So that an accident to the machinery might not have an immediately disastrous effect by permitting an inrush of water before the men could escape.

The supply shafts marked are only used at the last, where concrete is passed in through them, to fill up the working chamber. The shafts themselves are also all filled with concrete, and the whole structure is a solid mass of timber, concrete and stone. Sinking foundations by compressed air has many advantages—the sinking can usually be quite accurately directed; it enables all the pier construction and excavation to proceed together; it enables all kinds of materials to be removed, and it permits of a careful examination and preparation of the bottom before concrete is put into place.

An example of such construction is detailed in Patton's "Foundations," at a cost of

$16.82 per cubic yard for the caisson material;
$10.76 " " crib "
$7.83 " " sinking "

making an average of about $20 per cubic yard. This was for a depth of 68 feet below water and in 56 feet of mud—evidently the cost would vary with the depth and the materials encountered, in this case the sinking was at the rate of 1½ to 2 vertical feet per day.

Open Dredging.—This method has been long practiced in India, where circular brick wells are built with heavy walls, and gradually lowered through soft soils by excavating and undermining, the material being raised in some primitive manner. This is improved upon now by using steel cylinders and excavating by clam-shell or other dredges. There is usually difficulty in controlling the direction of movement, and large logs and boulders are troublesome. So that open dredging is usually used only where the depth is too great to admit of using compressed air and where the materials can be freely dredged (in India, submarine blasting of boulders, etc., tended to crack the cast iron cylinders, but would, probably, not have a bad effect on timber cribs). A striking example of this process is that of the foundations for the Poughkeepsie bridge, which were sunk through a depth of 50 to 60 feet of water and 75 to 80 feet of mud, clay, sand and gravel, or a total distance of 140 feet below high water. (See Fig. 75.) The cribs, 100 feet by 60 feet, had 31 gravel pockets, extending from top to bottom, which afforded enough load to sink the cribs when undermined; there were 14 dredging wells extending from top to bottom 10 feet by 12 feet, in cross section, through which the dredging was done by a clam-shell dredge. The walls were 2 feet thick of solid timbers, laid in alternate lapping courses, well drift-bolted together, and after the cribs arrived at good bottom the wells and pockets were filled with concrete, and a floating caisson similar to Fig. 69 was brought out into position and built into until it sank on to the top of the crib. The chief difficulties in carrying out this process, aside from anchoring such a huge mass of timber in a swift current, preparatory to dredging, are that it is difficult to guide the crib in direction as it settles down, and that logs, boulders, etc., under the cutting edges, cause delay and necessitate, often, sending down divers. A combination of compressed air and open dredging has been used in Europe, in which several working chambers surround an open well, the men force the material out under the inner edges of the working chambers from which it is removed by a clam-shell dredge; the process is cheaper in handling the material, but uses an enormous quantity of compressed air.

(To be continued.)

For THE CANADIAN ENGINEER.

DISPOSAL OF TOWNS' REFUSE.

BY W. M. WATSON.

(Concluded from last issue.)

Lately the scientific journals of the United States have been reporting a process of garbage disposal invented by a person named Harris. I visited his experimenting room and examined the garbage gas manufacturing machine, consisting of an extra large wood burning box stove, covered by two iron tubes, which acted as retorts for carbonizing the garbage, with another tube on top of the two, which answered for a superheater or reburner of the gas after leaving the retorts. I saw four lights of gas burning, stated to be from the gas manufactured from the garbage in the retorts, but after reading the description published on page 170 of the October issue of THE CANADIAN ENGINEER, I feel almost certain that the gas I saw burning was made from the coal oil, and, probably, chemicals that were mixed with the garbage when charging the retorts. I do not believe that Mr. Harris has found a chemical that can work what should be called a miracle, supposing that the reports should be true. A fuel gas can be made from vegetable or woody garbage that would add a great quantity of heat to a fire composed of wood or coal fuel, but would make a poor show if depended on to give heat or light alone. But even this kind of gas can scarcely be made with the little heat that can be generated with the experimental box stove, and I base my opinions on a two years' experience in the manufacturing of illuminating gas from sawdust, and the lessons I received, teaching me how to make water gas, and when I have explained the two methods, my readers will be able to judge the soundness of my views.

If ten pounds of melon skins and potato peelings be properly dried until all the moisture is extracted, it will be found that the vegetable substance left will weigh under 3½ pounds, proving that there was 6½ pounds of water in them, so that there is 3½ pounds of vegetable that can be made into fuel gas by a heat at a temperature of about 2,000° F., and 6½ pounds of water that can be made into a good heating gas, by first converting the moisture or water into a high pressure steam, then passing the steam through red-hot pipes which super-heats it, making the steam gaseous, then discharging it on to a fire heated to a temperature of about 3,000° F., in fine small jets, it is then turned into large volumes of gas, and by allowing drops of coal oil to drop on to the fierce fire along with the fine sprays of gaseous superheated high pressure steam, a passable illuminating gas is made at about the third of the price Harris declares he can make gas from garbage. In making gas from sawdust, we carbonized sawdust that was first dried well upon hot plates; if we needed illuminating gas we carbonized pine wood sawdust containing plenty of resin, which was probably the substance that gave out most of the gas needed. If we were well stocked with gas, we then carbonized dried hardwood sawdust that made large quantities of valuable acids; but we could not use wet sawdust to advantage. no more can Mr. Harris use wet garbage to make gas, for the two materials have a similarity. If we used sawdust in an undried state it condensed watery acids and threw off a

gas, useful only to burn under the cast iron retorts along with the bunch wood. So, plainly speaking, Mr Harris cannot make a combined vegetable and water gas with the heat that can be got out of wood burning box stove, because the heat needed to make gas from watery vapors would melt both his stove and his iron retorts, and the gas got from vegetable refuses will not be profitable to manufacture into illuminating gas.

The scientific papers of Great Britain make fun of the reports published in the United States about the garbage gas invention, and laugh the project out of court, saying that the reports read like fairy tales. There is a sarcastic article on page 522 of the *Surveyor*, printed in London, Eng., Nov. 5th, that handles Mr. Harris' reports of his invention without gloves.

It is in order for the inventor to prove that he has found a chemical that will totally change vegetable substances and give them a virtue equal to coal that has taken the earth thousands of years to instill into its nature the gas and heat-giving properties. When that can be done I will gladly welcome the invention.

In Bradford they destroy bad meat and fish by a machine similar to a boiler, that possesses a steam jacket, and revolves, and is evidently filled with knives, for after the wet meat has been in and revolved about an hour, it runs out through a small hole in a fine dry powder, of great value for fertilizing, and the residue of the furnaces is manufactured into mortar, etc. They also find a paying market for every castaway found in and picked out of the rubbish. With the heat evolved they generate electricity and supply power for useful purposes. At Southampton they have lately set in a few extra furnaces of the Goddard, Massey & Warner's type, with forced draught appliances, making them capable of burning 15 tons a day. Multitubular steam boilers are erected on the top of these furnaces that generate steam to a pressure of 160 lbs., which is used to pump and turn the machinery that chemically treats the sewage of the town. The boiler being placed on top of the furnaces will cause the hot gases to have a continuous rising grade from the furnace to the chimney, while in other destructors the gases drop down several feet from the combustion chambers to the underground flue, often as much as 15 feet. This system will be highly satisfactory to engineers, who believe that bending and dropping the flues, and compelling the smoke and heat to go down hill, spoils the draught and wastes the heat. The destructors at Rochdale are somewhat different to the others, being fired by hand through the clinkering doors at the front, similar to the Lancashire boiler. This has the advantage of its being possible to spread the refuse evenly over the fire and of the proper thickness to insure quick combustion, destroying a larger quantity of refuse than those that are fed from the top, but, on the other hand, the objectionable stuff has to be tipped on the ground floor in front of the furnaces, in place of on top out of sight of most of the attendants, and where the smell can be least perceived. The boroughs of Dewsbury and Warrington have the high temperature destructor furnaces designed by Beaman & Deas, which supply the largest number of units of heat, and a small residuum of well-burnt clinker and ash. They create a great heat from the foulest refuse and garbage that can be handled, supplying a greater amount of heat per lb. of rubbish consumed, besides completely destroying the poisonous fumes usually thrown off when burning excrement, offal, etc.

These furnaces are built in pairs, the fire bars being horizontal, at the rear end there is a sloping, inclined, drying hearth and it has the feeding door at the back end, where the refuse is usually thrown in by hand labor, and when the fires are cleaned and clinkered at the front doors, the refuse which has dried with the heat from the furnace during the time it has been lying on the drying hearth slides down on the top of the fire. There is only one combustion chamber to each pair of fires. Each fire is fed and cleaned alternately, so that when one fire is newly charged with green refuse, and consequently at its coolest period the twin fire is at its highest temperature, and both having to deliver their discharged smoke and gases into one and the same combustion chamber, the high temperature of the one mixing with the low temperature gases of the other, reburns it and raises it up to a high temperature. Thus, the combustion chamber remains at a white heat, which fully destroys any unconsumed fumes of foul gas that may be cast off by the furnaces. A suitable fan is used to create a forced draught which delivers the current of air into the closed ashpit, thus the air is forced pretty evenly between the grate bars into the body of the fire. The crown of

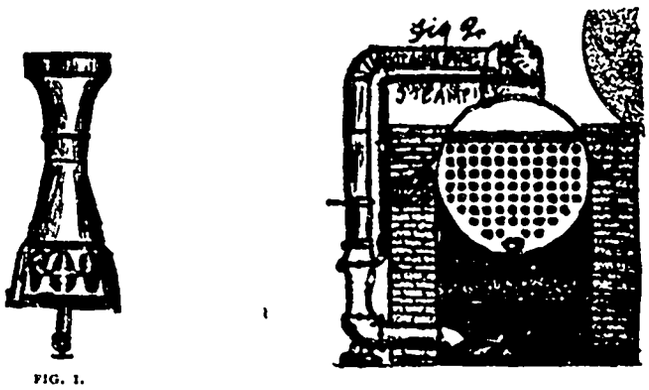


FIG. 1.

the arch over the fire, called the fire screen, being the partition between the furnace and combustion chamber, is perforated with holes near the front, over the cleaning door, for the escape of the smoke and gases, which compels the fumes from the roasting refuses on the drying hearth to pass over the fire from back to front before entering the combustion chamber. Perhaps the most advantageous and valuable feature of this destructor is the hollow firebrick fire-bridge that forms a passage of atmosphere air from the outside to the rear end of the combustion chamber, where it enters through a quantity of small distributing holes, adding a quantity of warm air to the fiery gases entering the chamber, supplying them with the oxygen needed at that point to reburn and increase the temperature of the gases sufficiently to thoroughly burn and purify the obnoxious fumes. It will be obvious that the cold air passing through the fire bridge must pick up a large quantity of heat by radiation and enter the combustion chamber at a moderate temperature. It is stated that the clinker comes as low as 25 per cent. of the weight of refuses destroyed, while the slow combustion only reaches 33 per cent., a difference of 8 per cent., which means a great deal in the cost of cartage where the residuum of the furnaces has no handy way of being disposed of or manufactured into mortar slabs, paving brick, etc., etc.

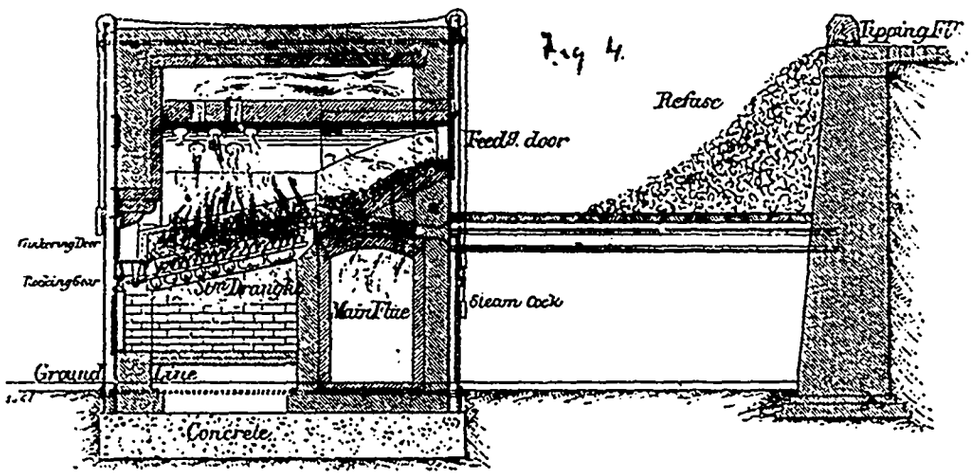
This type of destructor has been improved upon in several ways, viz.: In place of using a cold air fan, which chills the fire at the point of attack, cooling the clinkers and causing them to stick to the grate bars, a combined steam and warm air blower is used similar to the steam blower mounted by R. S. Earl, of Toronto, over ten years since, and employed by many steam users in Canada and United States. It consists of a bunch of fine steam jets discharged into about a 9-inch tube, something similar to

Fig. 1 and Fig. 2, which shows the blower in the act of giving a forced draught to a steam raising boiler. This will help to explain how the machine acts in this kind of a destruction furnace. It shows that the supply of air in that case is drawn by the exhausted steam jets from over the heated boiler, and mixing with the hot steam in the ashpit, where it enters the furnace between the bars at a high temperature, without the least shock or cooling effect to the outer edge of the body of the fire. When applied to a destructor furnace the air and steam is superheated on their way to the ashpit from the blower, by passing through the hollow, square cast iron tubes that form the side walls of each furnace (see Fig. 3 and 4.) The steam blower is fixed in position at the side of the inclined drying hearth (see Fig. 4), and at the point where it enters the hollow walls. Arrangements are made to draw off the fumes discharged by the roasting refuse, forcing them into the ashpit to be passed through the body of the fire, which thoroughly cremates them. It will be seen by the sketch that the blower exhausts the foul air both from the tipping floor, where the men stand to charge the furnaces, and the drying hearth behind the fire, thus making the handling of unhealthy and disagreeable excrement or offal almost as healthy as ploughing a field, besides giving a strong forced draught to the fire, saving the expense and doing double the work of a tall chimney. The firebrick sides of furnaces are usually the place where repairs are oftenest made, and it is an improvement to have hollow iron boxes, because they form a passage for the steam and air, which prevents them from ever getting red hot and burning out, as all firebricks appear to do at this point, therefore besides being of material use, they also save expense and annoying stoppages, but on the other hand they will have an acute chilling effect on the fire, which is made up again, by extra efficiency and power of the steam draught, and the extra units of heat made from the chemical combination of the steam and the burning material. At Oldham, Hamburg and other places these improvements are in full working order. They are patented and controlled by the Horsfall syndicate, even to the rocking bars and steam blower, which are purely American. The cost of construction and full equipment is about $500 for each cell or furnace, when the number of furnaces built exceeds four in a block.

FIG. 2.

It will be noticed that the Beamans and Deas plan of building the furnaces in pairs, each joining with one combustion chamber, and the introduction of oxygen into the combustion chamber, are advantages that go far to counterbalance the improvements controlled by the Horsfall syndicate. In other points they are similar in build, and if the good points of each could be combined, a unique and powerful destructor would be produced. In European towns that have a close packed and dense population they have as many as thirty furnaces grouped together in a circle or other convenient design, having a large secondary combustion chamber or vault that receives the flues from all the first and separate combustion chambers; the walls of this vault get red hot and assist in again mixing and reburning the gases, thus for a second time increasing the temperature and purifying the gases cast off by the refuse and offal of each furnace. The annexed illustration (Fig. 4) shows a sectional elevation through a Horsfall furnace with the latest improvement attached; Fig. 5 shows the position of the ten furnaces in the small town of Oldham, England. The chain governing the steam valves that cut off the steam from the blowers when the man desires to open the front doors is shown passing over the head of the furnace and hanging down to a convenient point. The fire screen, the combustion chamber, the drying hearth, the rocking fire bars, and the route that the smoke and gases are compelled to take are all clearly shown to the point where they enter the flues on their way to the general collecting vault, from which they are conveyed to the boilers which generate steam, that creates power to run any kind of machinery necessary to do the power business of the town, and the temperature of over 2,000 deg. Fahr. is reduced to about 600 before it enters the chimney, which may discharge the purified gases close to the windows of a closely built district, without the slightest injury to health or contamination of the atmosphere.

We are told by parties that have visited and investigated the details of construction of every kind of destructors at present working in Great Britain, that the managers, the inventors and attendants of each kind assure the visitors that their system is by far the best, and point out the advantages, showing high-class testimonials,

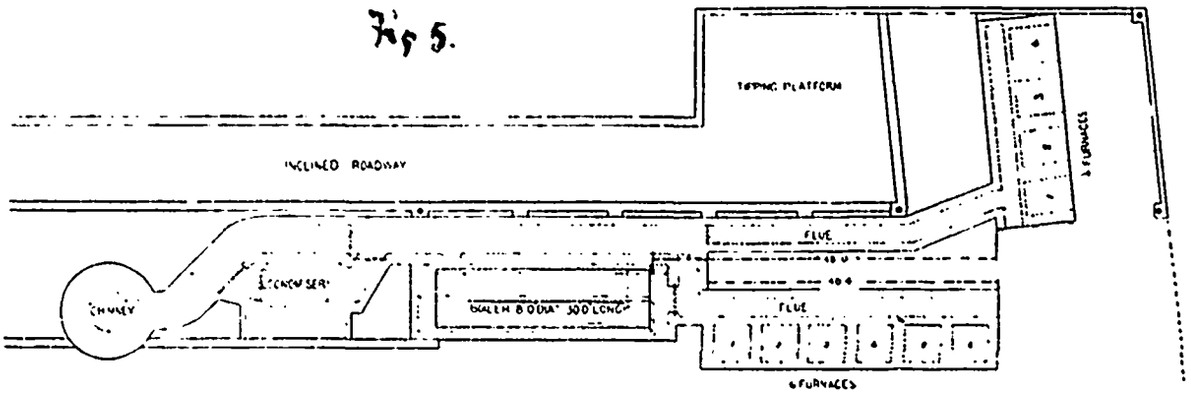


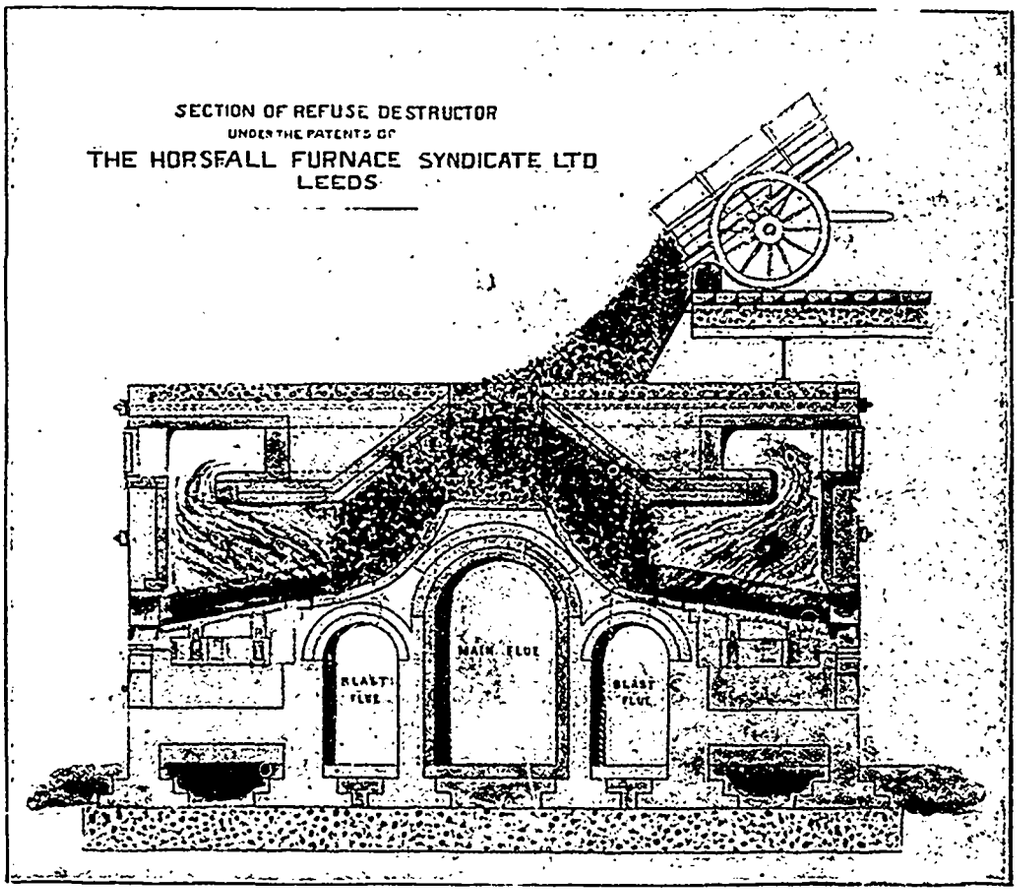
besides many pages of praise written in their book by previous visitors, which goes a long way towards mystifying and misleading deputations seeking knowledge. Those using the slow combustion and low temperature class, point out that one man can attend to fifty per cent. more fires than the men who attend the high temperature furnace, which may be true, but it is also true that the man attending to two high temperature furnaces consumes thirty tons of refuse each day, while the man who attends three low temperature fires, or one more than the other man, only

destroys twenty-one tons, or nine tons less than the man that only attends to two high temperature forced draught fires, so that their plausible argument is ridiculous when worked out in figures. They have a more combative objection, they say that the high temperature furnaces will soon burn out and the repairs will come high and expensive. Past experience of the few years that high temperature furnaces have been in use continually does not bear out the statement, for they remain sound and whole in places where they were well and properly erected, proving this argument wrong. The slag that attacks the brick in high temperature furnaces, and often believed to be caused by melting and running of the fire-brick, appears to have been proved by experts and experiments, together with careful watching during the past three years, to be silicious particles produced by the burning refuse and forced by the blast against the brick work, and can be easily knocked off. They also assert that it protects rather than damages the walls; this information is very satisfactory, and it is to be hoped that some person will find out a way of reducing silicious matter to either a powder or a gas, so that it will cease to be troublesome because it is a non-conductor of heat, and any combustion chamber lined with stalactytic formation will be useless as a re-burner of fumes and gases.

