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CONTENTS OF THIS NUMBER:

For The Canadian Engineer.

HYDRAULIC APPARATUS.

BY WILLIAM PERRY, HYDRAULIC ENGINEER, MONTREAL.

The Syphon.

There is nothing in the way of hydraulic apparatus much more simple than the syphon, but strange mistakes are sometimes made about it and the causes which enable it to perform its work. Its action does not depend, as some old writers on natural philosophy supposed, upon any inequality of atmospheric pressure upon the liquid in the two arms. As a matter of fact, the pressure is slightly greater upon the orifice of the longer or discharging arm, because of the two it is nearer the earth, and therefore a higher and heavier column of air rests upon it. Nor does it depend upon the difference in the actual length of the two arms, or in their diameters, but the larger t' e tube the more water will be discharged. What causes the syphon to act is the destruction of hydrostatic equilibrium, by the discharging part having a greater perpendicular length than the receiving part; as the pressure of fluids depends upon the depth of the column only, that in the longer arm necessarily preponderates, so that when once a partial vacuum has been artificially formed within the syphon, the fluid in the deeper arm is forced to descend, leaving still a partial vacuum behind it, into which the liquid is forced by the atmospheric pressure on its surface. The property of cohesion which all fluids in a liquid state possess enables the particles to drag those in the shorter arm over the bend, and in this way a constant discharge is kept up.

Some twelve years ago I put in a 7-inch syphon for the Dominion Bridge Co., Lachine, 1,600 feet long. It was then under the management of J. Abbott. Considerable experimenting was done and valuable information obtained. The earliest instance of the use of the syphon appears to have been its employment in Egypt for mixing wines. An inscription upon a tomb at Thebes, bearing date B.C. 1450, which tomb once contained the remains of Pharaoh Amunoph II., includes a delineation of three syphons, two of which are in operation, and the other is being charged by a man who has the long end in his mouth. The tomb of Rameses II., B C. 1235, has an inscription showing a number of syphons. Among other utensils belonging to the kitchen, syphons were used by Italians. In the sixteenth century quite a number were used by the Germans, and with satisfactory results, in transferring large quantities of water over rising grounds. One of them was made of wooden planks, closely nailed and probably jointed with pitch, forming a square trough; in the top of the box a hole was left to charge it, both ends being plugged, and when filled the plugs from each end were withdrawn, when the syphon would, of course, get into action.

The Ram.

It would be necessary to go a long way back to find the origin of the name which is applied to the water raising appliance universally known as the hydraulic ram. When the ancients first devised a machine for battering the walls of their foes, they called it a battering ram, in honor of the rather foolish animal of whose warlike action it was, in principle, a tolerably exact imitation. Ordinarily a beam of timber in length from thirty to sixty feet, suspended in the centre by chains to a tower, was impelled with great force against the wall or building by the united strength of a large number of men acting as one man. This kind of ram is well known; but it is, probably, not so generally understood that a column of water can act, and in some circumstances does act, in precisely the same manner. A long column of water, moving in one direction with velocity and encountering resistance, may have as destructive an effect as a beam of wood or iron, used after the manner of the old battering ram.

Probably most persons have noticed that if a compression cock on an ordinary supply pipe in our houses is suddenly closed, a blow is sometimes inflicted upon the pipe, which blow sounds almost as if it had been made with a hammer. It is caused by the water nearest the orifice which is being closed being forcibly driven against the moving mass of water in the pipe behind it. The force of the blow, as many people know, is often sufficient to burst a weak pipe. This is the real cause of large waterworks mains bursting, more especially near where elevators are running. It is on record that many years ago at a hospital in Bristol, England, a leaden pipe was carried from a cistern in one of the higher stories to the kitchen below; this pipe was frequently broken when one of the cocks was closed suddenly, and several attempts were made to remedy the defect in the system. They were not successful until a plan was hit upon by a local genius of attaching one end of a smaller pipe immediately behind the offending cock, and carrying the other end to the height of the water cistern; the pipe no longer broke when the cock was suddenly closed, but it was noticed that a jet of water was forced from the higher end of this new pipe to a considerable distance, consequently the height of the new pipe was increased by carrying it up to the top of the hospital, where still a small quantity of water was emitted each time the cock in the kitchen was shut. The local genius, in fact, without intending to do so, had provided a means of raising a small quantity of water without labor to the highest floor of the hospital, where it was, no doubt, much appreciated. He had arranged a water ram, which, except that it was not self-acting, was not different in principle from the hydraulic rams of the present day. In 1772, a watchmaker of Derby, Eng., named Whitehurst, made a water ram, although not self-acting; but water was raised the desired height by opening and shutting a cock. He had a pipe 600 feet long, with a fall of 16 feet. At the extreme end was the cock from which water was taken at repeated intervals. Whenever it was closed, the momentum of the long column of water in the main pipe forced a small quantity through a valve into an air vessel, and then up a vertical pipe into a tank placed some distance above the original source of supply. The invention of a self acting ram is claimed by Montgolfier, a Frenchman, who brought out his Belier hydraulique in 1796, a year before Mr. Boulton, of Boulton & Watt, took out a patent in England for a similar contrivance. It was, no doubt, upon *the same plan as Whitehurst's, but the cock for domes*tic draughts which he affixed to the lowest parts of his pipe was replaced by a valve, loaded with just weight enough to open when the water in the main pipe was at rest: whenever this valve was open, the water in the main pipe acquired by the fall sufficient force to carry the valve against its seating; this brought the water in the main pipe to rest, and the shock caused by closing the valve had the same effect as the closing of the cock by hand; it forced a small quantity of water through a valve into an air vessel, and thence through the delivery pipe. When this had taken place, the water in the main pipe having been brought to rest, the escape valve opened, the water in the main pipe was again set flowing, and the whole process was repeated and went on constantly as long as the supply of water lasted and the apparatus was kept in order. This is precisely the hydraulic ram of the present day, which is so often inexpensively employed in raising water for different purposes.