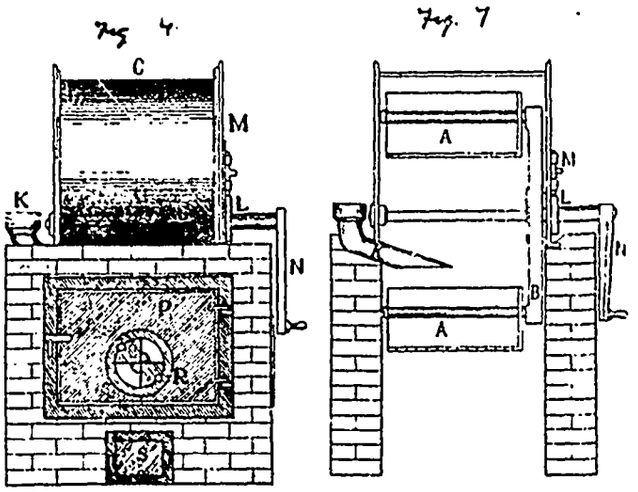
The solid advantages of high temperature furnaces is, that they burn all the fumes and injurious gases, without the aid of an expensive fuel eating cremator; they extract more heat, they reduce the refuses to the smallest possible weight and bulk, they make a harder and better clinker, they extract more heat per lb. of refuse and do double the work of the slow combustion type with less labor. Most of the low temperature sort are being altered and a forced draught added, making them into high temperature destructors, some of them on account of complaints that the unburnt fumes being discharged from their chimneys are a public nuisance. Before closing the subject of refuse disposal of towns, I might describe a useful refuse or house garbage destroyer, that if well built and carefully attended to when in use will be useful and valuable to any high-class residence or public building, placed in a country position where they cannot have the comforts of modern sanitary appliances, except they construct private ones for themselves. And where such places have their own private drainage and sewage disposal works this simple garbage destructor machine seems necessary to prevent the grosser solids, paper, grease, etc., from passing forward to the sewage settling tanks and choking the valves and pipes. The illustrations here produced, together with the explanatory references, will go a long way to

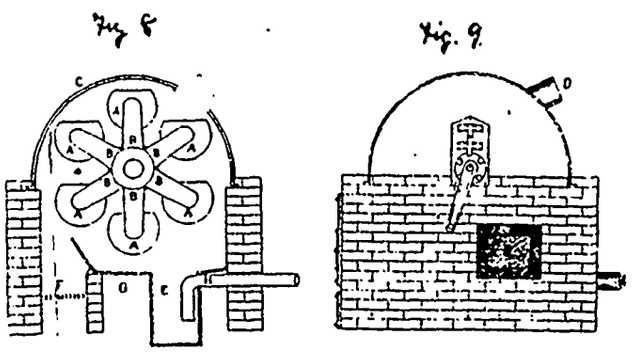
Fig 5.





explain the working of the machine. The apparatus consists of a series of perforated swinging buckets, holding about 1½ cubic feet, hung on a cross-bar, which holds in position the arms radiating from a central shaft similar to the Ferris Wheel. They are enclosed in an air-tight case, which has a connection by an iron pipe to a chimney and a 4-inch iron soil pipe that bring all the excrements and





A A A are the buckets or baskets of about 1½ cubic feet capacity *B B B* are the arms supporting buckets. *C* is the casing resting on an 8-inch wall *D* is the opening and thimble to connect to chimney. *E* is a grease trap made of common tiling. *F* is the grates. *G* is sand or clay filling. *H* is sewer pipe. *K* is cast iron intake pipe. *L* is ratchet wheel. *M* is the pawl to engage with ratchet to hold buckets in place. *N* is the crank arm. *O* is a door to get to grease trap. *P* is large door for access to buckets. *R* is a damper to regulate drafts. *S* is the ash-pot door.

sewage made in the building to the swinging buckets, together with the house garbage (except coal and wood ashes), which all fall and enter into the lowest bucket. The lowest bucket is securely held under the soil pipe, and when one is filled with the grosser solids, the attendant turns the wheel a notch, raising the full bucket up out of the way and leaving an empty one under the soil pipe. By the time the sixth bucket gets full the first is dried by the current of air circulating through the machine by way of the fire bars and chimney. The machine is so constructed that the sludge cake is easily turned out into the fireplace and the bucket swings back into its place. When the furnace place gets full with dry cakes, they are set on fire and quickly burn by themselves, and at the same time dry the contents of the six swinging buckets. If this cremator could be fixed near but outside of private buildings, it would answer for isolated places. There will be some smell from the machine, and the fumes from the burning sludge will pass out from the chimney when the sludge cakes are burnt about once a week, but the contrivance seems the best in sight yet for country places, and a great improvement on the present system in use.

A large number of towns dispose of their rubbish by sorting and cleaning that part of the rubbish that cannot be made into a manure, using the carbon and inflammable material for generating steam, and to enable the sorting to be done in a healthy atmosphere and without soiling the dresses of the employees, the best and latest designed machinery is used. By so doing, the cost of collecting the refuse is about covered by the sale of the products. Most of the cities and towns adopting this plan also adopt the pail system of privies, in place of vault privies, and very few water-closets are in use, because, having a well-disciplined army to regularly go around once a week or oftener to remove the full one, clean the place of lodgment out, and replace a well cleaned, disinfected pail, the places are kept sweeter and healthier than 90 per cent. of the water closets in use, and the sewage of the town is easier handled, being almost void of excrements. There are also towns which have the dual system of manufacturing manure and selecting out salable castaways, also destructor furnaces to consume the most objectionable offal that is collected.

Whatever system is adopted, the success and healthful efficiency almost entirely depends on cleanliness and well-disciplined management.

For THE CANADIAN ENGINEER.

WATER MAIN CLEANING IN ST. JOHN, N.B.

BY W. MURDOCH, C.E.

There are three leading mains supplying the city of St. John, N.B. Number one, 12 inches in diameter, was laid in the year 1851; number two was laid in 1857, and has a diameter of 24 inches; number three also twenty-four inches diameter, was laid in the year 1873. The reservoir from which the city's supply is derived is an artificial lake on Little River, distant five miles from the summit of the city and 160 feet above the level of high water in the harbor. The summit of the city is 130 feet above h.w. datum, and the hydraulic gradient in summer time generally reaches this district at an elevation of about 145 feet, the fall being thus about 15 feet, and the head of water 15 feet. In winter this head of 15 feet has been known to disappear during lengthy periods of zero weather when water was being wasted to prevent freezing.

The two older mains had become so foul through internal incrustation that, when No. 3 was shut off for repairs and the city depended on the other two pipes, all the portions at a height of 80 feet or more above datum, comprising an area of about 200 acres and containing a population of about 8,500 souls, were without water. On the other hand, with No. 2 shut off and supply coming by Nos. 1 and 3, every pipe was full and water delivered at a level of 130 feet. This was an ample demonstration of the foulness of the old mains as compared with that last laid. In the summer of 1897 the common council passed an order directing that the mains be cleaned, and preparations were forthwith begun.

There being no hatch boxes on the main lines, such fittings had to be designed and tenders asked for their manufacture. James Fleming being the lowest bidder, he was awarded the contract at two cents per pound. Delivery began in the month of October, and the work of cleaning No. 2 was started soon after. In designing the cleaner or mechanical scraper, special precautions were taken to avoid the misfortune of having it lodge in the pipe with such consequent vexations, searchings and cuttings of pipe as have often occurred elsewhere. The desiderata laid down were:

a. That the apparatus be as light as possible, so as to

be easily projected up ascending gradients by the pressure of the water, and to offer generally as little resistance as possible whether through inertia or otherwise.

b. That as it is more desirable to take light cuts and make frequent runs, than attempt to remove all the dirt at once and have the scraper stick; therefore, the pistons should be so loose as to permit a free escape of water to carry off the loosened dirt in advance of the cleaner, and that the arms be not so rigid as to hold it up against any hard and abrupt obstruction encountered.

With these maxims in view, the machine was made as shown in the accompanying cuts, the pistons being

MECHANICAL SCRAPER, USED IN CLEANING ST JOHN, N.B., WATER MAINS.

of birch set in layers, each layer being one inch in thickness and placed crosswise of the other to prevent warping and increase the strength of the piston. Leathers were secured to the piston by means of an iron ring bolted against them, the bolts running through the piston. The spindle connecting the two pistons is of 3-inch wrought-iron pipe with a cast-iron flange screwed on each end and pinned over with a hammer to prevent the screw backing out. These flanges are each bolted through the piston to another flange on the opposite side. Projecting beyond the forward piston is an iron rod fitted with two sets of radial arms sloping back as shown in the cuts. There are four arms in each set made of No. 10 (B.W.G.) spring steel two inches wide, and each fitted with a forged steel scraper on the end, of the form shown in the drawings. The long sloping fish-tail form of this scraper enabled it to glide safely over every obstruction. In making the first runs, only one set of scrapers was attached; but in the latter, the whole eight were in use. This precaution was taken for the reason given, viz., lest a large amount of dirt should be loosened at once, and the cleaner become buried and stop.

A section of No. 2 main extending from the reservoir toward the city, a distance of about 6,000 feet, having been prepared by inserting a hatch-box at each end, the work of cleaning began on October 12th at 1 p.m., and was continued that afternoon. The head of water upon the upper hatch-box was 20 feet and on the lower 27 feet. The first run took four hours, for the reason that a cord sufficiently long to reach the whole length had been placed on a revolving drum 10 feet in circumference, and furnished with an indicator to register the revolutions. The end of this string was attached to he cleaner, and a record kept of its location as it sped along. But when the first flushing branch was reached the twine drifted out here and down the brook, while the drum kept on revolving and the indicator registering until the whole string was paid out. Meanwhile the cleaner had become securely moored near the flushing branch and could not be liberated until the stop-cock was dug to and uncovered. On the twine being cut and pulled out and the stop-cock lid restored, water was let on again and the cleaner finished its journey, a distance of 2,200 feet in about five minutes. This first run was sufficient to show that twine was dangerous, and we also learned that it was entirely unnecessary, for the grating sound of the cleaner as it passed through the pipe was heard quite distinctly by the two watchers under their feet as they followed the sound along the line. Two more runs were given that same afternoon, the time occupied to go the distance being about twenty minutes. The water was inky black for some time as it flowed from the flushing pipe, and it was allowed to run for two hours after the cleaner had been removed, this time having been required for the water to clarify.

The next section was taken on Saturday, October 23rd. It extended about 6,600 feet cityward, but in order to give the first section another scraping it was concluded to insert the cleaner at the dam and run it through the entire $2\frac{4}{10}$ miles. A misfortune was met this time in the following manner: The leathers having worn out during the first cleaning were renewed with a harder and stiffer quality than formerly, but they repeatedly caught in a new joint made while inserting the hatch box. Each time the lid was removed to ascertain why the cleaner did not start, it was found firmly fixed by this imperfect butt of the two pipe ends. After twice extricating it and again finding it caught in the same way, a jack-screw was applied to push it past this obstruction, the lid was again put on and the water let in at 4.05 p.m., and this time it started. At each of the five flushing stations the gate was left open fully ten minutes after the cleaner had passed, and then closed. As soon as the gate was closed the cleaner again proceeded, and the scraper, with only one piston, reached the end of its run at 5.25 p.m., having been one hour and twenty minutes going 2.4 miles, but when 50 minutes of a total stoppage are reckoned, the machine was found to have been in motion 30 minutes. As stated, only the forward part of the cleaner arrived, and search had to be made for the remainder. Nothing was done on the following day, which was Sunday, the castaway piston, which was lying obliquely somewhere in the pipe, having but partially obstructed the flow, and the water was left on until the Monday night following.

A receiving chamber unites Nos. 2 and 3 mains near No. 3 hatch box, and they are controlled by stop-cocks on each side of the receiver. It was, therefore, an easy matter to reverse the current of water in No. 3 by closing the stop-cock at the dam, and opening that at the receiver, as well as the flushing branches. This was done, and men were distributed along the line to listen for a rumbling noise, which at length was heard within about a quarter mile of hatch box No. 3, from which the cleaner had been extracted. The sound was followed along the line toward the reservoir until hatch box No. 2 was reached, when the derelict was taken out, after having travelled nearly a mile and crossed a valley about 90 feet in depth. It was found that the pressure of the jackscrew in forcing the cleaner past the uneven joint had cracked one of the flanges, with the result that after having travelled about 2¼ miles the cleaner fell apart. The forward part, comprising a piston and the scraper, pushed on, but the spindle attached to the rear piston fell to the bottom of the pipe, ploughed up some dirt and finally became embedded and jammed. The reverse current striking the piston as it did, drove it back with the spindle trailing behind. The apparatus was repaired and three more runs made through this double section of 12,600 feet, on October 29th, without any further mishap, the time taken for each run, including ten minutes stoppage at each of the five flushing stations, having been from 1 hour 46 minutes to 1 hour and 55 minutes. The cold weather being on when

the next castings arrived, cleaning operations were suspended for the season, to be resumed next spring.

On testing the efficiency of the cleaned main by shutting off No. 3 from the reservoir to the receiving chamber, where both unite, and bringing the supply through Nos. 1 and 2, it was found that the pressure in the city was as good as when No. 2 was shut, and the whole supply coming through Nos. 1 and 3, thereby showing that the capacity of No. 2 had improved to such an extent that whereas, with No. 1 it had formerly delivered to a height of 80 feet only, when unassisted by No. 3, and left 200 acres of the city, containing 8,500 inhabitants, without water, now the whole city could be supplied without the help of No. 3 and the water rise to a height of 130 feet above high water. The general improvement in pressure with all three mains on was found to be about four feet. Nearly two miles of this line remain yet to be cleaned, after which the other two pipes will be taken as soon as the coming season permits

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For THE CANADIAN ENGINEER.

TORONTO MAGNETIC OBSERVATORY.

BY R. F. STUPART, DIRECTOR OF THE OBSERVATORY.

The importance of obtaining a correct knowledge of the elementary facts of terrestrial magnetism, for the purpose of supplying a foundation whereon the advancement of that science on inductive principles may be based has for long been strongly and extensively felt.

From an early period of the meetings of the British Association for the Advancement of Science, the interest of terrestrial magnetism had received no inconsiderable share of the attention and exertions of its members. In the year 1834 a magnetic survey of the British Isles was commenced and carried through in the two following years by the joint labours of five of its members. In 1835 the association called for a report from one of its members, on the state and progress of researches regarding the geographical distribution of the magnetic forces on the surface of the globe; proposing to ground on the preliminary examination an application to the Government to aid in the prosecution of the enquiry in remote parts of the earth, unattainable by the means at the command of the association itself, or of its individual members. This report, presented in 1837, was taken into consideration at the meeting of the association, at Newcastle, in 1838, and a memorial was addressed to the Government which, being favorably received by Her Majesty's Ministers, originated the naval expedition equipped in the following year for a magnetic survey of the high latitudes of the southern hemisphere. Deeming the opportunity a fitting one, the British Association availed itself of the same occasion to solicit the attention of Her Majesty's Government to the expediency of extending the researches to be accomplished by fixed observatories, to certain stations of prominent magnetic interest within the limits of the British Colonial Dominions; the stations named were Canada and Van Diemen's Island, as approximate to the points of the greatest intensity of the magnetic force in the northern and southern hemispheres; St. Helena, as approximate to the point of least intensity on the globe, and the Cape of Good Hope as a station where the secular changes of the magnetic elements presented features of peculiar interest.

The committee recommended that the proposed colonial establishments should be placed under the general supervision of the Ordnance Department of the Army. The Government having expressed a desire that such extensive arrangement involving a considerable expenditure should be strengthened by the concurrent support of the Royal Society, a deputation was appointed to express the cordial participation of that society in the recommendation both of the Naval Expedition and of the fixed observatories. Arrangements having been completed, Lieut. Charles James Buchanan Riddell, R.A., was selected for duty in Canada, who, leaving his detachment, consisting of four non commissioned officers of the artillery, to embark with the instruments on a vessel bound direct to Quebec, proceeded himself to Canada by the more expeditious route of the United States; and having waited on the Governor-General at Montreal to present a letter of introduction with which he had been furnished by the Master General of the Ordnance, and communicated with the Commanding Engineer, to whom he was the bearer of instructions and authority to build an observatory, he proceeded to examine different localities which were suggested as convenient sites. The preference was finally given to Toronto, where a grant of two and a half acres of land belonging to the University of King's College was offered by the Council of the University. The first observatory building was of logs, roughcast on the outside and plastered on the inside; it was completed during the summer of 1840 and observations were begun in September. The operations of the observatory as an Imperial establishment were brought to a close in the early part of the year 1853, and were resumed under the authority of the Provincial Government in July of the same year.

In the autumn of 1853 the present observatory was commenced, to take the place of the old building. Very great care was taken during construction to insure all the stone used being entirely free from magnetism, and all nails and fastenings were of either copper or zinc. For twenty-three years the position of the Observatory was as far as is known, faultless, and observations were carried on systematically and carefully, and results given to the scientific world, which with those obtained under the old military regime, have made the Toronto Observatory famous in the history of terrestrial magnetism.

In 1876, however, trouble began with the building of the School of Science, which institution, however, being principally of brick and wood, caused but very small changes in zero values, which could be allowed for. Then followed a few years later electric light circuits which produced a change in the force instruments whenever the current was turned off or on, this difficulty was in part overcome by the Light Company courteously agreeing to arrange their wires in the vicinity of the Observatory in such a manner that currents should counteract each other. The next difficulty occurred when the addition was given to the School of Science, tons of iron being used in the construction of that building in an all too close proximity to the magnetic instruments, and much time and labor has been required to determine the precise effect of this "iron mine" on the various instruments. It was not, however, until the autumn of 1892 when the trolleys began to run that we began to suspect that sooner or later the Magnetic Observatory would have to be removed to another site.

The magnetic instruments in the Observatory consist of those brought out by Lieut. Riddell in 1840, of which eye readings have been taken six times each day, and of another set of similar instruments consisting of a bifilar for the measurement of the horizontal component, a balance needle for the vertical force and a declinometer, all of which record photographically.

Electric cars first ran in Toronto on August 17th, 1892; the line first put in operation was that on Church street, which was followed on September 5th by King street, between George street and Dufferin street. During

the first few weeks, while a very small vibration of the needle was discernible on the V. F. curve it was generally almost inappreciable, and it was not until September 20th that the movement increased to an extent sufficient to really impair the value of our magnetic curves; a marked increase of current must have been used on that day and afterwards. On October 10 the cars first ran on Yonge street, and there was only a very small increase in vibration, but a decrease of about .000070 of a dyne was observed when the current was on. About 10 a.m., on the 14th January, there was a marked increase of vibration, and the vertical force increased about ·000200 one dyne. This disturbed period was only temporary, and shortly after 5 p.m. of the 17th there was a reversion to the smaller vibrations, which continued until May 15th, when very large vibrations began again and continued with varying intensity during the summer, while the decrease of the V. F. with the current ranged from ·ut ·000200 to ·000500. This disturbance was very g·.t between September 12th and October 17th and at intervals during the following year, but there was no radical change in conditions until December 17th, 1894, when a decrease of V.F. while the current was on, was changed to an increase, this occurring when the cars first ran on McCaul street. Throughout 1895 the vibration and amount of permanent deflection was very nearly as it has been since, but on October 15th the increase of V. F. with the current was again changed to a decrease, this occurred at the time that the railway company made certain changes in the feed wires. It is noticeable that although several changes occurred in the V.F., it at times having been less with the current on and at other times greater. The horizontal force showed a steady decrease on all occasions with the turn on of the current, which during the past two years has been ·000200 to ·000500. No appreciable deflection of the declinometer magnet can be noted, the only effect being a continuous vibration which has rendered the curves very ragged and difficult to read with accuracy.

A study of the traces during the times that the various electric lines were put in operation shows that with the currents ordinarily used there is little effect at ¾ mile, and a further survey with a portable instrument affords further evidence in the same direction; it has, therefore, been determined to remove the magnetic instruments to a point distant two miles from any probable trolley route and about nine miles from the present location, and continue what is certainly the most valuable and extended magnetic records outside of Europe.

NOTE—The history of the establishment of the Observatory at Toronto is taken from the early reports.—R. F. S.

PROCEEDINGS OF THE THIRTEENTH ANNUAL MEETING OF THE ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS, AT PEORIA, ILLINOIS.

The Illinois Society of Engineers and Surveyors assembled in thirteenth annual meeting in the rooms of the County Superintendent of Schools, in the court house, January 26th. The executive secretary's report showed the society to have eighty-one old members in good standing, and during the course of the meeting twenty-two new members were added. After the secretary's report had been read, C. C. Stowell, president of the society, delivered his annual address. The report of the waterworks committee was presented by Dabney H. Maury, jr., chairman This report gave information regarding the rules, regulations and rates of water companies throughout the State of Illinois. The secretary read a paper on "Railroad Construction in Mexico," by L P. Atwood, engineer of the maintenance of way of the Rio Grande, Sierra Madre and Pacific Railway. Mr. Atwood also presented a detailed account of the cost of steel tie plates used in the construction of this road. John T. Stewart, of Paxton, gave his experience as a leveler for the United States Geological Survey, in running lines in the Black Hills country. S. S. Greeley gave an interesting discussion upon the topic, "The Status of the Surveyor of Illinois; Is it a Profession or a Trade?" His conclusions went to show that surveying is one of the liberal arts; a profession, and not a handicraft or trade. He argued strongly for the licensing of surveyors and engineers, referring to the recent Act of the Legislature of Illinois requiring architects to be licensed.

The evening session, which was held at Bradley Hall, was given up to a description, with stereopticon illustrations, of the Peoria Park system, by R. R. Bourland, O. F. Du Buis and L. K. Dowein. The exercises were opened by an address of welcome by Hon. John Warner, mayor, which was followed by an address to the engineers by Hon. O. J. Bailey, president of the Polytechnic Institute. Before the opening of this session members of the society inspected the Bradley Polytechnic Institute. Thursday morning, Prof. Wm. D. Pence, of the University of Illinois, read a paper on the Graphical Representation of the Magnetic Declination, describing in a very interesting manner the daily and annual movements of the magnetic needle. P. C. Knight, chairman of the Drainage Committee, submitted his report on drainage and gave a description of the drainage of the Meredosia swamps in Whiteside county. Centrifugal pumps are used, having a daily capacity of 36,000,000 gallons of water per day with a lift of sixteen feet. An interesting paper upon the purification of sewage by the Ferozone Polarite System, as observed at Acton, England, was presented by John V Alvord, Chicago. The discussion which followed the reading of this paper indicated that this system is to be adopted in the vicinity of Chicago at an early date. One of the most valuable papers which was presented to the society was on "Water Analysis," by A. W. Palmer, Professor of Chemistry at Champaign. Prof. Palmer being in charge of the sanitary survey of the waters of the State of Illinois, has much information upon this subject.

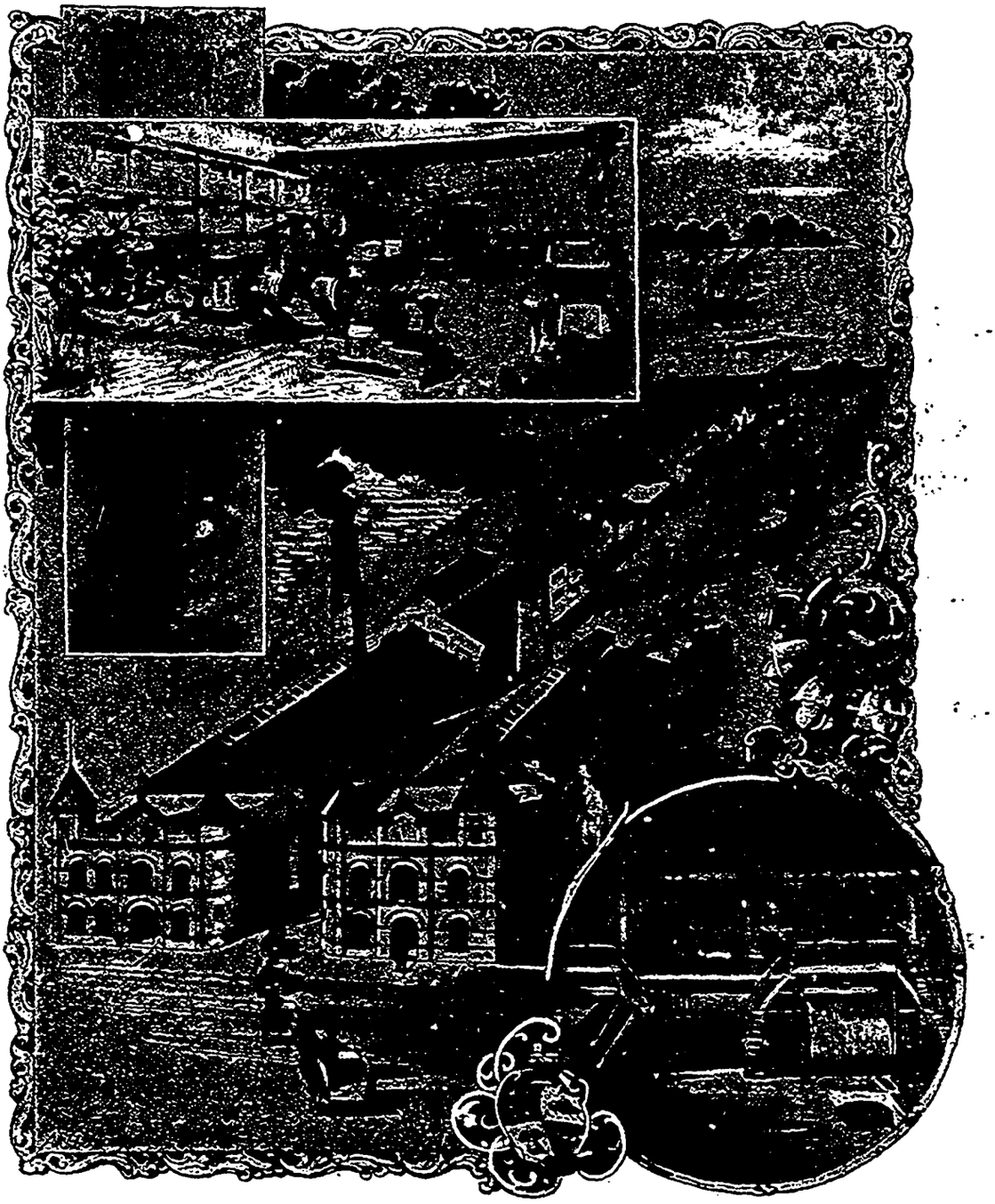
The afternoon of Thursday, the 27th, was devoted to an inspection of the Peoria water works plant and the Atlas distillery. At the evening session, Charles H. Nicolet, chairman, read the report of the committee on Municipal Engineering. A paper on Proposed State Supervision of Water Supply and Sewage Disposal was read by Jacob A. Harman. This paper gave a record of the efforts of the engineers and physicians of the State to have a bill passed providing that the State Board of Health should have control of the water supply and sewage of the State. The following officers were elected for the ensuing year: President, A. D. Thompson, Peoria; vice-president, W. A. Darling, Rock Island, executive secretary and treasurer, Jacob A. Harman, Peoria, recording secretary, J. C. Quade, Kewanee, trustees, W. D Pence, Champaign; S. S. Greely, Chicago; C. C. Brown, Bloomington.

Friday, the 29th, the last day of the session, was devoted entirely to the reading of papers and committee reports and discussions. Prof. A. N. Talbot, of the University of Illinois, presented a report for the committee on paving brick specifications, and recommended that the society adopt certain uniform methods of testing. This report was finally referred back to the committee for further investigation to report at the next annual meeting. The first paper on the programme was "Deep Well Pumping," by E. E. Johnson, of Chicago. His paper gave very valuable data with reference to the air lift pumps and other systems of deep well pumping; he also exhibited a model of a new design of deep well pumping, which shows a great economy over any forms of deep well pump heretofore in use. S. S. Greeley, chairman, reported for the committee on the metric system, and a resolution was passed endorsing the adoption of the metric system for general use in the United States. Mr. J. E. Miller read a paper on "Brick and Macadam for Country Roads," describing work which had been constructed north of Monmouth, Ill. J T Schmeltzer, Mantino, read a paper on Improving the Roads of Illinois A most interesting paper on the road problem was that on The Improvement of Transportation in Country Districts, by E. E. R. Tratman, Chicago, resident editor *Engineering News*. A. Lagron reported for the committee on Public Highways, and showed a disposition to discourage action upon the subject by engineers because of the lack of interest exhibited by the farmers, or those who have most use for the roads. M. Huebinger, Peoria, presented a paper on City Map Making. After numerous resolutions, and installation of officers, the society adjourned.

An Ontario charter has been granted to G. B. Meadows, A F. Ede, Rose Ellen Meadows, May K. White, and T. Urquhart, Toronto, Ont.; W. G. Meadows, Buffalo, N.Y., as the George B. Meadows Toronto Wire, Iron and Brass Works Company, Limited, to manufacture and deal in wire, wire-cloth, wire-fabric, wire goods, ornamental wrought iron-work, fencing, art metal goods, bank and office-railings, window-fixtures, display-stands, brass and brass goods, iron or wire-cots and bedsteads, elevators and elevator-coverings.

THE NEW WORKS OF THE TORONTO ELECTRIC LIGHT COMPANY.

We are enabled in this issue to furnish our readers with some views of the new buildings of the Toronto Electric Light Company It will be remembered that on the 21st of January last year, a destructive fire occurred, causing a loss of the arc lighting station of the company. Some effective work was done in providing temporarily for the illumination of the streets until permanent quarters could be provided for a new plant. The location of the works is one of the best that could possibly be chosen for a central distributing station. It is upon the water front of the city and at the foot of its principal thoroughfare and business centre. Unlimited water is available for condensing purposes and facilities for the unloading and storing of coal, both from cars and vessel, are of the best. In re-building it was determined to eliminate altogether the risk of loss and interruption by fire, and the new buildings are therefore constructed exclusively of iron, brick and stone. There is absolutely no wood used in their construction. The arc light station, No. 1, of which two views are shown, was completed about the first of September last, and is 165 feet in length by 68 feet wide. The foundation rests upon piles which were driven to the solid rock, and upon these a bed of concrete two feet nine inches thick was laid over the entire surface. Upon this the dynamos and engine foundations were build of hard brick and cement. They were raised high enough to permit of good head-room below, and the floor was formed of brick arches, resting upon these foundations and upon I beams and iron pillars in the intermediate spaces. In the tunnels thus formed the driving shafts are placed. The dynamos are driven by belts passing through apertures in the arches to the floor above. There are in this building two compound condensing engines of 350 h.p. each, and two pairs of high-pressure condensing engines of 450 h.p. The shafting is all 6 inches in diameter, and runs on self-oiling bearings, being driven from the engines by triple leather belts 38 in. wide. A twenty-ton traveling crane is constructed to cover the entire floor space. This has been of the greatest value in placing the machinery in position, and when repairs are required, will be able to handle the heaviest piece of machinery at a minimum of both time and expense.



THE SCOTT STREET POWER HOUSE AND DOCK OF THE TORONTO ELECTRIC LIGHT COMPANY, LIMITED.

The arc light switchboard, which extends across one end of the building, is somewhat unique in both its methods and construction. It is built of pressed brick, with terra cotta facings. The terminals of the circuits are mounted on glazed tiles let into the face of the work. Ampere meters for each circuit are also mounted on other glazed tiles, and are large

enough to be seen from any part of the building. It is not necessary for the attendants to go to the switchboard, but they can see the state of the various circuits at any time, and wherever they may happen to be. Behind the wall constituting the board is a slate shelf, extending the entire width, to accommodate a standard ammeter or other testing instruments, which can be plugged in any circuit at any time by means of spring-jacks in each line. In each line also is a polarity indicator to ensure the correct direction of the arc lighting currents. The whole is surmounted by an electrically-driven cock, also built of brick, with a dial 6 feet in diameter.

Immediately adjoining this building, and forming the front premises, as seen at the left-hand of the engraving, is another fire-proof structure, which will be used as store-rooms for all kinds of supplies and show-rooms for incandescent fixtures, etc., and a completely fitted up meter department having all the latest appliances for repairing, reading and testing the various kinds of meters in use in the business. No. 1 boiler-house has re-erection. It is now a frame iron-clad structure, lined inside and on all the joists and timbers with sheet-iron. It is intended to replace it as soon as the weather permits with an iron and brick structure to match the others. The foundation work is now all completed and ready for the walls. As it is proposed to replace the building without interfering with the operations going on inside, considerable ingenuity will have to be exercised to avoid stoppage of the machinery for any considerable length of time. The building contains a double upright tandem condensing engine of 1,000 h.p., besides dynamos of all classes, arc light alternating and direct-current power machines, besides a pair of 110-volt machines that are supplying the underground mains of the Edison system in conjunction with the generators at the Terâulay street station of the company. At one end of the building is located the general switchboard controlling the entire output of electricity for all purposes. One attendant thus has under his hand the output from all the buildings except the arc light.

3,000 H P Engines in No. Station, Toronto Electric Light Co.

also been re-built, and has an iron roof with swinging sash for light and ventilation. This boiler-room contains three Heine water tube boilers of 250 h.p. each, and 10 return tubular boilers of 120 h.p. capacity each. No. 2 boiler-house, opposite, has two 250 h.p. Heine boilers, and two 250 h.p. Caldwell water tube boilers, with capacity for as much more.

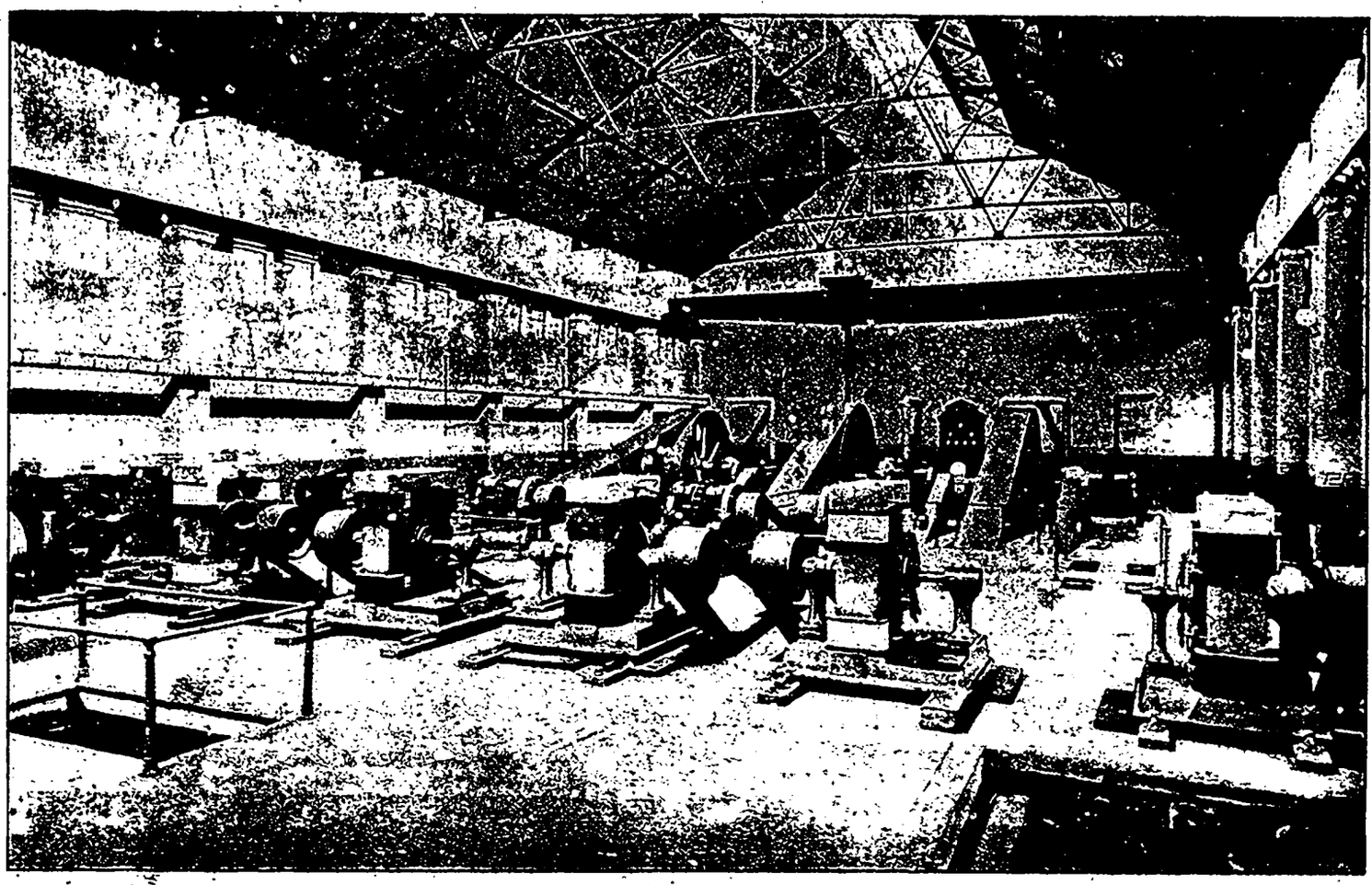
Station No. 3 is a handsome fire-proof building, with iron roof and stained-glass windows. It is used for production of electricity for motor power and incandescent lighting. It contains two pairs of vertical Corliss engines of from 1,000 to 1,500 h.p. each. These are shown in the engraving. At the time the views were taken the ornamentation of the building was not completed. The brick walls which are shown bare, are colored a cream tint, with chocolate-colored dado and frieze. There are four dynamos only in this building, but they are machines of great capacity. Two of them being direct current 250-volt generators of 500 kw. each, and two double armature alternators of 450 kw. each. The air pumps of these engines are driven by independent Corliss engines, and make a very complete and satisfactory arrangement. The dimensions of this building are 80 feet by 68 feet.

Station No. 2, which is the building immediately in rear of the offices, shown on the right of the view, is now in course of

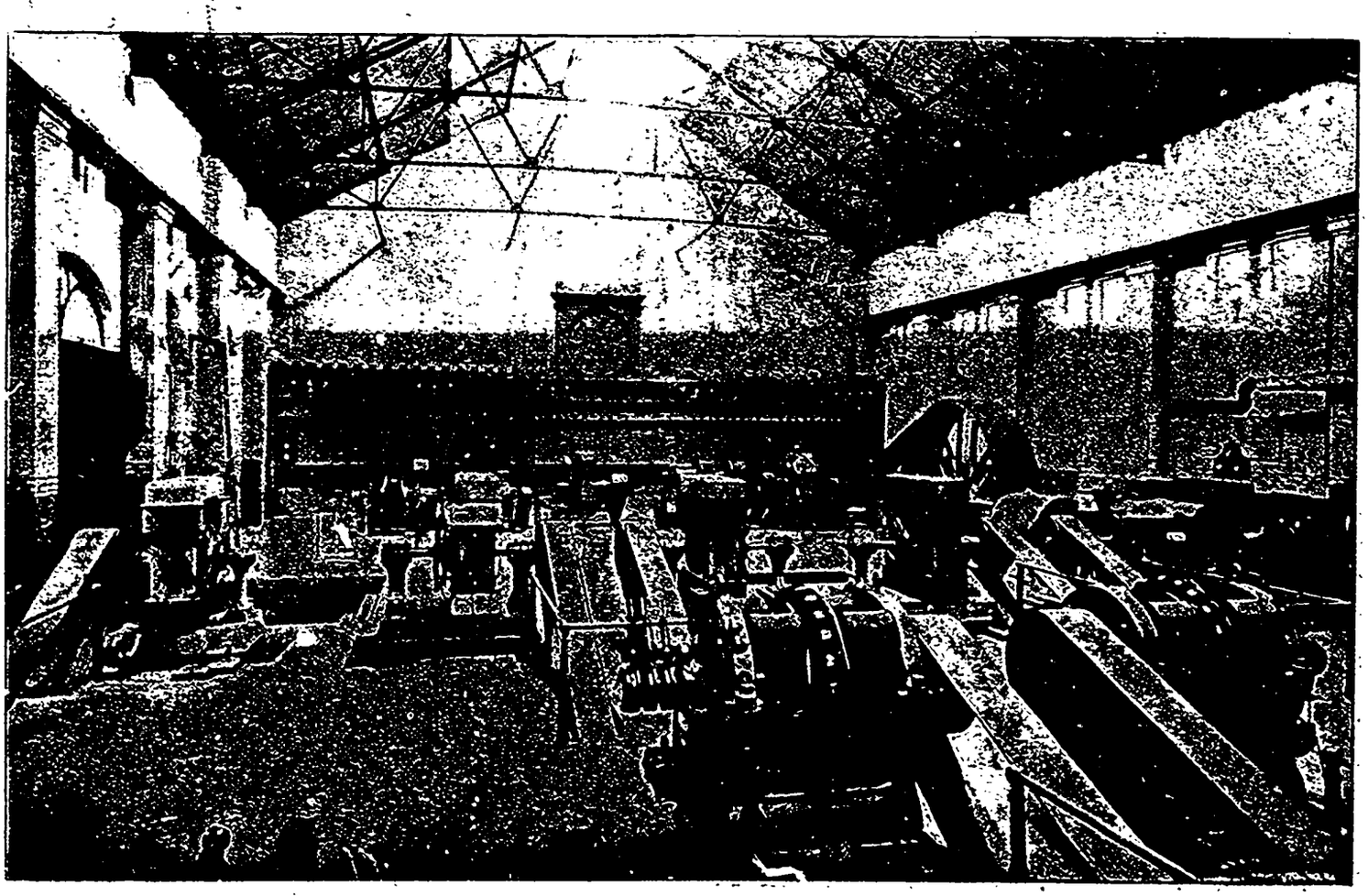
At the further end of the lot is a spacious wharf on which will be erected for the opening of navigation an extensive coal storage plant and electric hoist for unloading vessels. Adjoining this are the stables with accommodation for 30 horses. linemens' quarters, lamp inspectors' and trimmers' room, carpenter shop, store-house, blacksmith shop, and a commodious machine shop, where a large amount of manufacturing is being carried on, as well as all the repair work necessitated by the operations of the company.

When the contemplated improvements are finished, the entire installation will be one of the most complete and up-to-date to be found in the country. The entire work of re-building has been done by day labor by the employees of the company, even to the construction of the iron roofs. The design and execution of the various works are creditable to the management and the efficient staff having charge of the various branches of the work.

While the air is charged with rumors of so-called "cheap power" and various schemes, "fake" and otherwise, are being promulgated, the Toronto Electric Light Company are steadily proceeding with their developments. They are, it is claimed, producing power at the present time quite as cheaply as it can be transmitted from Niagara or any water-power, and the con-



ENGINE END OF NO. 1 ARC LIGHT STATION, TORONTO ELECTRIC LIGHT CO.



SWITCHBOARD END OF NO. 1 ARC LIGHTING STATION, TORONTO ELECTRIC LIGHT CO.

templated installation of coal-handling apparatus to further reduce the cost will enable them to compete with electricity produced from any source. The rate at which power is being sold in Toronto, namely, 2 cents per horse power hour for 10 h.p., is said to be the lowest on the Continent of America to-day from a plant of a similar nature.

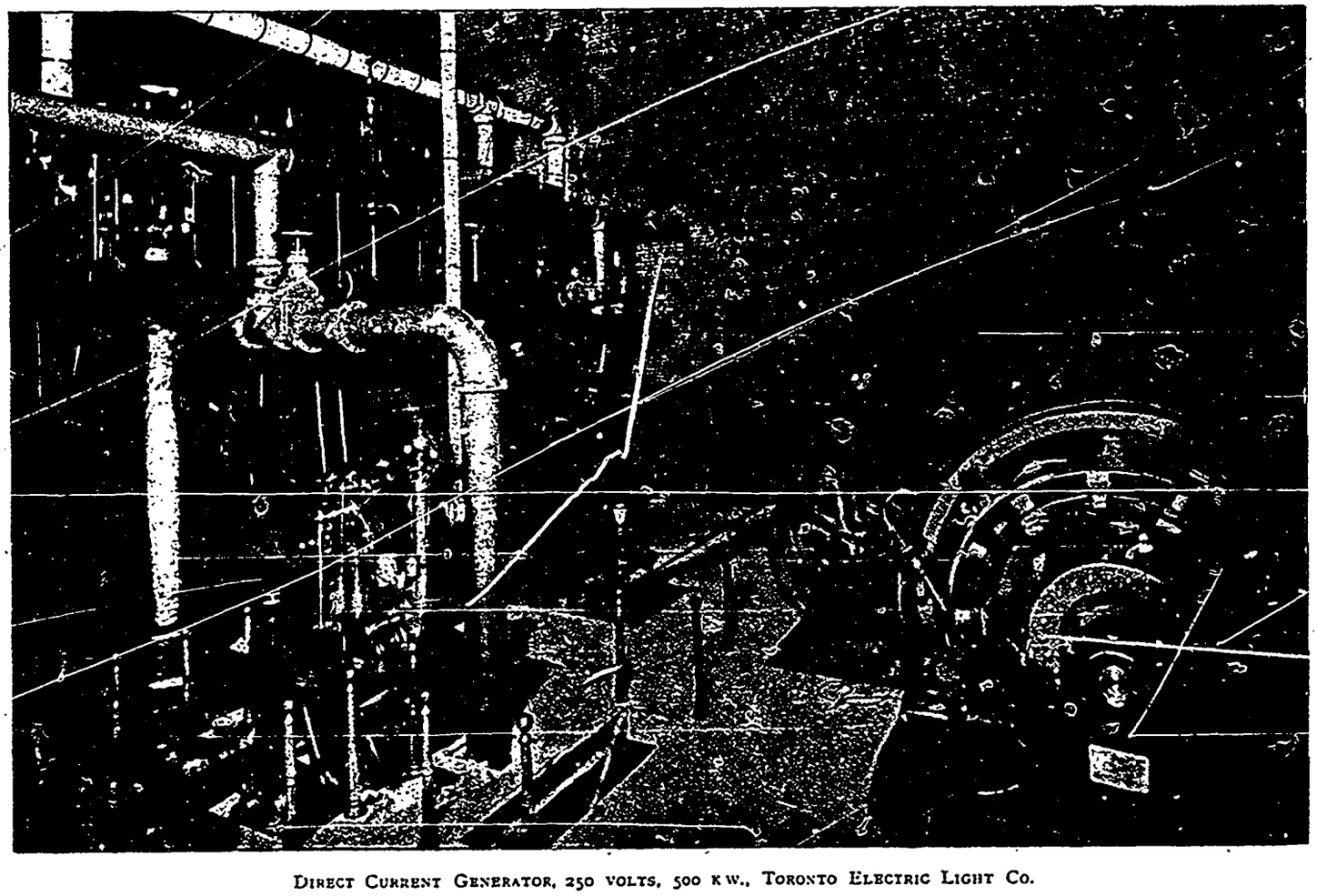
J. J. WRIGHT.

J. J. Wright, manager of the Toronto Electric Light Company, whose name is very well known in connection with the development of the electric lighting industry in Toronto, is one of the pioneers in the business of producing electricity for industrial use. He was born in Yarmouth, England, in 1850, and was educated at Shireland Hall, near Birmingham, and subsequently served some years at mechanical engineering. His father was a minister of the Methodist Church in England, but as he died while the subject of our sketch was but a youth, there were no ties to bind him to the Motherland, and Mr. Wright, like many others, in the early seventies struck out for the New World and landed in Canada some twenty-seven years ago. He went to Philadelphia at the time of the Centennial Exhibition of 1876, at which time electricity was beginning to attract attention as a commercial possibility. He there became acquainted with Professors Thomson and Houston, then members of the faculty of the High School at Philadelphia, and constructed for them some of the earliest experimental dynamos, crude enough in themselves, but the embryos from which have sprung some of the brilliant results of to-day. Mr. Wright constructed some of the first lamps used for street illumination, and was among the first to handle electric light wires in the construction of under-ground service, having constructed a line of under-ground wire for electric lighting in Market street, Philadelphia, between the City hall and Fourth street, in the year 1881. He was a member of the Franklin Institute of Science and Arts, and also a member of the National Conference of Electricians, convened by the United States Government.

In the spring of 1883 Mr. Wright returned to Canada and commenced the construction of the first plant for the distribution of electricity in this part, if not in the whole of Canada. It was located near the corner of King and Yonge streets, Toronto, and was the nucleus from which has sprung the extensive electric lighting interests of the city of to-day. When the Toronto Electric Light Company was organized the original plant was absorbed in the new company, and since that time Mr. Wright has filled the position of general manager. He has been three times elected president of the Canadian Electrical Association, and one of his most cherished possessions is a handsome gold watch that was presented to him at the close of his first year of office by members of the association.

Mr. Wright built and operated the electric locomotive that was for several years used at the Industrial Exhibitions in Toronto. This was the first electric railway in Canada, and during the years of its operation successfully carried many thousand of passengers. Mr. Wright was the recipient of an engrossed resolution and handsome testimonial from the Exhibition directors for the successful carrying out of what was then a new and untried service.