THE PRODUCTION OF METALLIC BARS OF ANY SECTION BY EXTRUSION AT HIGH TEMPERATURES.*

The author stated that the system of manufacture he now had the privilege of bringing before the Institute was the invention of Mr. Alexander Dick, the inventor of Delta metal. It related to the production of all kinds of metallic sections, from thin wire or plain bars to complex designs, by simply forcing metal, heated to plasticity, through a die by hydraulic pressure. He referred to the fact that although the principle of extrusion was employed in the manufacture of lead pipe and lead wire, yet the temperature in those cases was very much lower than in Mr. Dick's system, which required the metal to be red hot (about 1,000° Fahr.).

Mr. Dick's process consists in placing the red-hot metal in a cylindrical pressure chamber or container, at one end of which is a die. Upon pressure being applied at the opposite end the plastic metal is forced through the die, issuing therefrom as rods or bars of the required section and length. The container of the first apparatus was a solid steel cylinder, bored out to the required diameter, to form the chamber for the hot metal, and heated in a coke fire. In practice, however, it was found that the strain set up by the unequal expansion and contraction of the walls of the cylinder, added to that caused by the internal pressure applied to force the metal through the die, developed cracks in the cylinder which rendered it useless. After a long series of experiments with various kinds of steel cylinders, Mr. Dick abandoned the solid wall principle and devised a built-up container. It is composed of a series of steel tubes of different diameters placed one outside the other with annular spaces between them, the spaces being filled in with a dense non-conducting packing. This proved perfectly successful, and machines on this principle are now in operation on a commercial scale not only at the Delta Metal Company, Pomeroy street, New Cross, London, of which Mr. Dick is managing director, but also in Germany, and at one of the large Birmingham metal rolling mills on license.

These machines are served by two men and one boy, so that the cost of labor per ton is very small.

The author described the working of the system and referred to the great variety of sections (some of a very complex nature) produced in Delta metal, brass, *aluminum, aluminum bronze, and other alloys and* metals, samples of which were exhibited. These ranged from wire weighing about $\frac{1}{100}$ of a pound per foot run, to heavy rounds, squares, hexagons, etc., weighing 40 lbs. and over per foot run. He pointed out that the pressure put upon the metal greatly increased its strength, and at the same time rendered it still more homogeneous. Some tests made at Woolwich Arsenal with Delta metal bars produced by this machine showed a tensile strength of 48 tons per square inch with 32.5 per cent. elongation on 2 inches, as against 38 tons per square inch tensile strength and 20 per cent. elongation of rolled bars of the same metal.

*Abstract of a paper read before the British Iron and Steel Institute, by Perry F. Nursey.

THE ELECTRIC WAGON ON THE FARM.

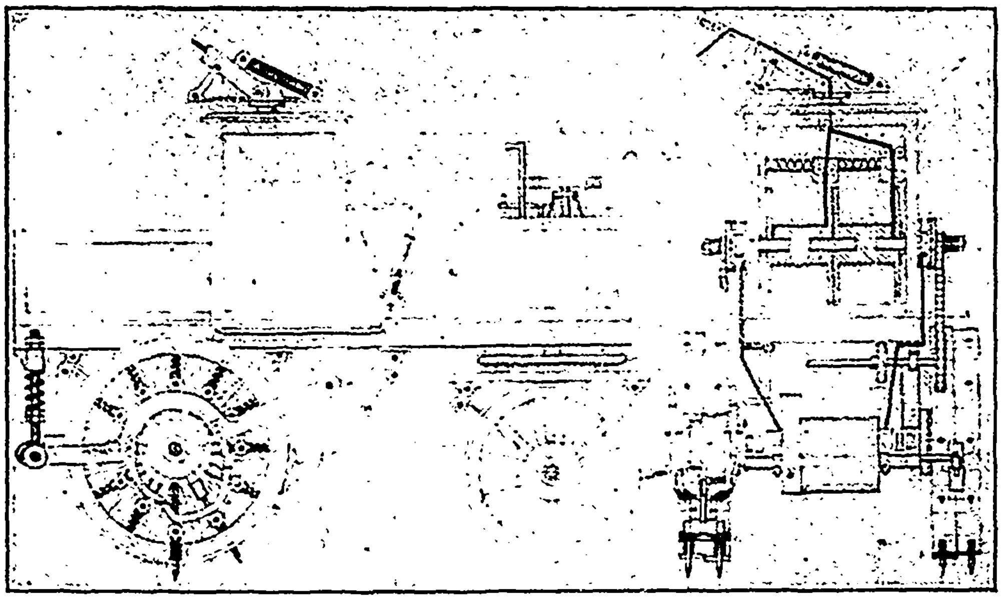
For THE CANADIAN ENGINEER.