The design and construction of the new work of the Toronto Electric Light Company, which we illustrate in this issue, is Mr. Wright's latest work, and is one that has been most highly spoken of by more than one who is in a position to be a most competent judge.



DIRECT CURRENT GENERATOR, 250 VOLTS, 500 K.W., TORONTO ELECTRIC LIGHT CO.

THE CHEMISTRY OF FOUNDRY PRACTICE.

BY ERNST A. SJOSTEDT.

Compared with the chemistry of the blast furnace process (in which the ores are deprived of their O., and the reduced metal combines with elements like carbon, silicon, manganese, etc.), and the different processes of iron and steel making (whereby the said foreign ingredients are oxidized and eliminated to a more or less complete degree), the chemical changes taking place in the cupola, where the metal is merely re-melted, are quite simple. Nevertheless, these changes, small though they be, are sometimes of great practical importance, and as the physical qualities of the castings (such as strength, hardness, elasticity, etc., are very largely dependent on the chemical composition of the metal, it is evident that the adaptation of chemical researches in connection with the foundry practices are well deserving of a most careful attention. The importance and necessity to the blast furnace manager and the steel worker of applying chemistry in their daily practice has long been recognized, but it is quite recently that the services of the chemist have been called upon to help solving the many puzzling problems which the foundryman constantly encounters. However, his legitimate place and position is already well established at the larger foundries in the United States and in Europe, besides at such works where a specialty is aimed at (such as car wheels and malleable castings), and the smaller foundries are slowly following their example.

In the hopes of arousing some interest in this important subject also (in this country, and especially) among the members of this association, the following notes and facts are hereby presented as a nucleus for discussion, founded as they are on the best authorities, and in all essential parts having been found correct and a most valuable help to the writer, in connection with his labors and investigations as chemist at different iron and steel works. Even at the risk of appearing pedantic, the writer has aimed at making this treatise as elementary as possible, in order to interest those least familiar with the subject, and must therefore, ask of the well-informed members their kind forbearance.

As we all know, absolutely pure iron does not exist as a commercial product, for what we are working and dealing with is not a single substance, but an alloy, composed of a number of elements in different proportions, the total sum of which, however, seldom exceeds 5 to 10 per cent. Among these elements, carbon is an essential constituent, and one that plays a most important role in determining the physical character of the iron. In fact, its influence on the iron is so great that its presence in smaller or greater amounts is responsible for the three well-known classes—with so distinctly different characteristics—in which iron has been divided, namely, wrought iron, steel and pig-iron: pig-iron containing about 2.5 to 5.0 per cent. of carbon, steel, from .4 to 2.5 per cent., and wrought iron, from about .03 to .35 per cent.; and their characteristics are so familiar to us all that it is here only necessary to recall their different melting points, which for pig iron is from 1,800 deg. F. to 2,200 deg. F., for steel, about 2,650 deg. F., and for wrought iron, about 2,880 deg. F. Again, we must carefully keep in mind that carbon, in pig iron, occurs in two conditions which are distinct in their physical and chemical relations, namely, as graphite and as allotropic modification, combined carbon. If present as graphite (i.e. simply mechanically mixed with the iron), the pig has a gray, soft fracture, but when in chemical union with the iron, the fracture is white and hard, with metallic lustre. In molten pig iron all the carbon is present in its combined form, and it all depends on the time and conditions allowed during cooling, which state—graphitic or combined—it will assume in the casting, the slower the cooling is taking place the better opportunity the carbon will have to crystallize (forming graphite), and the grayer the iron becomes, whereas, if made to cool suddenly (as when poured against a chill block) the carbon is not given this opportunity, and consequently, it is retained, more or less, in its combined state, and the iron becomes hard and white—always provided no other strong agent is present that will break this rule, and of which we will speak presently. The carbon, per se, as long as it remains combined in the pig iron, increases the absolute tensile strength of the iron, but when separating as graphite, it makes the iron weaker, it also increases the hardness, but decreases the elasticity and the melting point of the iron (i.e. white pig iron is somewhat easier to melt than gray). The following analyses of combined and graphitic carbon in a certain coke iron (Embreville, Pa.), will give a clear idea of the influence which the different modifications of carbon exert on the fracture of the pig:

	Per cent.			Per cent.	
No. 1 foundry pig.....	3.80	graphite	and	.10	C.C.
No. 2 foundry pig.....	3.78	"	"	.25	"
No. 3 foundry pig.....	3.60	"	"	.39	"
Gray forge	3.00	"	"	.70	"
Mottled	1.50	"	"	1.70	"
White	.10	"	"	3.10	"

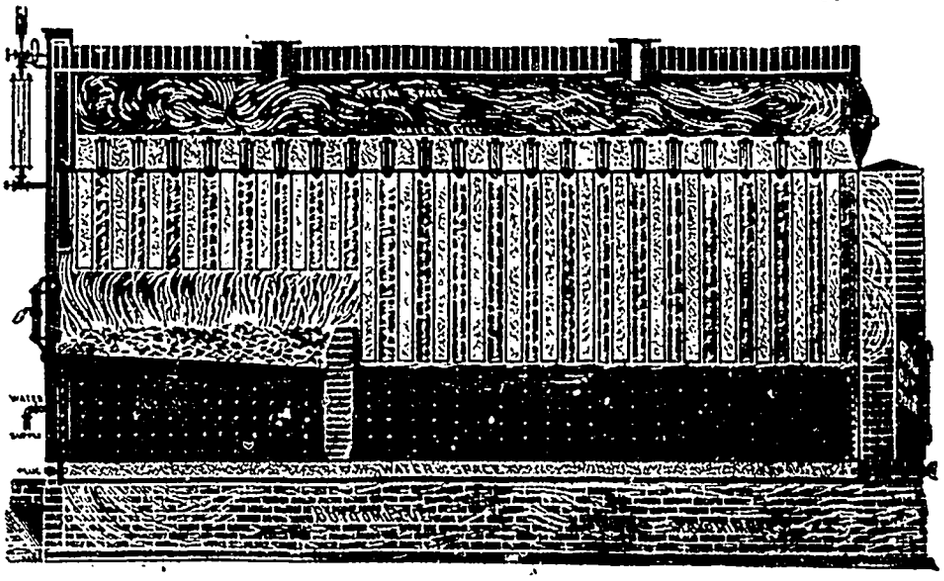
Among the other elements usually present in the pig iron, and the one next to carbon in importance, as regards its effect on the iron, we must place Silicon. Silicon, namely, exerts a controlling influence on the chilling properties of the iron, owing to its tendency of separating the carbon as graphite. Its percentage in the pig iron is generally in proportion to the temperature at which it has been produced. Thus, a coke iron is higher in silicon than a charcoal pig, and varies from a few tenths of one per cent. (as in Swedish charcoal pig), to 1.5 and 2.0 per cent. (in iron usually suited for machine castings), and runs as high as 2.5 to 3.5 per cent. in good soft coke iron, and the "silvery iron" contains about 4 to 5 per cent. silicon alloys with iron in greater proportions than carbon (ferro-silicon contains 30 to 50 per cent. Si.), and decreases the absorption of carbon. Hence, coke iron is generally lower in total carbon than charcoal pig, and iron with 2 per cent. silicon and no manganese has seldom more than 3.8 per cent. C. It increases the fluidity and fusibility of the iron, and lowers its smelting point, makes the iron retain its heat for a longer time, and thus lessens the formation of blow holes, and decreases the shrinkage (in proportion to the amount of graphite that has separated) Added to "pure cast iron" it has been found to improve the strength of the iron up to 2.5 per cent., but above this amount it makes the iron weaker. From the above properties of the silicon it is easy to see why it is that pig iron which contains a high percentage of silicon acts and is used as a "softener," and that by melting various portions of such iron with hard iron, all the different grades can be obtained, from close to very open-grained soft iron. In re-melting pig iron loses about .25 per cent. of silicon, which should not be forgotten. Another disturber of the equilibrium in a pig iron is sulphur. Contrary to silicon, sulphur present prevents the formation of graphite, and consequently, it has a tendency of producing a white, hard casting: it also makes the iron sluggish and full of blow holes, sulphuretted hydrogen gas, causes red shortness, and increases the shrinkage. Besides, being generally irregularly distributed in the iron, sulphur tends to make an uneven, unreliable casting For these several reasons sulphur has well been called "the foundry man's bane," and owing also to the hindrance it offers to annealing, it should especially be avoided in malleable castings, also in iron intended for car wheels. Sulphur has a great affinity for iron, combining with it at a lower temperature, and in any proportions, up to about 53 per cent., and as its evil effects are perceptible already at a fractional part of one per cent., it must be a matter of great importance for the foundryman to keep track of this element. As a general thing it is rarely found in a soft, open foundry pig—for its presence to any high degree would make the iron more or less close grained or white—and this great enemy, therefore, is not always shunned as much as it deserves, but its presence in the coke, and sometimes also in the limestone, is certain to bring it in the casting, and thus it happens that a good iron often has been condemned when the fuel and the flux alone were to blame. Good Connelsville coke contains seldom over .6 per cent. sulphur, but at many a foundry 1.0 per cent. S. in the coke is not unusual, and if a basic change and a high temperature be not resorted to in the cupola the iron, in re-melting, will increase .2 to .5 per cent. in sulphur, which is sufficient to spoil it for most purposes. if the silicon be not present in sufficient quantity to neutralize its effect.

To be continued.

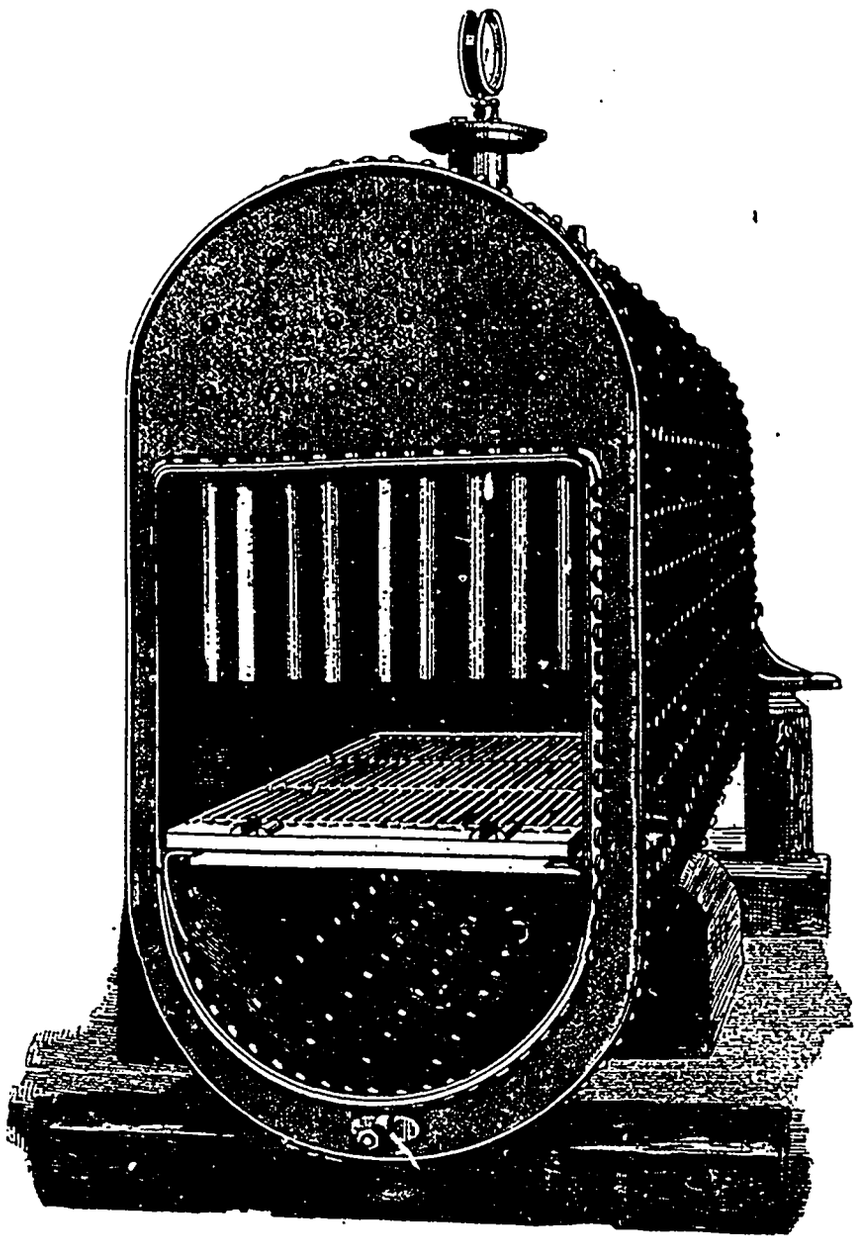
Two or three years ago marl beds were discovered near Orangeville, Ont., and D. B. Brown, T. M. Rowan, R. H. Gillespie, and J. M. Rowan have acquired 500 acres of land in the township of Caledon, within three miles of Orangeville, 400 acres of which contain a bed of marl, varying in depth from eight to twenty-one feet. The marl is pronounced to be particularly good, and suitable for making Portland cement, etc. It will likely be developed at an early date.

KINGSLEY WATER-TUBE BOILERS.

The Kingsley patent water-tube boilers, herewith illustrated, are constructed with two shells—an outer and an inner. The outer shell has vertical parallel sides and semi-circular top and bottom. The inner shell is fixed parallel to the sides and bottom of the outer shell, by means of two flanged heads and numerous stay-bolts, leaving a uniform space about four inches wide between the two shells extending the full length of the boiler. The crown sheet is horizontal, and extends continuously the entire length of the boiler. It is flanged down three inches along each side for its entire length, and forms the top of the inner shell by being riveted to it along each side. The tubes are threaded at their upper ends with standard pipe threads, and are screwed into the crown sheet. The bottom ends of the tubes are plugged with ¼-inch iron and are then welded solid. The tubes are made of standard 2-inch iron lap-welded pipe. They are short enough in the fire-box to leave



THE KINGSLEY PATENT DROP WATER TUBE BOILER.

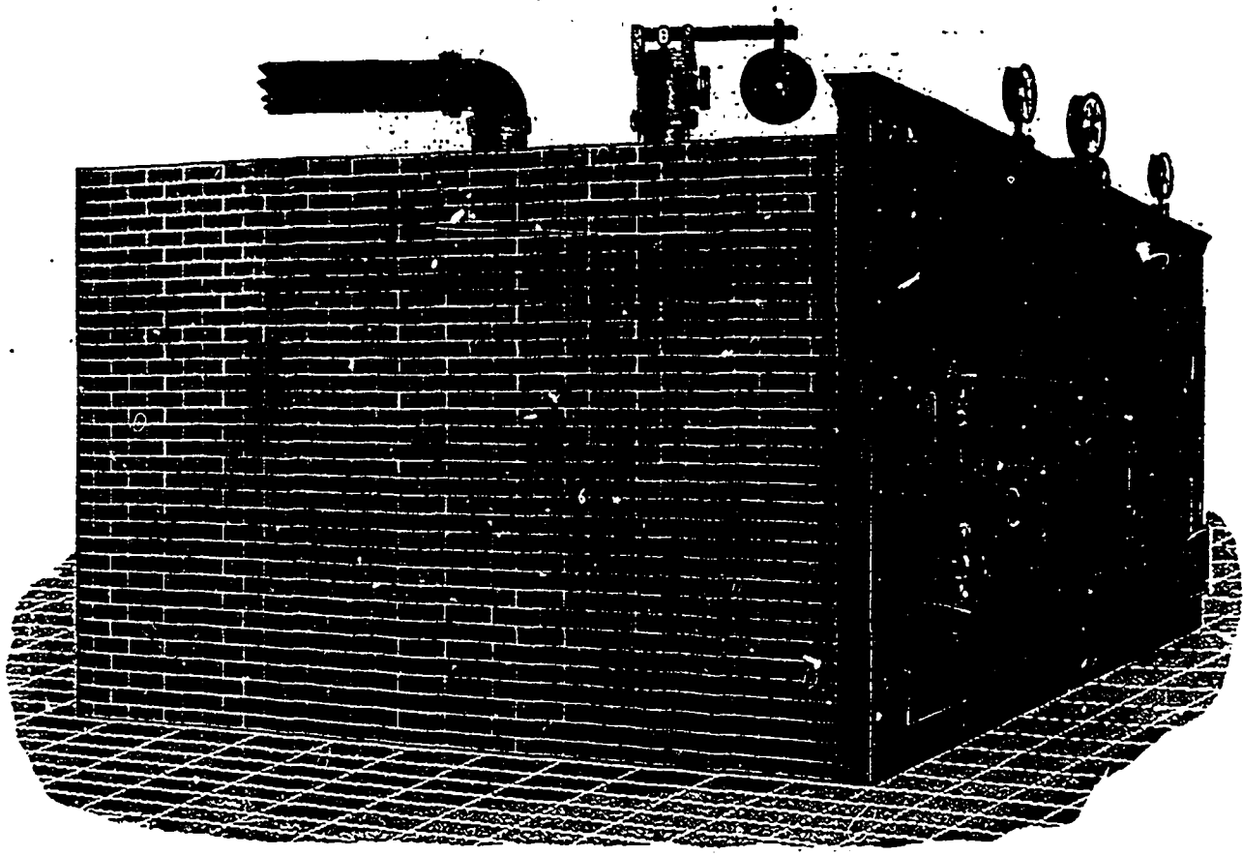


KINGSLEY BOILER - FRONT END VIEW OF NAKED BOILER READY FOR WATER TEST.

an ample combustion chamber, and are longer behind the bridge wall. Any tube can be readily screwed in or out of the crown sheet without touching any other tubes. The crown sheet is strongly stayed by stay-bolts, screwed simultaneously at various angles, into the semi-cylindrical top of the outer shell and into the crown sheet. These stay-bolts and those connecting the two shells are headed on each end. The parts of the two flanged heads forming the ends of the steam chamber are likewise stayed by rods screwed simultaneously into each, these rods being headed at each end or fitted with nuts.

The water is contained in the tubes, and in the space between the shells, and extends up a few inches over the crown sheet. As this water surface extends unbroken for the full length and width of the boiler, no rapid fluctuations of water level can take place, although the boiler is a very rapid steamer. It is possible to supply any capacity of water or steam space by extending the outer shell upward above the level of the crown sheet to any desired height. It is sometimes desirable to thus increase the steam space where large volumes of steam are required at one time, which occurs in various industries. No steam drum is used on these boilers. This is a great advantage over most water-tube boilers as well as many other types, as a steam drum elevated far above and away from the hottest fire can of itself act only as a condenser, as it is the tendency of steam to cool and condense immediately on leaving the direct action of the fire. In the Kingsley boiler the tubes, being vertical and short, liberate steam very freely, and without friction or impediment, which in all water-tube boilers with inclined tubes, causes a large percentage of water to be carried up with the steam. This is also one reason why this boiler produces dry steam even under the heaviest forcing. By those who have not investigated, an argument may be advanced regarding the deposit of sediment in the tubes. This, the manufacturers claim, may conclusively be answered by referring to boilers which have been in use for upwards of ten years. One of these in Chicago, being fed on the dirtiest of feed-water, has been in use for nine years. The users, a short time ago, wrote: "We have never had any trouble with the tubes filling with scale or sediment; but, on the contrary, we think they are brighter than new." Hundreds of tubes have been screwed out and examined for sediment, in various parts of boilers which have been running for different periods, and have been found perfectly clean; in fact, any scale formed in manufacturing the tubes appears to be loosened and removed by the ebullition and rapid currents when the boiler is under steam. After such investigations there can be no reasonable doubt on this point.

The reason for this exceptional cleanliness of the tubes is said by the makers to be clear when we consider the construction of the boiler. The feed-water, entering at the front of the boiler, between the shells, below the level of the grate-bars, in passing up becomes intensely heated before reaching the crown-sheet. It is well-known that water heated to a few degrees above the boiling point, parts with most of its impurities, as mud and carbonates of lime, and at a temperature of about 300 degrees Fahr., equal to 52 lbs. steam pressure, it can no longer retain in solution the sulphates of lime, magnesia, etc., which form the much-dreaded scale in boilers. In this boiler, these impurities being separated by the intense heat, precipitate into the space between the shells, at the bottom of the boiler, where the heat is not sufficient to bake them into scale, and whence they can be washed out occasionally through the hand holes. This boiler is, therefore, by its construction, stated to be a perfect feed-water purifier; and no sediment or scale can gather in the drop-tubes, because only purified water reaches the crown-sheet, from which the tubes are supplied.



KINGSLEY BOILER—REPRESENTING TWO BOILERS OF 150 H.P. EACH.

The boiler, being internally fired, has the fire-box entirely surrounded with a water-jacket. The incandescent gases from the fuel, passing up among the short tubes in the fire-box, are drawn backward among the long tubes to the end of the boiler, whence they divide and return, half on each side, between the outer shell and the brick casing toward the front of the boiler. From this point the now nearly exhausted gases can either be carried by means of a saddle over the front of the boiler direct to the chimney, or they can pass down into a flue under the boiler along to its back end, and thence to the chimney. There is no appreciable difference in economy of evaporation between these two methods of circulation of the gases. The tubes are "staggered" in the crown-sheet and are spaced at such distances that the gases which pass zig-zag and strike each tube at right angles, while being confined on all four sides by the water-jacketed shell of the boiler, lose nearly all their available heat before they are returned on the sides. For this reason this boiler can be operated also as a locomotive boiler. The gases are passed out of the chimney only sufficiently hot to insure a good draft. This boiler requires the same size of chimney as any other type of boiler. For hot-water heating for buildings there is no change in the construction of the boiler, the steam space being simply filled to the top with water. The fuel

economy is the same as for steam purposes. The circulation of the water is the most direct that can be desired, as there is a continual uninterrupted rise from bottom to top of the boiler. For marine purposes there is no change in the essential design of the boiler, the difference being in details and setting, as the brick casing could not be used. It has been installed for the highest pressures, and is as easily cleaned and as durable as any boiler made. The economy of installation is apparent when we note the claim that this boiler occupies one-third less ground area than the other ordinary types of horizontal water-tube boilers, or the return-tubular boilers, and less than one-half their cubic contents. It requires only 6½ feet in height. The brick casing is used only for the return gases, and hence never requires renewing. As there is no firebrick furnace to renew periodically, the repairs are reduced to an absolute minimum. It is not necessary to refer to the exceptionally high evaporative economy of this boiler, as this could be readily predict d from its construction.

THE BARREN LANDS OF CANADA.

On a recent Saturday afternoon J. B. Tyrrell, of the Dominion Geological Survey, Ottawa, lectured to a very large audience in the Biological Department of Toronto University, Toronto, on the timely and interesting theme, "The Possible Resources of the Barren Lands of Canada." Introducing his subject, Mr. Tyrrell said that Canada was just now face to face with problems particularly her own. Reports of the fabulous wealth which reach us from the Yukon and elsewhere in the Dominion are naturally followed by the question: Are our young men being equally well trained for going out to the forest wilds to possess this wealth, as they are for other occupations in life? Continuing, Mr. Tyrrell deprecated the prevailing idea that a trifling knowledge of rocks and minerals is all that is necessary for the equipment mentally of young men going out to the gold and other mineral fields. Ignorance, he said, emphatically, means loss and failure in the locating of mines and minerals. Who would win in such search must be well trained. Only 10 per cent. of the great area of Canada is under cultivation at present; 35 per cent. only is capable of cultivation; there is a vast extent, roughly from about one to two million miles, which will not grow cereals, and which bears little or nothing. There are 750,000 square miles in which there are no fur-bearing animals, and which are rarely if ever visted by white men. These are known to the Indians as the Barren Lands. Of these there are 300,000 square miles in the Arctic Islands, 50,000 square miles in Northwestern Labrador, and 400,000 square miles west of Hudson Bay. Of these the lecturer said that he would consider the latter in his lecture, and try to show that there was every ground for hope that in the not far distant future Canada would have in these barren lands a sub-Arctic mining province, covered with comfortable homes, whose enormous wealth would in a great measure compensate the inhabitants for the rigor of the climate and other privations which are not known where nature is more kindly disposed. The barren lands of Northern Canada are three times as large as the British Isles, are bounded on the north by the Arctic Ocean and on the east by the west coast of Hudson Bay and Fox Channel. They are generally a vast undulating plain, broken by ridges, stony and bare, very flat for the most part, the grassy grounds covering a floor of soft creaceous shales and sandstones: a dreary, rocky, barren country. The highest point is reached in the Stony Mountains, which lie east of the Coppermine River, and are 1,500 feet above the sea level. The lecturer then went on to describe the inhabitants of these lands, who number 2,000 Esquimaux, whose pursuits are hunting and fishing, and 500 Chippewayan Indians, who retire to the forest for the winter. He described the animals, the principal of which is the Arctic caribou. Its flesh is excellent food for explorers and pioneers; it is here in countless numbers, and should it ever become extinct, it could be replaced by the Lapland reindeer. Other animals are the musk ox, which lives in the plains of the north; predatory animals are the white wolf, the wolverine, and the white bear. Whitefish and trout are plentiful in the rivers and lakes, and in the lecturer's expedition to these lands 124 specimens of plants were found. "But," said the lecturer, "it is to the mineral of these lands we must look for any real contribution to the national wealth." He then plunged into a very scientific description of the geology of the country, described the structure and nature of the rock, showed that from Tobaunt Lake to Baker River there is a great extent of mineral-bearing rocks similar to the gold, silver and copper-bearing rocks on the north shore of Lake Superior, and in the Lake of the Woods district; he said that copper-bearing rocks extend along the Arctic boundary, and that there was every evidence to show that similar conditions existed in the numerous adjacent islands; indeed, there were many thousand square miles of these lands plentiful in copper; so plentiful were the evidences of this mineral that the lecturer thought that the barren lands will be as productive as Michigan. Besides copper and lead, gold, silver and nickel are there, with iron in enormous quantities; in brief, the lecturer had collected abundant evidence to show that there is a great natural wealth in the barren lands of Canada, which can now be reached with little trouble and expense. Ocean steamers can sail to the head of Chesterfield Inlet, which is open three months of the year; south of Chesterfield Inlet are good harbors, from which the Huronian rocks may be explored. Still further south, Fort Churchill is an excellent land-locked harbor, open for five months of the year, from June till November. The Hudson Bay steamer runs from London to the harbor. In every way Mr. Tyrrell thought that these lands were worthy of exploration and settlement; they are easily accessible, and the climate is not too rigorous in winter; and that their vast wealth now locked up will yield splendidly to work and enterprise.

Mr. Tyrrell's lecture was well illustrated by photographs, which were taken during his expeditions to the barren lands. When thrown upon the screen they gave a very good idea of the nature of this country, its inhabitants, animals, lakes and rivers.

MECHANICAL DRAWING TOOLS.*

By S. J. Ireland, Principal of Hamilton Art School.

Many parents have the mistaken idea that by getting a cheap set of drawing tools for a boy as a present they are creating in him an incentive to the study of art. A cheap case of instruments has been the means of spoiling many a boy's ardor for drawing. I have before me two cases of drawing instruments. One of these cases costs but $1.50; the instruments in this case have their points rounded, and their joints can be opened to permit cleaning. For a cheap case this is very good. The other case costs from eight to ten dollars, but as far as the merits of the instruments are concerned, I would rather have the first. Everyone knows what a pair of compasses is and what used for. The cheapest kind have brass cheeks and heads, but it is a well-known fact that brass rubbing on brass causes too much friction. Another kind has double cheeks, and is known as the hair divider. Most compasses are of English make, and these instruments appear to be made to last forever. The instruments made by the Germans, with exception of those made by one firm, are practically useless. But this one firm which is the exception makes the best instruments in the world. The best English compass is known as the Sexton joint. Compared with the German, the English compass is heavy and lob-sided, while the German instrument is finely balanced, easier to handle, and is superior to the English compass in the joint.

Pencil drawings must be inked in. Pens form one of the chief features of the draughtsman's outfit. A pen with both points bent inward should be thrown aside. The screw must not be so near the handle as to leave the ends too long. If overcharged with ink, a pen of this kind is apt to blot. The German pen has short ends and a registered screw. The time saved by the use of this pen is considerable. I have here a pen by the use of which circles and curves can be made without the aid of a ruler. For the finest work a spring point is used. This instrument has not been improved on in the last forty years. The Germans produce a very fine instrument of this kind with which you can take a measurement to the three-hundredth part of an inch. The cost of this instrument is $4.85. The German rotating compass has never been successfully imitated by the English or Americans. An instrument is now made for making dotted lines; it does fine, regular work, and is the means of saving considerable time. For making larger circles a longer radius is required. In the old English beam the pencil point and the point on which the pencil rotates are both of the same length, while the German beam has the advantage of having the pencil point shorter than the other by

*A Paper read before the Hamilton Branch, C.A.S.E.

the thickness of the drawing board. A dotting machine is also made to be used in connection with the beam. Protractors are used when the drawing is so fine as to be measured by degrees, minutes and seconds. All lines drawn on a level surface should be done with the aid of a "T" square. The best kind of these squares are those having an inclined edge. The best set squares are made of hard rubber. The slide rule is of great importance to every class of the community, but very few know how to use it. There is no arithmetical calculation known that cannot be solved by the use of this instrument. More can be done in five minutes with this rule than can be done in five hours or five days by arithmetic and algebra. A book on the use of the slide rule, written by Riddell, may be found in the Public Library in Hamilton.

THE FEDERATED CANADIAN MINING INSTITUTE.

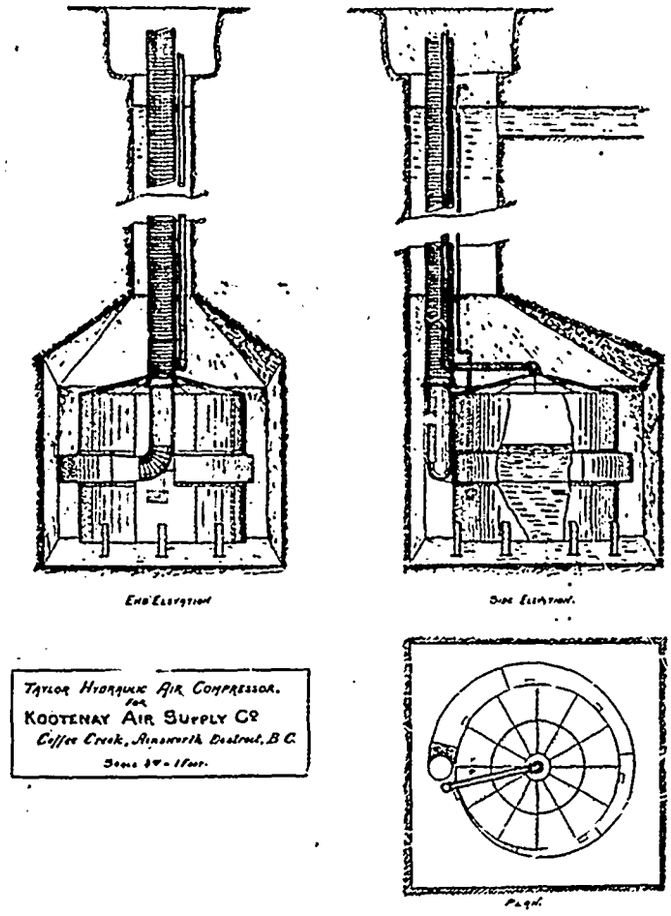
The second conference of the Institute opened in Montreal on March 2nd. As the meeting was held so near our date of publication, we are unable to give a full report of the proceedings. Considerable discussion took place on the effort made by the Canadian Society of Civil Engineers to become members of that association before practising in Canada. The Institute was resolved into the Canadian Institute of Mining and Metallurgy, a constitution being adopted. The Institution passed a resolution condemning the export duty on nickel mat. J. E. Preston, McGill University, read a paper on "Notes on the Ventilation of a Deep Metal Mine as Affected by Seasonal Changes of Temperature," at the evening session. This was followed by "Cableways as Applied to Open Pit Mining," by Spencer Miller, C.E. F. T. Snyder read a paper on "Some Modern Forms of Milling Machinery," and John Birkinbine, Philadelphia, one on "Commercial Progress as Influenced by the Development of the Iron Industry." Hamilton Merritt's paper treated of the gold-bearing reefs and placers of Northern British Columbia, and W. L. Goodwin read some Notes on the Anaylsis of a Rare Mineral. The following officers were elected: President, J. A. Hardman; Vice-presidents, W. A. Carlyle, Victoria; Charles Fergie, M. E. Westville, Nova Scotia; John Blue, and Dr. G. M. Dawson, F.R.S.; members of the council: Nova Scotia, Henry S. Poole, Stellarton; Major L. G. Leckie, Clarence Dimmock, W. L. Libbey, British Columbia; J. P. Hobson, Canal Forks; F. C. Loring, Rossland; W. Blackmore, Coal Creek; and R. G. McConnell, at present of the Geological Survey. Ontario, Archibald Blue, James McArthur, Sudbury; F. T. Snyder, Keewatin; H. Merritt, Toronto. Quebec, G. F. Drummond, G. R. Smith; Penhill, J. Obalski, M.E., Inspector of Mines, Quebec; Treasurer, A. W. Stevenson, Montreal; Secretary, B. T. A. Bell.

—F. J. Appleby, C.E., and J. J. Wilde have commenced business under the firm name of Appleby & Co., Room 501, Board of Trade Building, Montreal, as manufacturers' agents for bridge work, metals and rubber, mining machinery, tools, etc.

THE KOOTENAI AIR SUPPLY COMPANY.

The compressed air plant under the Taylor Hydraulic Air System, which is now being installed at the camp of Ainsworth, B.C., by the Kootenai Air Supply Co., is of such general interest to the mining world that a detailed sketch of the plant will be of interest to the numerous readers of THE CANADIAN ENGINEER.

Ainsworth is the oldest working camp in West Kootenai. The ores are silver-lead in a very heavy formation, where the cost of development is quite high, and requires considerable power. The veins carry considerable water, and so far no great depth has been attained on any of the properties. There are several shipping mines in the district, and two concentrators. The point at which the Kootenai Air Supply Co. is installing its plant is on Coffee Creek, about two miles south of the heart of the district. The creek rises 25 miles back from Kootenay Lake in the high altitudes of the Slocan Mountains, and the stream is fed by a huge glacier. Like all mountain streams, the flowage varies abnormally, the lowest reading being about 2,500 cubic feet to a maximum of 8,000 or 10,000 cubic feet per minute. The high water period extends through the summer months, and until late in the fall, or during the period when a greater demand occurs for air. The creek has an average fall of 10 feet in 100, and the company is now building a dam across this creek five feet high, and a circular stave barrel flume, which has been sawed by the Salmo Lumber Co., the staves being 3 inches by 4½ inches, bevelled to the shape of a barrel five-eighths-inch round; iron bands, with take-up bolts will be used to hold the flume together, and these will be set every three or four feet on the flume. Joints are broken alternately in the wooden stave, a saw cut being made at the end of each stave, one-eighth inch thick and one inch deep, and a piece of iron of the same size is inserted to join the staves together. The lumber used is cedar, and the flume will be set on ties and wedged in place This form of construction is quite common on the coast, and a flume of the character in question will last longer than a light hydraulic iron flume, the lumber becoming water-soaked and practically imperishable. The total length of the flume is 1,354 feet, and the pressure on the flume will vary from 5 to 10 lbs., dependent on the height of the stream. This flume will cost complete with iron rods, exclusive of grading, about $1.25 per foot. The lumber is laid down dressed at $11.50 per M., lumber being exceedingly cheap in this section, while iron, owing to excessive freight rates, is very high.



The company is proposing to instal the receiving water tank and the down-flow pipe in wood, stave barrel construction being used throughout, so that the only iron in the plant will be the air chamber at the bottom of the shaft, and the ⅝-inch iron rods necessary to hold the flume and the down-flow pipe.

The head under which the plant will operate is 107 feet from the level of the water in the tank to the level of the water in the creek, and the back pressure of the rising water in the shaft will equalize the pressure in the down-flow pipe, so that the severest pressure at any point on the down-flow pipe will not exceed 60 lbs. The hoops will be put on at distances varying from 6 inches to 3 feet. The total depth of the shaft, which is now down about 90 feet, will be 210 feet, of which 20 feet at the base will be for the compression tank. In order to overcome the loss in the Magog plant due to ineffective separation, some slight modifications will be made in the construction of the Ainsworth plant, as will appear from the detail annexed. The down-flow pipe discharges its water into an iron inlet, which extends itself all round the centre or water line of the compression tank, and as the circumference of this tank will be approximately 51 inches, and the water with its corkscrew motion and its high velocity swings around this inlet, every particle of air carried down will be separated, so that the company's engineers figure on an efficiency of at least 70 per cent. of air h.-p. out of the gross h.-p. of the stream.

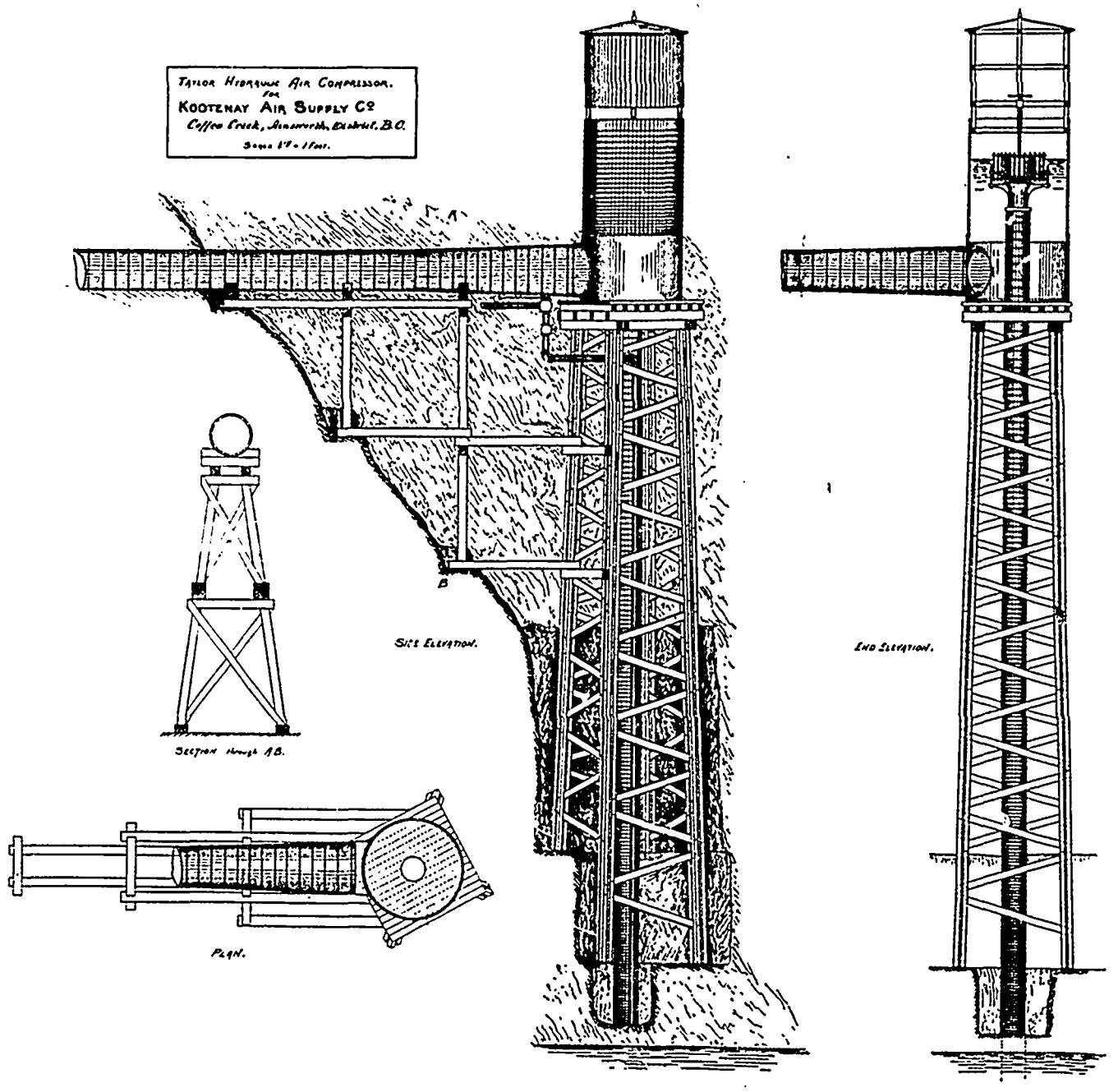
By the substitution of wood for iron in this work, the cost of the installation will be a moderate factor, and when the compressor outputs 500 air h.-p. the h.-p. cost of the air at the compressor site will represent a capital investment of only from $22 to $23. The h.-p. output of the compressor will vary from 340 h.-p., when the flowage is

2,500 c.f. per minute to a maximum of 650 h.-p. when the flowage is 4,500 c.f. per minute, the details of the plant being all worked out for the maximum flowage, which could be maintained throughout the entire year, if necessary, by the construction of further dam accommodation to store the water for the heavy load.

The company is now working 20 men sinking the shaft. The shaft is 6 x 8 feet in area, and a small boiler, 6 x 8 double hoist, and No. 2 Rand drill—all supplied by the Jenckes Machine Company—are now running on the work. The shaft is being sunk alongside the creek, and up to the present time, on account of the hardness of the rock, very little water has been met. Progress at the rate of about a foot per diem in sinking is attained, the cost being between $25 and $30.

Co. expect to sell power for the air drill on the 24-hour run at $3 per day, or less than the price of a miner's wage, and the mine owner will be saved all the capital cost of installing a compressor, with its attendant worry and cost of operation. Any prospector along the line of the pipe-line can tap on with a small pipe, and run a drill or a hoist, the capital cost of which is not very great, and when he is through with his work upon any particular property he can take up his outfit and move it to another claim. The power company, while able and ready to cut existing rates in two, will still make handsome profits, for with a drill rate of $3 (less than half the price of a miner's wage on the 24-hour run) the air h.-p. will still net, if from 20 to 30 drills are connected, between $140 and $150 per h.-p. per annum.

The estimated cost of the pipe lines laid on the ground is $18,000,



The main pipe-line of the company will be run from the compressor to some point on the "Black Diamond" ground, a distance of 10,000 feet. This pipe-line will be 9 inches in diameter in the clear, and with an initial pressure of 90 lbs., and allowing a loss of 10 lbs. in transmission, will discharge 4,600 c.f. of free air per minute, or, with 5 lbs. loss, giving a final gauge pressure of 85 lbs., will discharge 3,000 c.f. of free air per minute. From the "Black Diamond" ground branch pipe-lines will reach out to the principal operating properties in the district, and it is expected that with two miles of these branch pipe lines, varying in size from 3 to 6 inches, from 250 to 350 h.-p. of air can be sold. The pipe-lines will be of wrought iron, with bolted joints and rubber gaskets.

Throughout the Kootenay district the present charge for the air drill, consuming from 80 to 120 c.f. of free air per minute, varies from $5 to $7.50 per day, dependent upon the size of the steam compressor plant and the fuel conditions prevailing. The Kootenay Air Supply

a portion of which, however, will be borne by the consumer, bringing the total estimated cost of the plant to $30,000. When once installed, the maintenance and operating expenses should be inappreciable. There is no moving machinery to wear out, no operators needed at the central station, and the life of the pipe-line is almost perpetual, as being laid above ground, it is affected only by atmospheric conditions.

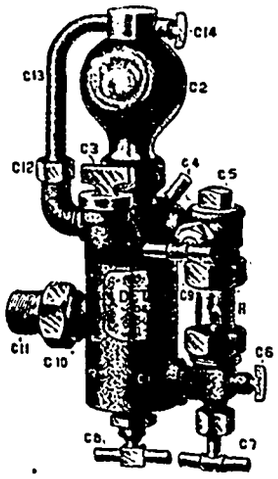
The greatest interest is being taken by miners, who are the largest users of air in the world, in this installation at Ainsworth. It means a vast saving in mining, for there are few mining districts throughout the entire West where a sufficient amount of water power is not available within from five to ten miles of mines to operate plants, and after the capital investment has been made the miner practically gets his motive power (and air is absolutely essential to him as motive power) without any cost other than the interest charge.

Steps are now being taken by the Taylor Air-Compressing Co., which is installing the plant at Ainsworth through its sub-company,

the Kootenay Air Supply Co., to make a similar installation in the Rossland and Ymir districts. In the former district some 750 actual air h.-p. are to-day being consumed, and the total cost of the air h.-p. at the mine to-day averages more than $200 per air h.-p. per annum. This section is one of the most inviting fields for the installation of a plant, the rock being especially hard, and the air power being absolutely indispensable for mining in the district.

A COLD WEATHER LUBRICATOR.

In the Northern States and Canada, where the winters are severe and of considerable length, it is often a difficult matter to maintain a steady feed of oil to the cylinders of engines. This is particularly true in the case of many mills and other steam plants where the engine room is exposed more or less to the cold. The oil thickens into a viscous, jelly-like mass, which will not break up into drops nor feed through the ordinary lubricator. As a result, the valves become cut and worn, and there is a double waste of energy due both to the cold and to the friction. Recently an ingenious lubricator has been designed by the Detroit Lubricator Co., of Detroit, Mich., to overcome these conditions. It is very appropriately called the "Zero," and is shown in the accompanying cut. Right above the support arm, inside the outer shell, is a heating chamber, which is always filled with steam while the engine is working. This steam heats the oil, and keeps it warm and in a liquid state, no matter how cold the weather. Of course, in very cold weather, it will use up some steam to keep the oil heated, just as it does to keep the cylinder heated, but the heat in the one case is just as positive as in the other. This heating chamber is perfectly automatic. In cold weather the steam in this heating chamber condenses more or less, and the condensed water runs back into the steam-pipe, keeping the chamber always filled with steam. These "Zero" cups have been on the market for nearly two years. They have been adopted by almost every American builder of threshing engines and by several Canadian ones. They are also used very generally on stationary engines that have to work in cold locations. Any one interested can obtain a descriptive circular or a complete catalogue showing them by dropping a card to the manufacturers.



ZERO LUBRICATOR.

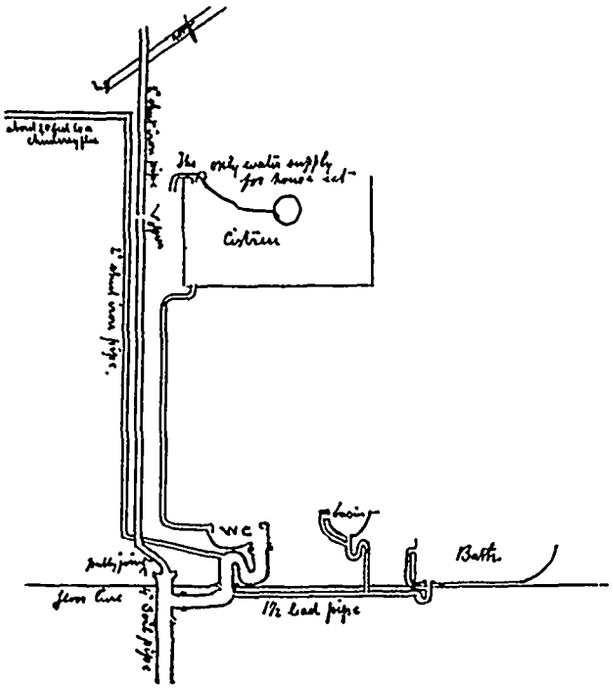
DANGEROUS PLUMBING.

Editor THE CANADIAN ENGINEER.

SIR,—In one of Toronto's large, well-appointed and handsomely furnished residences, a licensed plumber was engaged to remove an old pan water-closet, and the lead bend and P.-trap, and fix in a 4-inch by 4-inch tee in place of the lead quarter bend, and a 4-inch lead bend in place of the P.-trap, and an improved sanitary two-piece water-closet in place of the old pan water-closet.

The house had been fitted up in the first place in the old English style, having a large lead-lined storage cistern, from which the w.c. was flushed, and the range boiler and every water tap in the house was supplied. The cistern itself receiving its water through a ball tap and lead pipe direct from the city water mains. The old pan was vented by the 2-inch horn upward through the roof by a 2-inch sheet-iron pipe that dropped in two when the old closet was removed at the point shown in the sketch between the cistern and a wall having a space of about six inches jammed with about six different lines of pipes.

From the socket of the 4-inch to 4-inch soil pipe tee, the plumber fixed a 2-inch piece of sheet iron pipe up to within 1½ inches of the end of the old pan w.c. vent pipe at the end of cistern (see sketch), and there left it as a completed job, because one end was vertically under the other. By this, most of the sewer gas that should pass out through the roof is abstracted and absorbed by the drinking water stored in the cistern close by, which would partly poison the water and make it unfit to use for domestic purposes. And if not all absorbed by the cistern water, the balance would pass into the room, little if any would pass up the pipe except when the temperature of the room was lower than the outside. From the vent-horn of the new sanitary trap, he took another two-inch sheet iron pipe up and over the ceiling of room for twenty feet perfectly level to a chimney. He could have graded upward to a higher level of 8 feet if he chose. To expect air to circulate through so long and small a pipe laid level is absurd, and if it did deliver the sewer gas in the chimney at the point about 12 feet below the discharge head, it would not ascend upward except when the flue was warm When no fire was burning and the flue was cold the sewer gas would descend the straight flue into the living apartments.



The third error is seen by referring to the sketch at the point where the 1½-inch bath waste joins the heel of 4-inch lead bend. When bath pipes are joined in this way the excrement is liable when it bounces on the heel of bend to rebound back up the 1½-inch pipe, and charge the pipe, beside pressing the foul air in the small pipe through the water seals and by the act of making the water seal to oscillate to break the seal of the trap and leave it open until more water is run in.

This job has only been done within a few weeks time and one would hardly have expected to find such dangerous ignorance displayed, especially in a house where the total cost of good sanitary arrangements and workmanship would probably be only one-tenth of the amount of the house furnishing.

WM. WATSON.

567 King st. W., Toronto, Feb. 15th, 1898.

METAL IMPORTS FROM GREAT BRITAIN.

The following are the sterling values of the metal imports from Great Britain during January, 1896, 1897.

	January. 1896.	January, 1897.
Hardware and cutlery	4,765	1,636
Pig iron	380	504
Bar, etc.	1,236	285
Railroad	..	50
Hoops, sheets, etc.	1,840	827
Galvanized sheets	654	2,031
Tin plates	22,508	11,929
Cast, wrought, etc., iron	1,684	1,874
Old (for remanufacture)	191	..
Steel	2,586	4,521
Lead	519	978
Tin, unwrought	3,046	422
Cement	468	518

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.

KINGSTON NO. 10.

A special meeting of Kingston No. 10 Canadian Association of Stationary Engineers was held in Congress Hall, January 26th, 1898. It was called for the purpose of visiting the members of Parliament, B. M. Britton for the city and David Rogers for the county, *re* legislation. The following members of the association were present: President Simmons, Vice-President Asselstine, Past President Donnelly, Bros. Hoppins, Blomely, Woodrow, Davis, Taudrein, Linton, Strong, Gascoyne, Selley, Derig, Bajus, Turnbull, sr., Tait and Orr. There were also present certificated members of the Ontario Association: David Leslie, P. McArdle, James Ross and George Hazlett, of the Winnipeg branch of the association. All of the above members formed a deputation and proceeded to B. M. Britton's office; when David Rogers arrived the business was proceeded with, President Simmons reading and presenting an address, along with a copy of the Act, to Mr. Britton, after which H. Hoppins, in a few well chosen remarks, pre-

sented a copy of the address and the Act to David Rogers. Both gentlemen replied. After a few questions were asked regarding the working of the association, which were answered satisfactorily by President Simmons, Past President Donnelly, Bros. Hoppins and Blomely, the question was put to Mr Britton if he would support the bill. He stated he would, and more than that, if the party having the bill in charge wanted any help to get it in shape to go before the House, he would only be too happy to give him any help he could to make it a success. Mr. Rogers was then asked if he could support it. He said he could not see anything in the bill but what was right and just, but he would not pledge himself until he made further enquiries. The deputation retired, feeling satisfied that when it came before the House he would support it At a regular meeting held on the 3rd February, there was a resolution made that a hearty vote of thanks be tendered to B M. Britton and David Rogers for the reception they gave the deputation of engineers who waited on them, and also that a copy of the minutes of the special meeting be sent to THE CANADIAN ENGINEER for publication.

JOHN L ORR, Sec.,
Kingston No. 10, C A S.E

C.A.S E., TORONTO, NO 1.

C.A.S E., Toronto, No 1 held its regular meeting on Feb. 2nd. There was a good attendance and two initiations, and two propositions were received There were several questions in the question box. Bro. Miln took them up and figured them out on an old door, the new blackboard not being finished. Bro. Miln also took up the question, "What Makes a Motor Go?" and his explanation was highly appreciated by all the brethren present.

Their regular meeting on Feb. 16th, was held in their hall, 61 Victoria Street. There was a fair attendance, and after the regular business was over, and the question box opened, it was found to be full of Scranton School questions, some of which were answered and some taken home by the brethren, to ponder over till the next meeting night, when they will be expected to work them out on the new blackboard.

At the regular second Tuesday evening open meeting, Feb. 15th, Bro. Wickens continued his talk on The Steam Engine Indicator, after which a hearty vote of thanks was tendered to Bro Wickens

At the regular meeting on March 2nd, Engineers' Hall, 61 Victoria street, there was a good attendance and one candidate was initiated. A number of questions were asked and figured on the blackboard by Bros. Past Presidents Fox, Moseley and Bannan, which work was greatly appreciated by the brethren present. A Legislative Committee reported that all the members of the Dominion Government present in Toronto had been written to, asking their support for the Engineers' License Law and Boiler Inspectors' Act, which is to come up at the present session, and a number of them have promised their consent.

The regular open meeting will be held Tuesday evening, 8th inst. Mr. St John has kindly consented to give a talk on the strength of boilers. The president expects a large attendance, and invites all engineers to the open meeting. The members "do not want to keep all the good things to themselves"

—The annual meeting of the Canadian Press Association will be held in Ottawa, 10th and 11th inst Among the important matters to be considered will be the postage question, insolvency legislation, and the visit of British journalists to Canada. Frank A. Munsey, who has been without doubt the most successful modern publisher, will deliver an address on and discuss the "Elements of Success in Newspaper Publishing" It is hoped that one or two of the following representatives of the British Institute of Journalists will be present: Lord Glenesk (London *Morning Post*), Sir Hugh G Reid, M.P., J. M. Maclean, M.P., and Sir Edward Russell. The dinner will take place as usual, when a number of important speeches will be made.

—P. B. OWENS writes to a contemporary:—"In these days of enormous productions of iron and of stupendous commercial transactions, it no doubt will interest many of the present generation to learn that mining, smelting and manufacturing of iron was an established industry in the County of Essex, Ontario (then Upper Canada), in the early part of this century A smelting furnace was built in the Township of Gosfield, on the farm of Michael Fox, about one mile north of where the Olinda post-office now stands. The ore was taken from natural deposits in the adjoining Township of Mersey, and the fuel used was charcoal produced in the immediate vicinity. The writer remembers how wonderful the furnace, the smoking stacks of wood covered with earth, and the sluice boxes for the washing of the ore all appeared to his childish mind. A large quantity of timber was consumed in the production of the charcoal, timber which, if now standing, would be of enormous value. But no kind of timber, except white oak, was then considered of any value, even black walnut being made into fence rails, and much of it actually burned up in clearing the land."

—The German Association for Acetylene and Calcium Carbide will hold an exhibition of the recent progress that has been made in this industry, and at the same time a congress to consider the various scientific and practical questions that have arisen in connection with it. The exhibition, which will be held in Berlin from March 6th to March 20th, will comprise acetylene generators, lamps, purifiers and mixing apparatus, acetylene burners, motors and soldering tools, calcium carbides, electric furnaces and electrodes, and the different varieties of machinery used in the manufacture of the calcium carbide. Rigorous regulations have been adopted by the Berlin police to prevent any premature explosions, and no generating apparatus using more than about one half pound of the calcium carbide will be permitted in the main exhibition hall. The use of pure, compressed, or liquefied acetylene gas will be prohibited, and a limit of a hundred and twenty pounds pressure has been placed on mixtures of the gas. The use of acetylene gas for illumination is increasing, and the coming exhibition will show how general its application can be made, as well as the simplicity with which the gas is generated.

Industrial Notes.

THE St. Thomas, Ont., city council is looking for plans for the new city hall.

GEO. GRANT, Arnprior, Ont., has the contract for building a bridge at Burnstown, Ont.

CHAS RITZ has bought the foundry until lately run by C. Ritz & Co.—*New Hamburg Independent.*

THE Grand Trunk Railway, it is stated, contemplate building a mammoth hotel in Quebec city.

D RICHARDS & Co. speak of the erection of a steel and brick addition, 90 x 40 ft., to their soap factory at Woodstock, Ont.

A BY LAW, under which Goderich, Ont., is taking $50,000 stock in the Elevator Company, has been carried by 416 majority.

J. WILSON, foundryman, St. Catharines, Ont., has received a large order for wire cables for mining in British Columbia.

THE Stellarton, N.S., Lubricating Company, we understand, intends shortly to commence the manufacture of their lubricant on a large scale.

J. R. ADAMSON, Cornwall, Ont., is one of the incorporators of the Black River Creamery Co., Limited, which intends building a factory at once. Capital, $2,000.

APPLICATION has been made for the incorporation of a company to be known as the Woodstock, N.B., Sash Balance and Lock Company to manufacture and sell a patented window raising and locking contrivance.

THE residents of North Cypress, Man., are endeavoring to make arrangement for a bonus of $10,000 to a flour mill and elevator. The mill is to have a capacity of 300 barrels and the elevator 100,000 bushels capacity.

THE new agricultural hall at Shawville, Que., will cost about $3,000 The design has been made by architect Edey of Ottawa, and is for a building of octagonal shape, the dimensions being 99 feet diameter, and a 27-foot wall.

THE Knowles Bicycle Company, Limited., is applying for incorporation; chief place of business, Brantford, Ont.; capital, $50,000. The provisional directors are. W. J. Knowles, W G. Nott, J. T. Ham, J. H. Ham, and Maria Knowles, Brantford.

A DOMINION charter has been granted to C. Guimond, Beauharnois, Que.; C. F. Lalonde, Montreal; J. Leduc, Beauharnois; J. B. Roy, Beauharnois; Delia Rochette, wife of Emilien A. Manny, Beauharnois, as the Star Iron Company, Limited, with a capital of $60,000.

FRED. H. DOUGHTY, formerly in the employ of Jas McPherson & Co., Hamilton, Ont., has purchased the business of H. B. Livingston & Son, machinery agents, Leicester, Eng., and, with Mr. Livingston, jun., will continue the business under the firm name of Livingston & Doughty.

A PLEASANT event took place at the B. Greening Wire Company's works, Hamilton, Ont., on a recent evening, when the employees of the rope department presented the foreman, Charles A. Herald, with a set of drawing instruments. Louis Beck made the presentation, with a felicitous speech. Mr. Herald made a suitable reply, thanking his co-workers for the pleasant surprise.

W. BURROW, C. Stewart, J. Milne, J. Stewart and C. Milne, Hamilton, Ont., and W Burrow, jr., Chicago, Ill., are applying for a Dominion charter as the Burrow, Stewart & Milne Company, Limited, to manufacture stoves, furnaces, scales and hardware generally. Chief place of business Hamilton, Ont.; capital, $250,000.

LONDON, Ont., wants an engine to run its stone crusher.

ST. CHARLES COLLEGE, Sherbrooke, Que., is to have a new building.

A ONE hundred thousand dollar block of buildings is to be erected at Victoria, B.C., by the Molsons Bank

DESERONTO will vote on a $20,000 bonus towards a charcoal iron smelting works in that town, to cost $250,000.

PETER STEWART, Arnprior, Ont., has secured a position with the Wm. Hamilton Manufacturing Co., Peterboro, Ont.

THE contract for building the Simcoe county, Ont., House of Refuge has been awarded to A. Tessier, Penetanguishene, for $14,966.

THE New Brunswick Government has invited tenders for the extension of the breakwater at Centreville, N.B., estimated to cost $4,000.

THE Carleton Place, Ont., council has had a letter from the Perth Waterworks Co., Limited, asking for a similar franchise from that town as they received from Perth, Ont.

THE Lancaster Machine Works, Lancaster, Ont., are kept busy with orders in all lines, especially in their line of cotton mill machinery, in which they are building up a good trade.

A NEW single span iron bridge will be placed over the River Raisin, at South Lancaster, Ont., the coming spring, to replace the old wooden structure, which has been condemned.

THE London, Ont., Foundry Company has received orders for four carloads of wheelbarrows, forges and miners' tools, for shipment to the Klondyke. The order comes from a Vancouver firm.

THERE is every indication of a good dairy season during 1898, and manufacturers are preparing for it, already the Lancaster Machine Works have booked several orders for their patented specialties.

THE Nelson, (B.C.), Iron Works are employing 12 men at present. They make and repair machinery for the mines in the vicinity. They recently completed a contract for water hydrants for Grand Forks.

WE have received from the International Correspondence School, Scranton, Pa., a booklet containing some hundred testimonials from pupils all over the world, who have studied under its direction with much benefit.

THE Massalon Paving Brick Company, of Massalon, Ohio, is endeavoring to place its wares on the Canadian market. The Massalon brick is larger than any of Canadian manufacture, and is said to be one of the best made.

G. H. MCGILLIVRAY, township clerk, will receive tenders up to noon on the 19th inst. for the construction of two stone abutments on the site of the Lancaster bridge, South Lancaster. Tenders will also be received for concrete abutments.

THE stock and plant of the Beaver File Works, Levis, Que., was sold by auction a short time ago. The purchasers were Marcau & Jauteau, who have now decided to change the name, and in future the concern will be known as the Mechanics' Star File Manufacturing Co.

THE Moore & White Co., of Philadelphia, manufacturers of clutch pulleys, couplings, etc., have appointed the Lancaster Machine Works, of Lancaster, Ont., as their representatives in Canada, from whom all particulars regarding these justly celebrated friction driving devices may be obtained.

THE Hamilton, Ont., municipal estimates for 1898 contain the following large items, among others: Catharine street sewer, $22,000; Wood street (John to James) sewer, $3,700; trunk sewer, east end annex, $20,000; Aberdeen avenue sewer (Locke and Garthe) $3,900; disposal works, expense, $10,000; gully drains and ventilators, $2,500; Mountain drain improvements, $2,500.

THE Ingersoll-Sergeant Drill Company has issued a very neat booklet, which is practically a condensed edition of their catalogue of air compressors. It contains illustrations of the various types of compressors, and shows some of the uses they may be put to. Copies of this handy little volume may be had by applying by postal card to the Montreal office, 299 St. James street.

G. W. RICHARDSON, representing the proposed Rossland, B.C., Gas Company, asks the following concessions from the municipality: The right to construct and operate gas works and to supply gas to the citizens of Rossland for ten years, with the right to lay mains and service pipes along the streets of the city; gas to be of a standard not less than 16-candle power, and to be supplied at a rate not more than $2.50 per thousand feet; work to commence in six months and to be completed within two years; gas to be supplied to the city at $3 per month per light, if 25 lights are taken, and $2.50 per lamp if more than 30 lamps are used, corporation to have the privilege of purchasing the plant at any time within ten years at a price to be decided by arbitration.

J. HANBURY, Brandon, Man., is negotiating with the municipality to start a wood-working factory. The proposed building is to cost $20,000.

W. PERRY, representing the R. H. Buchanan Co., engineers, Montreal, in connection with the Rider Ericsson Hot Air Pumping Engine Company, recently, at their works, Walden, N.Y., made a test of the new improvements on the hot air pumping engines, which far exceeded any previous tests, and was in all details satisfactory. The severest tests were applied

THE Willson Carbide Works, Merritton, Ont., have been so crowded with orders that they decided to start their works on Sunday; that is, instead of closing at 12 o'clock Saturday night and remaining closed until 12 o'clock Sunday night, they now run until 7 o'clock on Sunday morning, and remain closed until 5 o'clock Sunday afternoon. To these arrangements the Lord's Day Alliance took exception, and caused fourteen of the employees to be summoned before the police magistrate.

THE Hamilton, Ont., papers reported that Engineer Barrow had made a test, for capacity, of the pumps and machinery at the sewage disposal works. The showing made was 3,175 000 gallons in 24 hours, which is 175,000 gallons above the requirements. This work was done with one engine only in operation. Mr. Barrow expects to be able to bring about a great saving in chemicals, not only by a change in the precipitants used, but also through the large settling surface. At the east end works the machinery which runs the pumps is now being used to operate the mixers, and thus a saving in fuel is effected. Mr Barrow expects, in time, to bring the cost of operation to a much smaller figure than at present. From the number of changes proposed it would appear that plant is at present found to be expensive.

A BRIDGE has recently been completed at Dundas, Ont., that is a decided departure from the usual class of work done by municipal councils. To protect the banks from the cutting action of freshet water, caused by the curving of the current at this point, the abutment walls were made just high enough to provide a margin for highest freshet known, and on the tops of these walls steel rail piers were placed to support the superstructure, and the abutment walls carried up and down stream in such a way as to turn the current, making in all a length of wall of about 200 feet. The walls were topped with a cap having a half-round face, with 4-inch projection and 12 inches depth. All of this work is of concrete construction. John S. Fielding was the designer and contracting engineer; J. F. Armour, the town engineer, in charge.

H. J BEEMER, president of the Pontiac and Pacific Junction and the Ottawa and Gatineau Railways, stated recently that preparations for beginning active operations on the new bridge that is to be built across the Ottawa from the city of Hull at Nepean Point were well under way. The contract for the substructure has been given to a New York firm, while the superstructure will be built by the Dominion Bridge Company. There will be five piers, with a cantilever span of 550 feet in the clear, with arms of 250 feet each. The total length of the superstructure, according to the plans, is to be about 1,300 feet. The bridge will carry a railway track, two tracks for electric cars and a sixteen feet roadway on each side. The object of the 550 cantilever span is to get the piers out of the great accumulation of sawdust in the Ottawa river. The total cost is estimated at about $750,000.

THE following are some of the orders lately received by the Goldie & McCulloch Co., Limited, Galt, Ont. J. R. McComb, flour mill and oatmeal mill, including engine, etc.; Jas. Pender & Co., St. John, N.B., "Ideal" engine. Michigan Central Railway Co., two locomotive boilers; Montreal Transportation Co., Kingston, "Ideal" engine; Delhi Fruit Co., Delhi, one heater; C. G. Gelinas & Co., Three Rivers, "Wheelock" engine; Jas. Richardson & Co., Kingston, "Wheelock" engine, boiler, condenser, shafting, etc.; Maritime Sulphite Fibre Co., Chatham, N.B., heater; Orangeville Electric Light Co., Orangeville, one boiler; Cronkhite Bros., Wisawasa, engine, boiler, heater, etc.; J. S. Metcalf & Co., Chicago, elevator at Coteau Landing, "Wheelock" engine, condenser, feed pump, two boilers and one "Ideal" engine; G. M. Angier & Co., Boston, for Asylum at Fairville, N.B., two "Ideal" engines, two boilers, heater, feed pump, etc.; N. Wenger & Bros., Ayton, one "Ideal" engine. Ogilvie Milling Co., Winnipeg, Man., two boilers; Dominion Bank, large bankers' safe; Electrical Power and Manufacturing Co., Hamilton, engine, boiler, etc.; Molson's Bank, Montreal, two bankers' safes; D. Marshall & Co., Aylmer, two boilers, heater, etc.; Wm. Hamilton Manufacturing Co., Peterboro, six boilers; M. Beatty & Sons, Welland, one boiler; the T. Eaton Co., Toronto, two "Ideal" engines, S. Lennard & Sons, Dundas, one "Wheelock" engine; Bank of Hochelaga, Sherbrooke, large bankers' safe; Bank of Hamilton, Hamilton, large bankers' safe.

A THEATRE to cost $30,000 will be built in St. Roch's, Que.

THE Granby, Que., rubber factory is being extended. Neil & Kent have the contract at $8,500.

THE Welland Vale Bicycle Co., St Catharines, Ont., have shipped recently 50 wheels to Austria.

ARTHUR DENISON, Toronto, architect, has passed the Walkerton town hall, and taken it off the contractors' hands.

A CONTRACT for building a bridge over the Holland River near Bradford, Ont., will be let during the coming summer.

RIDGETOWN, Ont., has offered a large bonus and exemption to W. E. Hall, furniture manufacturer, Galt, Ont., to remove to that town.

THE Ontario Rolling Mills, Hamilton, Ont., lost no time in getting their premises into shape after the fire, and will soon have everything in as good condition as formerly.

RHODES, CURRY & Co., Amherst, N.S., recently obtained a contract to build 50 twenty-ton box cars for use on the extension of the Drummond Counties Railway at Montreal.

WORK at the Shawenegan Falls, above Three Rivers, Que., is to start shortly, and the hotel there has been reopened for the accommodation of tourists and people connected with the works.

DARTMOUTH, N.S., has a proposition before it to bonus a pulp mill to have a capacity of 20 tons per day. The promoters have secured options on suitable water power and land in the town.

THE Taylor Air Compressor Company, of Montreal, is installing a 500 h.p. plant at Ainsworth, B.C., and expects to distribute the power to mines within a radius of five miles. A full description of this plant will be found on another page.

THE Almonte, Ont., town council has been approached by the Perth Waterworks Co., asking if the council would be willing to enter into negotiations, even in an informal way, with the ultimate view of granting them a franchise for the supply of water and light.

THE Three Rivers, Que., Iron Works is completing the erection of a large brick machine shop and foundry, in connection with their already extensive works. The firm has large contracts on hand, which will give full work to their establishment for the next few months.

AT a recent meeting of the Essex County, Ont., Council the Road and Bridge Committee sanctioned the construction of the following: New bridge over River Canard, cost $1,732; new bridge over Bell River, cost $1,099; new bridge over Tremblay Creek, on county line between Essex and Kent.

IN April, 1897, the Cooper Machine Company of Toronto was incorporated, with $20,000 capital, one-fourth of which was paid. Last month the creditors had a meeting, and their statement showed assets of $4,800, against liabilities of $5,500. An offer of 40 per cent was made and accepted.

THE local papers in Almonte, Ont., are discussing a system of water works for that town. The finances of the town are in good condition, and such a scheme might be put through; however, the laying down of the mains would be a most expensive undertaking, as almost every foot of excavation would be rock cutting.

JOHN MCCONNELL, of McConnell's Electric Carriage Works, Guelph, Ont., has invented a carriage wheel which ought to prove a revelation in carriage manufacture. The new wheel is set on roller bearings and has no boxings to break or get loose. It is dustproof, and requires oiling once in a season, there being no friction to require the continuous use of oil.—*Guelph Herald.*

THERE was a meeting of the Iron Founders' Association of Montreal recently, in the reading room of the Laurie Engine Company. Among those present were W. H. Laurie, H. R. Ives, J. H. Garth, Thos. Monaghan, Wm. Rodden, John Laurie, E. Lamb and G. H. Weaver. During the evening a most interesting paper on "The Chemistry of Iron" was read by Ernst A. Sjostedt.

THE board of management of the public works of St. John, N.B., will receive tenders till April 1st for the supplying of about 3,116 tons of best quality 24 and 12 inch cast-iron water pipe, according to specifications and drawings prepared by Wm. Murdoch, Esq., C.E., engineer and superintendent S. and W. Supply, copies of which specification may be had on application to the director, A. Chapman Smith.

IN our last issue, THE CANADIAN ENGINEER stated that a writ had been issued against the Welland council of 1897 by the Waterous Engine Works Company, claiming damages for the non-fulfilment of a contract to purchase a fire engine. The statement, we find, is incorrect. A local informant states that our item might truthfully refer, however, to the village of Fort Erie, which is having some trouble with the Waterous Company.

THE secretary of the General Hospital, at Kingston, Ont., has been instructed to advertise for tenders for the reconstruction of the Watkins' wing, the cost of which is estimated at $12,000. The plans provide for twenty rooms. The question of putting in an elevator has not yet been decided.

THE Somerville course of lectures for 1898 at the Natural History Society Hall, Montreal, has been announced. The following lectures will interest our readers: Thursday, March 24th—The Modern Steamship, by Prof. A. J. Durley, B.Sc., Assistant Professor of Mechanical Engineering, McGill College. Thursday, March 31st—Precious Metals Where they come from and how they occur, by Prof. F. D. Adams, M.A Sc., Ph D., president of the Natural History Society. Thursday, April 7th—Coal and Iron, by Osmond E LeRoy, B.A., of McGill College. Thursday, April 14th—Our Railways, by Prof. Cecil B. Smith, M.A.E., Assistant Professor in Civil Engineering, McGill College.

IN the works of the Robb Engineering Co., Amherst, N.S., has a concern of world wide reputation. At present, in every department, the hum of industry is heard, not only during the day, but night. Recently there was a test of a Robb-Armstrong engine. This one, which is compound, goes to Europe to be placed in an electric installation, and will be completed and ready for shipment at an early date. It is 125-h.p. Besides this one just referred to, three compound engines of the same type, each 200-h p., being made for a foreign order, two of 225-h.p. each, for the Rathbun Co., Deseronto, Ont., and two more of 150-h.p., each, simple, for St. Thomas, Ont. These engines are of the side-crank type. In another part of the premises a large boiler is being finished, which will go to Parrsboro, N.S. It is known as the Mumford improved patent boiler. It is entirely cased in, with furnace in centre, and the smoke returns round the outer part of the shell. The boiler is arranged so that the water has a positive circulation, and the steam is collected in a large horizontal dome at the top. The whole arrangement is such that a great saving in fuel is claimed to be effected.

THE new steel swing bridge across the Lachine Canal at Seigneurs street, Montreal, for which tenders have been called, is to replace the present old structure, which is too light in construction to allow of an electric car service. It has only a clear roadway of seventeen feet, and a total width of twenty-eight feet. The new structure will have a clear roadway of thirty-seven feet, with two sidewalks of four and a half feet in width, and a clear roadway of twenty-six feet. Its length will be one hundred and thirty-eight feet between ballast walls, and be about eighteen inches higher than the present structure. The Atwater avenue bridge across the Lachine Canal is expected to cost about $75,000. The bridge is to be a swing bridge, with a clear span between abutments, ballast wall of two hundred and forty three feet. The total width of the bridge will be thirty-eight feet, giving five-foot sidewalks on each side. The bridge can be built during the season of navigation, the abutments being placed far enough from the canal bank, so as not to interfere with the canal walls. The centre pier is founded on concrete placed within a square made of piles, with rods passing through the walling pieces. The rest pier work down the centre of canal, is composed of cribs, with ten-foot openings, and will be about two hundred and ninety feet in length.

RECENTLY a number of the people of Sarnia, Ont., witnessed at the Doherty Stove Works a test of T. Doherty's latest improvement in iron casting—the transforming of cast iron directly into steel by an air blast, passed through the melted metal as it emerges from the cupola. For some time Mr. Doherty has been at work on a new method for decarbonizing iron in the process of casting and bringing the resultant metal to a higher grade of steel than was obtainable by his original process. The basis of the latter was the introduction of a steam jet to the cupola. The new process is based upon the use of compressed air. A specially designed cupola also forms part of the new process, we are informed by a local contemporary. The metal, as melted, drops in a small stream through the bottom of the receptacle to a receiver below, and as it falls through a powerful blast of air is directed against it, which blows out the impurities, which find escape through an opening in the back of the cupola. The effect of the introduction of air under pressure is marvellous The carbon, sulphur and silicon in the iron can be eliminated to any extent desired by the foundryman by regulating the pressure, with the result of producing a steel casting suitable for the class of work for which it is required. At the test described the blast was regulated for stove plate casting and did not show the highest results obtainable, but it clearly demonstrated the superior character of the process over that of the original patent. Metal produced under the air blast process shows all the characteristics of steel under the hammer, the drill or the lathe, and there appears to be no doubt that Mr. Doherty has solved the problem of producing steel from ordinary pig iron at a single process, at once simple and cheap.

J. E. Losby intends starting a feed mill at Amherst, N S., in a short time, and has ordered a 40-horse power boiler and engine from the Robb Engineering Co.

Senator Poirier, Shediac, N.B., has ordered a 60-horse power engine and boiler from the Robb Engineering Co., Amherst, N.S., for running a flour mill and shingle mill.

An application has been made for a charter under the name of the Nickel Steel Company of Canada, the incorporators being: John McLaren of Brockville, manufacturer; George B. Douglas, of New York, manufacturer; Alexander Fraser, of Ottawa, lumberman; David McLaren, of Ottawa, lumberman; F. F. Vandervoort, of Pittsburg, manufacturer; George A. Cox, of Toronto, capitalist; Nathaniel Dyment, of Barrie, lumberman; Alexander McLaren, of Buckingham, lumberman; Andrew Trew Wood, M.P., of Hamilton, merchant; John Moodie, of Hamilton, capitalist, and John Patterson, of Hamilton, secretary. The company wants power to "explore for, develop, operate and acquire by purchase, lease or otherwise, gold, silver, copper, nickel, lead, iron, coal and other mines and properties, and to dispose of the same by sale, lease or otherwise, to manufacture and treat metals, minerals and ores, and to carry on the business of manufacturing therefrom and in combination with other metals, minerals, ores, substances and minerals and all articles of merchandise that may be manufactured therefrom." It also wants power to construct railways to reach or connect the mines, etc., and to establish steamship lines John Patterson, Hamilton, the promoter, says there is $20,000,000 of capital behind the enterprise.

Electric Flashes.

The Guelph Light and Power Company recently started up its new Brush arc machine.

The Cardinal, Ont., Electric Light Company, Limited, has been incorporated; capital, $20,000.

The Buckingham Reduction Co of Buckingham, Que., is installing a 200 K.W. power generator. The order was given to the Royal Electric Co.

The Richmond County Electric Co. has purchased a 60 K.W. "S K.C." two-phase generator from the Royal Electric Co.

The Toronto Railway Company has just placed an order with the Canadian General Electric Company for 20-G.E. 1,000 motors with K-10 controllers.

S. Lennard & Sons, of Dundas, placed an order some time ago with the Canadian General Electric Company for a 100-light incandescent plant.

The Ossekeag Stamping Company, Hampton, N.B., has purchased a 200-light incandescent plant for lighting the works from the Royal Electric Co.

The Sherbrooke, Que., Street Railway Company has recently placed an order with the Canadian General Electric Company for additional G.E. 1,000 equipments.

The British Columbia Railways Company has placed an order for a freight car, using "Brill" trucks and G.E. 1,200 motors, with the Canadian General Electric Company.

The Electric Light Co., Edmonton, N.W.T., has purchased a new plant complete, including a 75 K.W. "S.K.C." two-phase generator, with "Stanley" transformers, from the Royal Electric Co.

The Midland Electric Light Co., Midland, Ont., recently placed an increase order with the Canadian General Electric Co for a 60-kilowatt, single-phase alternator of the company's standard type.

The Metropolitan Street Railway Company, Toronto, has placed an order with the Canadian General Electric Company for G.E. 1,000 equipments to replace the motors burned in the fire recently at the car barn.

W. B. Davey will immediately commence work for the lighting of Grand Forks, B.C. The order for the electrical machinery complete, including a 1,500 light alternator, has been given to the Royal Electric Company.

The Chateauguay and Northern Railway Co., Montreal, has placed an order with the Canadian General Electric Company for a 325-kilowatt steel frame generator. This will give that road a total capacity of 525 kilowatts.

The Hull, Que., Electric Company has ordered thirty-six G E. 1,000 motors from the Canadian General Electric Company These will be used as four-motor equipments, making in all fifty-two motors of this type which the Hull electric road will have in operation.

The Canadian General Electric Company is supplying three small direct connected units for the C.P.R. steamships on the Stikine River. These machines will be 4 kilowatts each, direct connected to vertical engine of special type, running at 1 o revolutions per minute.

The Canadian General Electric Company has been awarded the contract for supplying electrical machinery for lighting and power purposes at Ashcroft, B.C. The three-phase system will be used, and the pumping for the town waterworks will be done by an induction motor.

The Canadian General Electric Company has closed a contract with the Montreal Transportation Company at Kingston, Ont., for a 25-kilowatt generator of the well-known direct connected type. This machine will be used for lighting the new elevators and other buildings of the company at Kingston.

There is a good deal of favorable criticism of the kindly action of the Royal Electric Company in coming to the assistance of the Lachine Rapids Company, the power-house of which was burnt on the 6th ult. The Royal Electric Co. lighted Westmount and Mile End for its competitor.

The council of Orillia, Ont., has instructed Wm. Kennedy, jr., hydraulic engineer, Montreal, to visit the Ragged Rapids and give an estimate of the probable cost of the hydraulic work, with information as to the best methods, etc. The Canadian General Electric Co. and the Royal Electric Co. have been asked to estimate on the proposed municipal lighting and power plant.

The Canadian General Electric Company has been awarded the contract for supplying the entire electrical equipment for the new St. Thomas Street Railway. The order covers two 100 kilowatt generators, and eight two-motor equipments. The order for cars was given to the Ottawa Car Company, and for steam engine to the Robb-Armstrong Engineering Company, Amherst, N.S.

The Auburn Power Co. at Peterboro, Ont., has ordered a direct connected sub-station unit from the Canadian General Electric Company, consisting of a 75 horse-power induction motor. From this outfit current will be supplied at 500 volts to small power users throughout the town of Peterboro, it having been found that the high price of induction motors prevented their general use.

The Electric Reduction Company, of Buckingham, P.Q., have placed an order with the Canadian General Electric Company for a 1,000 horse-power three-phase revolving field generator to be used for electrolytic work. The machine will be similar to those installed at Lachine and West Kootenay, except that the current will be supplied at the low potential of 75 volts.

The Canadian General Electric Company has closed a contract with the E. B. Eddy Co., Hull, Que., for 1 500 and 350-light multipolar direct current generator, for lighting its mills at Hull. With these machines will be installed standard marble panels containing instruments of the latest type. The contract also covers the supply of material for the wiring of the place in strict accordance with the latest standard requirements of the fire underwriters.

The Sydney Electric Light and Gas Company, of Sydney, C.B., is making extensive alterations and additions to the plant, and has placed an order with the Royal Electric Co. for one 60 K.W. and one 40 K.W. "S.K.C." two-phase alternator, these machines being connected to deliver 150 volts per phase. This is the fourth order that has been placed with the Royal Electric Co. for low tension generators of this type within the last few months, and is an evidence of the growing popularity of these machines.

The Toronto Railway Company recently placed an order with the Canadian General Electric Co for an 850-kilowatt direct connected, direct current generator, which has since been installed and is now in operation in the power house. This machine is practically identical with one of the same type and size supplied by the Canadian General Electric Company to the Toronto Railway three years ago. The new machine is being installed to take the place of a direct connected unit, of another make, which had to be discarded.

The T. & H. Electric Co., successors to Kay Electrical Manufacturing Co., reports the following recent sales in Hamilton, Ont. Norton Manufacturing Co., 15-h.p motor; Bain & Colville, 20 light dynamo; Max Bernstein, 1-h.p. motor; Leitch & Turnbull, 10-h.p and three 15-h.p. direct-connected elevator motors and attachments; Bain & Sache, one 1-h.p. motor and 12 light dynamo; Electric Light and Power Co., several motors; G. H. Meakins, Esq., one 1-h.p. motor; Ontario Plating Works, one 400 gal. plater; Domestic Specialty Co., one 5-h.p motor; D. Moore & Co., Limited, one 150 gal. plater; Tolton & McKay, one 1-h.p. motor; City Brass Foundry, one 5-h.p. motor; Hand & Teale, one 1-h.p. motor; Post Office, one ½-h.p. motor; Geo. D. Membery, one 3-h.p. motor.

A BY-LAW for the establishment of an electric light system for Beeton, Ont., was voted on and carried by a unanimous vote a short time ago.

THE Welland, Ont., Aqueduct and Power Company has been organized, with a capital of $25,000, to supply electricity for light, heat and power

THE Acadia Coal Company's charter, Stellarton, N.S., has been amended so as to permit the company erecting an electrical plant and all necessary requirements for electric lighting.

THE British American Light and Power Company is seeking incorporation to build electric tramways and operate systems for electric lighting in the Yukon district, Northwest Territories and Northern British Columbia.

CHIEF ENGINEER HOPSON, of the Grand Trunk Railway, and a representative of the General Electric Co., spent a day a short time ago looking over the tunnel, with a view to introducing electricity to supersede steam as a motive power.

THE Royal Electric Co has presented its friends with a very handsome desk convenience, which consists of a very large and well-bound blotting pad, with a calendar and indexed engagements book in the margin. The whole souvenir is one of the most beautiful and serviceable articles it has been our pleasure to receive in a long time.

BY Ontario letters patent, the Saugeen Electric Light and Power Company of Ontario, Limited, has been incorporated. Charles Edward Kilmer, of Southampton, electrician; Clarence Hurd Burnham, of Port Elgin, electrician; Joseph Barber and James Barber, of Georgetown; Edward Kilmer, merchant, of Walkerton, are the parties. Capital, $20 000.

MARKHAM, Ont., has settled its claim against the Waterloo Mutual Fire Insurance Company, caused by the burning of the waterworks and electric light station on the 16th ult. The loss claimed by the corporation was $1,593, on which $1,550 was allowed by the company's inspector The council started at once to rebuild. The new boiler and engine room will be made fireproof.

IN a recently published interview, B S Jenkins, superintendent of the Canadian Pacific Railway Company's telegraph, said that a heavy copper wire is to be strung from Montreal to the Pacific coast, the work to begin almost immediately. The new cable to be laid between Vancouver and Victoria left England on one of the company's new steamers recently purchased for the Yukon Territory trade.

THE first regular meeting of the Royal Electric Engineering Society was held in Montreal not long ago. The following were elected officers for the present session: Hon president, Wm H Browne, general manager Royal Electric Company; president, Wm Bucke; vice-president, W. S. Dix, corresponding secretary, R. F. Morkill; recording secretary, W. G Angus; treasurer, L. A. Howland; librarian and curator, F. Cushing; committee, J Burnett, L. Mudge, K. B. Thornton. This society has been formed by the members of the engineering staff of the Royal Electric Company, and has as its primary object the advancement of knowledge in engineering subjects.

THE Toronto Electric Motor Co., Toronto, and Thompson Electric Co., Hamilton, have amalgamated, the change in the firm to take effect on the 15th inst, under the name of "Toronto Electric Motor Co, Limited" The Hamilton factory will be moved to Toronto, and will occupy the new buildings which the company is to finish by the first of May The new shops will be of the most modern type, with traveling cranes etc With this change the new company will be in a position to do the heaviest work in power apparatus, also arc and incandescent work of every kind. All communications should be addressed to Toronto Electric Motor Co, Limited, 107 Adelaide St West, Toronto, Ont.

D. A STARR, president and manager of the Cornwall, Ont., Electric Railway Co, appeared recently before the council of Peterborough, Ont., and explained a scheme for the construction of an electric road from there to Chemong and Lakefield, and connecting in town with the Jackson and Nicholls park, and south to the locks. Mr. Starr said his company also proposed to place four steamers on the back lakes, one steamer to run to Stony Lake, two on the Lakefield-Chemong round trip, one leaving each place each morning, and the fourth running from Chemong to Bobcaygeon The electric road, Mr. Starr explained, would handle freight, and give a half hour service between Peterborough and Lakefield and Chemong. The company propose to lease both the Chemong and Lakefield lines from G.T.R., convert them into electric line and take over its freight business. The former road would be diverted so as to enter the park. The cost was roughly estimated at $330,000, and the company asked the town to guarantee the interest for twenty years on $150,000 of bonds at 5 per cent.

THE new 2,000 light dynamo purchased by St. John's, Que., in January, to replace the present machine, has been installed.

WE are indebted to the Packard Electric Co., St. Catharines, Ont., for their neat monthly memorandum books and blotter calendars.

THE city of Three Rivers, Que., and the North Shore Power Company are negotiating for the running of the waterworks by electricity.

CHAS. MACBETH, son of Col. Macbeth, London, Ont., has been appointed engineer-in-charge of the construction of the St. Thomas street railway

THE town council of Napanee, Ont., has accepted a proposition made by J R Scott, agreeing to install an incandescent and arc plant within one year.

AN accident to the generating plant of the Electric Power Co., at Montmorency, left the twenty thousand incandescent lamps in Quebec City in darkness, on Sunday, 27th February.

ENGINEER LEYDEN, of the Cataract Power Company, has submitted to E G. Barrow, city engineer, Hamilton, Ont., a proposition for running the sewage disposal works by electrical power.

THE Halifax and Bedford Electric Company is seeking incorporation to build an electric railway from Halifax to Bedford, with such extensions as may be approved of by the municipalities. The head office of the company will be in Halifax, and the capital stock is placed at $250,000.

IT is stated that the Montreal Street Railway Co. will leave its present power house to the Royal Electric Co., and that it will be kept in reserve in case of accident, when the new arrangements are put in operation by which the street railway will be run by power from Chambly.

THE British-American Light and Power Company are applying to the Dominion Parliament for power to construct and to operate by electricity and other power, tramways at Dawson City, Fort Selkirk, and points in the Yukon and North British Columbia; and to operate heating and lighting systems.

APPLICATION is being made for incorporation of the North Shore Electric Railway Company, with powers to construct a railway on the north shore of the St. Lawrence, starting from a point near Three Rivers and through the district of Three Rivers and other districts. Also to generate and sell electrical energy.

AT the next session of the Legislature a Winnipeg company will ask for a charter to build an electric railway from that city to St. Andrew's Rapids, and through the municipalities of Springfield, St. Boniface, Kildonan, St. Paul's and St. Andrew's. The company also propose to construct saw mills, boats, telegraph and telephone lines.

SHAREHOLDERS of the Hamilton Radial Electric Railway met Feb. 22nd to consider matters the outcome of the relinquishment of the Leather interest in the road. The business was not in shape for immediate consideration, however, and the meeting was adjourned for two weeks. With the retirement of Thos. E. Leather from the company it is probable that the original idea of continuing the railway through Burlington and on to Bronte will be dropped, at least for this year.

JNO. PATTERSON, engineer of the Cataract Power Co., Hamilton, is also interested in promoting the new company which is being formed to manufacture steel and nickel, and electric power will be used. The water will be taken from the Chippewa Creek and the power canal will be enlarged to double its capacity. The power houses will be at Reynoldsville, Ont. Mr. Patterson states that power will be generated by his company by May 1, although it will be months before the works are completed. Poles are now being distributed along the G.T.R., and power will be conveyed to Hamilton, Ont., along that route.

AT the annual meeting of the Toronto Electric Light Company, the financial statement presented showed a surplus of $7,000 over dividends paid. A steady growth is shown in the business all through the past year, especially in private incandescent lighting and power. The old board of directors were re-elected, as follows. H. M. Pellatt, president, W D Matthews, vice-president, S. F. McKinnon, Hugh Blain, W. T. Murray, Hon. Geo. A. Cox, Robert Jaffray, W. R. Brock, A. E. Ames, Samuel Trees, Thomas Walmsley, H. P. Dwight, Frederic Nicholls, Hugh Ryan J J Wright, general manager, W. A. Martin, secretary.

THE annual meeting of the Bell Telephone Company was held in Montreal, February 23rd. The net revenue for 1897 was $297,751.57, and after dividends have been deducted the company will carry forward $82,364 17 to its 1898 account. There were present at the meeting: C. F. Sise, president; R. Mackay, F. X. St. Charles, G. A. Greene, P. R. Gault, Hugh Paton, C. R. Hosimer, R. Archer, R. W. Shepherd, Chas. Cassils, T. D. Hood, F. G. Payne, R. P. McLea, C.

A. Briggs, C. F. Paul, James Wilson, Herbert Wallace, George Sumner, H. A Budden, M. S. Foley, E. Rawlings, John Crawford, J. A. Grenier, George H. Holt, D Ross Ross, Charles Garth, F. B. McNamee, James Shearer, James Williamson. The annual report was submitted as follows: "Nine hundred and eighty-three subscribers have been added during the year, the total number of sets of instruments now earning rental being 30,445. The company now owns and operates 349 exchanges and 261 agencies. Thirty-five miles of pole and 703 miles of wire have been added to the long distance system in 1897; of these five pole miles and 200 wire miles are in the Ontario department, and 30 pole miles and 494 wire miles are in the Eastern department The long distance lines now owned and operated by the company comprise 16,567 miles of wire on 6,095 miles of poles. Under the authority of the shareholders $66 500 bonds have been sold during the year, the premium thereon being 10 per cent. Continuing the policy adopted in past years, your directors have charged to contingent fund $150,000, that amount having been expended during the year on construction rendered necessary by the introduction of trolley and other strong wires, but which has not increased the earning power of the plant. The following directors were elected. C. F Sise, Robt. Mackay, John E Hudson, Robert Archer, Wm. R. Driver, Hugh Paton, Charles Cassils, Thos. Sherwin.

Railway and Marine News.

THE story is revived that the C.P.R. will erect a million bushel elevator at St. John, N.B.

IT is proposed to run one of the Conneaut car ferries to Port Burwell, Ont. this season, instead of both to Port Dover.

GEORGE F. BAIRD, Yarmouth, N.S., has purchased the steamer "City of Monticello," for a price in the vicinity of $20,000

A DEPUTATION from Lancaster, Ont, has requested the Dominion Government to make an appropriation of $10,000 for a wharf there.

THE Sault Ste Marie *Star* says the steamer "Cambria" will be thoroughly rebuilt and again take her place on the Windsor-Soo route.

THE Alberta Railway Company have sold to Mackenzie & Mann, for use on the short line to Lake Teslin, a quantity of steel rails and four locomotives.

A SYNDICATE has been formed to operate two steamers on the Kingston and Wolfe Island ferry, and Kingston and Gananoque route, the coming season.

THE contract for building the Cobourg, Northumberland and Pacific Railway, running north from Cobourg, Ont., to the C.P.R., has been signed by C. H. Bowen.

IT is stated on good authority that the present intention of the company which controls the M. & N.W. Railway is to extend the line to Prince Albert this year.

THE Grand Trunk Railway authorities are putting new colonist cars on their Winnipeg route that for comfort and appearance excel anything of the sort yet seen in this country.

REPRESENTATIVES of D. C. Corbin have succeeded in obtaining the endorsation of the council of the Rossland Board of Trade for a railway charter from Cascade City to Grand Forks.

THE Grand Trunk Railway system has received for service in its western traffic ten locomotives of the heaviest and most powerful build, from the Baldwin Locomotive Company, at Philadelphia.

THE contract for building the Midland Railway line from Windsor to Truro, N.S., 60 miles, has been let to Fitzpatrick Bros., New Glasgow. The road will be graded and ironed by next fall, it is said.

THE C.P.R. shops are busy turning out new passenger coaches and locomotives to meet the demand for new rolling stock created by the boom in business and the extension of its service in the West.

THE second compound locomotive ordered by the Canadian Government Railway System from the Baldwin Locomotive Works, Philadelphia, has been shipped to Montreal, where it will be put together.

THE Canadian Pacific Railway has sent a representative to Newfoundland to engage 1,500 laborers to proceed to British Columbia to work on the Crow's Nest Pass Ry. The wages offered are $1.50 a day.

THE Government has decided to send immediately the chief engineer of the Department of Public Works, Louis Coste, and the chief engineer of the Department of Marine, Lt.-Col. Anderson, to the Stikine River and over the Canadian route to Dawson city, for the purpose of seeing what improvements are necessary to overcome obstructions to navigation. It is also the intention to erect a wharf at Dawson after inspection.

THE new pier at Margaretville, N.S., is completed, and the cost, $10,854, slightly more than the tender of the contractors, Simmons & Burpee, Gibson, N.B. The work has been done to the entire satisfaction of the Dominion Government engineer, C. E. W. Dodwell. As Margaretville is the nearest approach to a natural harbor on the Nova Scotia shore, between Minas Channel and Digby Gut, the necessity of a safe breakwater has been admitted.

THE Newfoundland cabinet has concluded an arrangement with R. G. Reid, the contractor who built the Transinsular Railway, to operate the entire railway system of this colony, six hundred miles, for fifty years, in return for a land subsidy of 2,500 acres per mile. Mr Reid will pay over to the Government one million dollars guarantee. This money, with the interest accumulations for fifty years, will belong to the colony at the expiration of that period, the railway then reverting to the representatives of Mr. Reid.

DAVIS Dry Dock Company is very busy this spring filling orders for launches, etc. There are being built a passenger and freight steamboat for Homer & Co., of Gravenhurst, Ont.; 25-foot steam launch for Muskoka Lake; three boats for the Adirondacks, for New York owners; one 17-foot ¾ h.p. gasoline motor; one 20-foot long gasoline motor; one 36-foot long steam engine, beside one 34 feet long and another 50 feet long on the stocks. They are getting out plans for a 20-foot boat with a small steam motor to fit back in the stern, a very pretty little launch, with plenty of room and at a very small cost.

THE steamer "Tecumseth," owned by McArthur Bros., Toronto, will undergo considerable alterations to her machinery this season at the hands of the Bertram Engine Works. The two present fire-box boilers, which are allowed 65 lbs. per square inch, will be removed, and replaced by one "Scotch" boiler 11 feet diameter, with a working pressure of 130 lbs. per square inch. This boiler will be fitted with a complete installation of the "Howden Hot Air Draft," in which the air is considerably heated by the escaping funnel gases before being forced into the ashpits. The present cylinders, which are 26 and 48 inches diameter, will be replaced by new ones of 19 and 40 inches diameter, the rest of the engine remaining practically as at present. The results anticipated are an increase of power, economy of fuel, both as regards quality and quantity, less weight of boiler, and more stowage room in the ship. As this is the first installation of the "Howden" draft on a Canadian lake vessel, it will be watched with interest. The work is under the supervision of A. P. Rankin, consulting engineer, of Toronto.

CHICAGO forwarders have sent out the following circular:—"It is our intention to put on three boats from Chicago to Parry Sound, the capacity of which will be in the neighborhood of 3,000 tons each, which will call at Milwaukee; also, two boats from Duluth, with about the same capacity. At Chicago we have leased a dock between the Ogdensburg Transit Company and the Lehigh Valley Transportation Company's dock, on which there is being erected a warehouse about 125 feet long, with an average width of 110 feet. At Parry Sound we have an elevator now ready for the handling of grain, with a capacity of about 1,250,000 bushels, and will have a warehouse 600 feet long by 80 feet wide, also a flour house 600 feet long by 80 feet wide, together with 2,500 feet dockage accommodation, on a 22-foot water line. We are also building at Coteau Landing, on the St. Lawrence river, at the mouth of the Soulanges Canal, a transit elevator, of 500,000 bushels' capacity, which will handle 240 carloads a day, also a warehouse and docks of sufficient dimensions for the handling of flour and package freight, our idea being to float our grain and package freight to Montreal and deliver alongside of the ocean vessels in Montreal harbor."

Mining Matters.

OIL has been struck at Croton, Bothwell county, Ont. The field is said to extend over an area of several miles. Some splendid wells have been struck on the town line of Zone and Camden.

THE Hall Mines Co. has closed a contract with the Dominion Wire Rope Company, Limited, Montreal, for 10 miles of wire rope for its cable way from the mines to the smelter. Its weight will be about 40 tons, and it will be made in six sections of over 1½ miles in length, for convenience in handling.

WHAT is known as the Dickenson mine in Michipicoten, Ont., has been sold to an English syndicate. George Fee, and J. J. Mackey, of North Bay, and J. L Caverhill, Montreal, were the vendors. E. A. Bremner, an English mining expert, acted for the syndicate. This claim was the first discovered in the Wawa, Ont., district.

CONSIDERABLE excitement has been caused in the county of Megantic, Quebec, by the discovery of gold on the banks of the Bullard Brook. The discovery was made late in the autumn, and several pits have been sunk, and in every case gold in small quantities has been found in the black sand that seems to be scattered over the whole of the flats.

THE annual meeting of the shareholders of the Intercolonial Coal Mining Company, Limited, took place recently, in Montreal. The sales of coal and coke, for the year ending Dec 31st, 1897, amounted to 186,654 tons. The following were elected directors of the company for the ensuing year, viz.: James P Cleghorn, president, H S MacDougall, W. M. Ramsay, Thomas Wilson, E Goff Penny, M P., A. W. Hooper, R. MacD Peterson, Charles Fergie, vice-president, and Wm. J Nelson.

IN a report to Arch. Blue, director of the Bureau of Mines, Ontario, Prof. De Kalb, the new professor of mining engineering at Kingston School of Mining, says that the corundum in the counties of Hastings and Renfrew is very rich. Tests have been made showing that concentrates may be made giving ninety-two to ninety-four per cent of corundum, and as the commercial standard of purity only requires eighty per cent of corundum, it appears that this limit can be easily passed Another thing that he says is that there is little difficulty in separating the corundum from the magnetite.

THE Geological Survey of Canada has just issued a summary of the mineral production of Canada for 1897, which, without being final—some of the figures not being obtainable just at present—is based on a general knowledge of the progress made in the various industries, and is sufficiently accurate for all practical purposes. The report shows that the value of the gold produced amounted to $6,190,000; of copper, 13,300,802 pounds were produced, value, $1,501,660; of lead, 39,018,219 pounds, value, $1,396,853; of nickel, 3,997,647 pounds, value, $1,399,176; of silver, 5,558,446 ounces, value, $3,322,905; of iron ore, 71,451 tons of two thousand pounds, value, $178,716; of mercury, 688 pounds, value, $324, and of platinum a value of $6,600. The report will be taken up fully in a later issue of THE CANADIAN ENGINEER, when the production in the United States will also be given, so that the relative increase in the two countries may be considered.

Personal.

WE regret to state that Wm. Hamilton, manager of the St. Lawrence Foundry, Toronto, was stricken with paralysis recently.

WM. MCLEAN, of the McClary Manufacturing Co., Limited, London, has gone to take charge of the company's office in Winnipeg.

P. S. ARCHIBALD, ex-chief engineer of the I.C.R., is engaged by Sir C..arles Tupper as chief engineer of the Klondyke Mining Company.

T H. WHITE, St Thomas, Ont., has been appointed chief engineer for the new line of railway to be built from the Stikine River to Teslin Lake.

HENRY BUDDEN, vice-president and managing director of the Intercolonial Coal Company, of Pictou, N.S., has resigned that office on account of ill health.

JAMES WARNOCK, one of the most prominent citizens of Western Ontario and a leading manufacturer in Galt, Ont., proprietor of the Galt Edge Tool and Axle Factory, died at his home the 5th February.

W. A. CARLYLE, British Columbia provincial mineralogist, has handed in his resignation, to take effect April 1, when he will leave for Rossland to accept the mining superintendency of the British America Corporation.

RICHARD G. MCCONNELL, geologist of the Dominion Geological Survey, has been appointed mineralogist of the British Columbia Government at a salary of $4,000. Mr. McConnell has been with the Geological Survey since 1879, when he graduated from the science school of McGill University.

IN attempting to remove a piece of wood that had stuck fast in a bed planer, Norton Olds, employed in the Mann Manufacturing Co.'s works, Brockville, Ont., accidentally placed his right hand in the knives, which gradually drew the arm in, cutting it off by inches to within a short distance of the shoulder.

MRS. ANN OWEN GREENING, widow of the late Benjamin Greening, founder of the B. Greening wire works, Hamilton, Ont., died at the residence of her daughter, Mrs. R. H. Merriman, Hamilton, recently, aged 88 years. Her husband died 21 years ago. Five sons and two daughters survive her.

CHAS. B. BROWN, of the Ontario Rolling Mills, Hamilton, Ont., has gone to Tacoma, Washington, to accept the position of superintendent of the Western Iron and Steel Company. Before leaving he was presented with an address and a purse of gold by his fellow employees of the rolling mills.

CHAS. DAWSON, who for the past five years has been Works Superintendent for the Central Bridge and Engineering Co., Peterboro, Ont., and was formerly with the Canadian General Electric Co., as master mechanic for the Engineering Department, has resigned his position with the former and has accepted the position of Assistant Superintendent with special charge of all Machine Tool Work for the Dominion Bridge Co., Montreal.

WILLIAM HOLTBY, mechanical engineer of the Canada Atlantic Railway, Ottawa, was accidentally killed at Coteau Junction, Que., Feb. 23rd. He was superintending the replacing of a snow-plough on the track, when he slipped and fell under the train. Mr. Holtby had been a resident of Coteau Landing during the construction of the Canada Atlantic Railway transfer, of which he was the foreman. At the inquest, the jury brought in a verdict that deceased was the victim of an accident due to his own imprudence.

ALPH DUFRESNE, one of the engineers on the Soulanges Canal, had a narrow escape from drowning Feb. 25th, while sounding for the depth of the water at the head of the canal. Mr. Dufresne, together with A G. Grant, another engineer, was engaged with his instruments, when the ice suddenly gave way, carrying him with it. Mr. Grant, at the risk of his life, seized Mr. Dufresne and succeeded in pulling him out of the water. The place was a dangerous one, being 25 feet deep and at the head of the Coteau rapids.

LITERARY NOTES.

We have received the "Transit," a pamphlet of 170 pages, published by the engineering society of the State University of Iowa, U.S. It contains some valuable and interesting papers on engineering topics, chiefly by graduates of the University.

We have before us the Proceedings of the Seventh Annual Convention of the Association of Railway Superintendents of Bridges and Buildings. It contains in 275 pages a number of valuable papers profusely illustrated.

The "Mining Resources of Canada" is a pamphlet of about a dozen pages of printed matter and as many more of handsome photo. engravings, issued by the Department of the Interior, Ottawa. A great many statistics are given of the mineral productions of Canada in the past and information about the mineral regions. A large map of the Dominion is also included.

FIRES OF THE MONTH.

Feb. 2nd.—McIntyre block of stores and offices, Winnipeg, Man. Loss about $500,000, to be rebuilt.——Feb 13th.—Ontario Rolling Mills, Hamilton, Ont., the main building destroyed; the loss was $16,472 The machinery, etc., was insured for $28,000, and the building, owned by the Grand Trunk, for $6,000.—— Feb. 16th.—The power house and plant of the Markham, Ont., electric light and waterworks; loss about $3 500 ——Feb. 16th.—George Middleditch's foundry and machine shop, Bothwell, Ont. Loss about $7,000.—— Feb. 17th.—Waterloo, Ont., Manufacturing Co.'s foundry; damages, $400 ——Feb. 19th —Bismarck cheese factory, near Wellandport, Ont., burnt down; loss about $2,500. —— Feb. 19th.—Barrel factory, Lequille, N.S., property of the Union Bank of Halifax; loss about $15,000.——Feb. 20th.—Flour mills, Burlington, Ont., run by W. H. Finnemore, owned by Estate P. Redpath, Montreal; loss about $10,000.——March 4th.—The Goold, Shapley & Muir windmill and bee supply factory, Brantford, Ont.; loss about $20,000.

—A hot air radiator, of special value to all users of wood burning stoves or furnaces, has been invented by R. W. Biggar, Sorauren ave., Toronto. It is a drum to be applied to a stovepipe in the ordinary manner, but, unlike any other heating drum we have seen, it sucks up the cold air from the floor of the room and throws it out at the top of the drum, thus keeping all the air in the room in circulation, and abolishing finally cold floors.

—The Hamilton Acetylene Gas Machine Company's generating apparatus, of which an advertisement appears on another page, possesses many features which make it of great value. The patent water spray, by which the water is supplied to the carbide in the generator, is a special feature of great interest. A further description of this machine will be given in the next issue of THE CANADIAN ENGINEER.

SOME EXPERIMENTS ON THE CONDENSATION OF STEAM.*

By H. L. Callendar, M.A., F.R.S., Professor of Physics, and J. T. Nicolson, B.Sc., Professor of Mechanical Engineering of McGill University, Montreal.

PART I.

As the result of some experiments by electrical methods on the measurement of the temperature changes of the walls and steam in the cylinder of a working steam-engine, which were made at the McDonald Engineering Building of McGill University in the summer of 1895, the authors arrived at the conclusion that the well-known phenomena of cylinder condensation could be explained, and the amount of condensation in many cases predicted from a knowledge of the indicator card, on the hypothesis that the rate of condensation of steam, though very great, was not infinite but finite and measurable. An account of these experiments was communicated to the Institution of Civil Engineers in September, 1896, and will, it is hoped, be published in the course of the ensuing session. In the meantime, the authors have endeavored to measure the rate of condensation of steam under different conditions by a new and entirely different method, with a view to verify the results of their previous work, and also to estimate the influence, if any, of the film of water adhering to the walls of the cylinder.

In considering the condensation of steam on a metal surface it is usually assumed that the surface exposed to the steam is raised up to the saturation temperature corresponding to the pressure of the steam, and that the amount of condensation is limited by the resistance of the water films to the passage of heat from the steam to the metal and from the metal to the water. If the steam contains air, there may also be a considerable resistance due to the accumulation of a film of air on the surface, but it is comparatively easy to exclude this possibility in experimental work.

In the steam-engine experiments, above referred to, it was practically certain that the water film due to the cyclical condensation never exceeded one-thousandth of an inch in thickness, and that the resistance offered by it was unimportant. At the same time, it appeared clear that the temperature of the surface of the metal at its highest was considerably below the saturation temperature of the steam: a condition which could only be explained by supposing the rate of condensation of steam on a surface to be limited by some physical property of steam itself, apart from the resistance of the condensed film of water. Interpreted in this manner, the experiments led at once to the conclusion that the rate of condensation at any moment was simply proportional to the difference of temperature between the saturated steam and the surface on which it was condensing.

The limit thus found was shown to be capable of explaining many of the phenomena of cylinder condensation in a rational manner; but the method by which it was established was of an indirect and somewhat intricate character, and appeared to require some simple and more direct confirmation.

If the rate of condensation of steam were really infinite, it should be possible by a suitable modification of the surface-condenser method (i.e. by getting rid of the water films on the outside of the tubes) to obtain values of the condensation considerably in excess of those given by the formula deduced from the temperature cycle observations.

To accomplish this, it is necessary to eliminate as completely as possible the resistance to the passage of heat through the water films between the steam and the metal, and between the metal and the circulating water, and at the same time to measure as accurately as possible the temperature of the metal.

These considerations led to the form of apparatus which was employed. The resistance to the passage of heat from the metal to the condensing water in this apparatus is practically eliminated by employing a thick cylinder, 5 in. diameter and 2 ft. long, with a screw thread cut on its outer surface. Water from the high-pressure mains is forced to circulate round this surface with a very high velocity in the narrow space between the cylinder and the surrounding tube. In this manner it is possible to obtain a very uniform temperature for the external surface differing but little from that of the circulating water.

If the cylinder is made sufficiently thick, its temperature may be approximately determined at any depth by inserting mercury thermometers. It was intended at first to use thermocouples for this purpose, but the apparatus in this form would have been unsuitable for students' use in the ordinary course of laboratory work, which was one of the primary objects in view in the construction. It would also have been desirable to make the cylinder of nearly pure copper, which would have reduced the resistance of the metal to the lowest point. The authors were compelled, however, to content themselves for the time with cylinders of cast iron and of mild steel.

The internal surface of the cylinder, upon which the steam was condensed, was a hole one inch in diameter, drilled in the solid metal. In order, as far as possible, to minimize the resistance of the surface film of condensed water, a revolving brush was constructed of very thin strips of steel to wipe the surface five or six times a second. This wiper was found to wear in a very short time to so perfect a fit and the water film must have been so energetically stirred that its resistance to the passage of heat must have been far less than that of the best conducting metal, when there was perhaps some small film present.

Under these conditions, if the rate of condensation of steam were infinite, it should have been possible to obtain a rate of condensation many times greater than the limit deduced from the cylinder-condensation experiments above mentioned.

On making the experiment, however, it was found that the wiper made very little difference to the amount of condensation. With the wiper revolving at the rate of 160 per minute, the condensation was increased by about 5 per cent. on the average of several experiments. It may be concluded from this that the drops of condensed water with which the surface is partially covered are in such rapid motion that they do not appreciably obstruct the passage of heat from the steam to the metal. In fact, Prof. Callendar actually found that the drops increased the condensation. A film of the same average thickness, if it were absolutely quiescent, and if its conductivity, as generally estimated, were only one-hundredth of that of cast-iron, would no doubt prove a serious obstacle; but, as a matter of fact, the viscosity of water at these temperatures is so small, and the motion so rapid, that the drops cannot be treated as a quiescent film.

The temperature at various distances from the inner surface of the cylinder was determined by means of mercury thermometers inserted to a depth of 8 in. or 9 in. in holes drilled parallel to the axis. From the temperatures so observed the conductivity of the metal and the temperatures of its inner and outer surfaces could be approximately inferred. It was found, however, that the presence of the holes interfered materially with the flow of heat through the metal, and that the readings of the thermometer under these conditions were not altogether trustworthy.

From a number of observations on the cast-iron cylinder a conductivity of 5.5 thermal units Fahr. per square ft. per minute per deg. Fahr. per inch was deduced, a result which agrees very closely with the authors' previous determination by a different method. For the steel cylinder a conductivity of 5.8 was similarly deduced. These results apply to a mean temperature of about 140 deg. Fahr., and are much lower than the values generally assumed for iron.

In order to verify the previous results as to the rate of condensation of steam derived from the steam-engine experiments, the temperature of the inner surface of the metal was calculated on the assumption of a rate of condensation equivalent to 0.74 thermal unit Fahr. per second per square foot per deg. Fahr. difference of temperature. The values so found agreed with the observed temperatures within the limits of error of the observations. Owing to the inferior conductivity of the iron the test was not absolutely conclusive, as the difference of temperature between the steam and the surface rarely amounted to as much as 30 deg. With a cylinder of pure copper, and thermocouples for determining the temperature at a given depth, it should be possible to obtain a more certain confirmation by this method.

In performing the experiments a number of variations in points of detail were introduced from time to time. The flow of the circulating water was varied in velocity, and directed in different ways. In order to secure uniformity in the distribution of temperature measured in different directions from the centre, the spiral circulation was found to be essential. In the second apparatus the screw thread was at first replaced by a baffle-plate, which was intended to direct the water into a spiral course, but the results found were unsatisfactory.

* A paper read at the annual meeting of the Canadian Society of Civil Engineers.

In some cases steam was admitted from the top of the apparatus, and in other cases from the bottom. With the steam supply at the bottom, it was found that condensed water refused to drain down the vertical 1-in. tube in opposition to the current of steam, although the maximum velocity of the steam could not have exceeded 10 ft. per second.

The following set of observations, each of which represents the mean of several taken on similar conditions, will sufficiently indicate the general nature of the results:

The temperatures of the metal at distances of 1 in., 1.5 in., and 2 in. from the axis of the bar were observed by means of mercury thermometers, which were very carefully centred by small iron washers in holes filled with mercury. The hole fitting the bulb of the thermometer was 3-16 in. in diameter The other holes were 5-16 in.

It will be observed that in this particular set of experiments the temperatures at 1 in. in the metal, when calculated to agree with the assumed rate of condensation, are all too low as compared with those observed, whereas the temperatures similarly calculated at 1.5 in. are all too high. This might at first sight appear to indicate a very rapid diminution of the conductivity with rise of temperature; but after making various tests the effect was traced partly to the disturbance of the heat flow caused by the presence of the holes, and partly to differences of density of the bar in directions at right angles. The latter differences were not observable in the case of the cast iron.

The observations taken at different pressures do not indicate any marked difference in the rate of condensation per degree second. These results, so far as they go, are in agreement with the authors' previous work, but they hope to be able to obtain more conclusive evidence.

AN ELECTRICAL METHOD OF MEASURING THE TEMPERATURE OF A METAL SURFACE ON WHICH STEAM IS CONDENSING.

By H. L. CALLENDAR, M.A., F.R.S., *Professor of Physics*, McGill University, Montreal.

PART II.

The object of the following experiments, which were made at the McDonald Physics Building with a different apparatus, was the measurement of the temperature of the metal surface itself by a more direct and accurate method. It was also desired to verify as exactly as possible whether the rate of condensation of steam at atmospheric pressure was the same as at the higher temperatures and pressures at which most of the preceding experiments were made.

The condenser used for these experiments was a very thin platinum tube, ¼ in. in diameter and 16 in. long. The thickness of the tube was only six-thousandths of an inch, and the greatest difference of temperature between its inner and outer surfaces at the maximum rate of condensation observed in the experiments could not have been greater than ¼ deg. cent.

The mean temperature of the metal itself was determined in each case by measuring the electrical resistance of that portion of the tube on which the steam was condensing. The author has had considerable experience in the employment of this method, which, moreover, is very easily applied if suitable apparatus is available.

The platinum tube was enclosed in an outer tube of brass or glass, and steam was admitted to the space between the two tubes. A steady current of condensing water was maintained through the platinum tube. The amount of condensation could be inferred by measuring the flow of water, and observing the difference of temperature between the inflow and the outflow. *In many cases the condensed water was also measured.* Applying a small correction for radiation, the two methods always agreed within one-half of 1 per cent. The pressure of the steam in the outer tube, which was never far from the atmospheric, was observed by means of a mercury column.

The conditions of the experiment as to flow of water and steam, size and length of the external tube, etc., could be varied within certain limits. The following is a summary of the more interesting results obtained:

CONDENSATION RESULTS SUMMARY. MILD STEEL BAR. WIPER REMOVED.

Condensation. Thermal Units per Square Foot Second.	Steam Temperature Observations.	Surface Temperature Calculations.	Difference, Steam and Surface.	Temperature in Metal at Distances. 1 In. Calculations.	1 In. Observations.	1.5 In. Calculations.	1.5 In. Observations.	2 In. Observations.	Conductivity, K.
	deg.	deg.	deg.	deg.	deg.	deg.	deg.	deg.	
20.0	330	303	27	208	214	154	153	113	5.84
17.8	300	277	23	193	198	143	142	109	5.66
15.4	274	253	21	179	184	136	134	103	5.81

1. With a short length of condenser and a very free escape of steam, the condensation observed was equivalent to 22.2 thermal units Fahr. per square foot per second, for a difference of temperature of 28.5 deg. Fahr. between the steam and the metal surface. This is equivalent to a rate of condensation of

(*Continued on page* xv.)