The application of steam to farming operations is no novelty, and since electricity seems at every point to be crowding steam power, we are not surprised that many efforts have been made to apply the newer motive force to the simplification of agriculture.

The accompanying engraving shows two elevations of an electric traction engine for ploughing and general farm work, the product of the inventive skill of O. W. Ketchum, of Baltimore, Md.

A 16 horse-power steam traction engine weighs about 14,000 lbs. Tests that have been made by different experimenters to ascertain the power required to draw heavy wagons, artillery, etc., over soft ground such as is encountered in fields, show that the tractional resistance or pull amounts to from 6 to 10 per cent. of the weight of the wagon; assuming a pull of 6 per cent., it would require 9 horse-power to propel the wagon alone over a field at a speed of four miles per hour. This would only leave 7 horse-power available for drawing ploughs.

As it is evident from the data available as to the power which horses can exert when ploughing and doing other similar work, that it would require in the neighborhood of two horse-power to draw a plough at the rate of four miles per hour, it seems evident that these engines when drawing six ploughs, work considerably beyond their rated capacity; assuming that it will require two horse-power to a plough, it would take 12 horse-power to draw the ploughs, and nine horse-power to draw the wagon, making 21 horse-power in all that would be used when ploughing on a level field. Although this showing is very good, the following brief calculation will show how the steam traction engine fails on hilly ground. The power required to run the traction engine alone up a grade at the rate of four miles per hour, assuming that it weighs 14,000 lbs., will be about 1½ horse-power for each 1 per cent. of grade; it will, therefore, be seen that on a grade of 4 per cent., six horse-power will be required to overcome the grade, and only six horse-power would be left for drawing ploughs; or in other words, three ploughs would be drawn on a 4 per cent. grade. On an 8 per cent. grade, it would take 12 horse-power to propel the engine, and there would be nothing left to draw the ploughs; that is to say, on an 8 per cent. grade the engine would be practically stalled when running light, and on a 6 per cent. grade would barely pull one plough.



The electric engine, on account of its lightness, would probably be free from this defect. Assuming the weight of the wagon to be 5,000 pounds, and assuming that in consequence of the increased resistance of rolling over the ground, due to the spikes on the wheels, that it would take half as much power again as a steam traction engine f r equal weights, that is to say, 9 per cent. resistance against 6 per cent. for the steam traction engine, it would then, on this assumption, require about five horse-power to propel the wagon over the ground. This deducted from the 37 horse-power would leave 32 horse-power (net), which would draw 16 ploughs over a field, assuming each plough to require two horse-power, as was assumed in the case of the steam traction engine. The power required to propel the wagon up the grade at the rate of four miles per hour, the weight being 5,000 pounds, would be at a rate a trifle over a half horse-power for each one per cent. of grade; therefore, on a four per cent. grade, the additional power absorbed would be two horse power, leaving 30 horse-power available, which would draw 15 ploughs. On an eight per cent. grade there would be 28 horse-power available, which would draw 14 ploughs; thus it seems that if a wagon with a weight of 5,000 pounds would have sufficient traction, assisted by the anchor-spikes, to draw 14 ploughs up a grade of eight per cent., on a similar grade the steam traction engine at the best could only run itself.

This wagon or truck has suitably designed steering gear in connection with its front wheels and an electric railway motor geared to its rear driving wheels. The electric current for driving the motor is conveyed to it by means of a double circuit insulated, stranded cable; a reel of this cable is fixed on the wagon, the fixed end of the cable is attached to the motor, and the loose end to the source of electric supply. As the wagon travels forward over the field the cable unwinds, the slack lying on the ground; as the wagon comes back it picks it up again, the reel doing this automatically without any attention from the driver. The driving wheels have self cleaning spikes, which are quickly adjusted so as to sink into the ground any depth that may be necessary to give the wheels whatever grip on the ground may be required to prevent them from slipping. The wagon can go anywhere within the reach of its cable, and as the wagon will not weigh more than 4,500 pounds, only a comparatively small proportion of its power will be consumed in propelling dead weight. The wagon has a normal pull equal to 22 span of horses; this power the motor will double, treble or even quadruple for a short time, when necessary, as in going up a hill, doing it automatically without any attention from the driver. This capacity of the electric motor to overcome increased resistance by power increased in proportion to it, is a feature of great value; it is a power only possessed to a limited extent by horses, and makes the electric motor exceptionally well adapted for the purposes intended.

The wagon will haul gangs of ploughs, harrows, rollers, seeders singly or in combination; it will push or pull mowers, tedders and hay loaders, reapers and binders, or reapers and threshers combined, loaded wagons, etc.; on account of its broad tires and light weight, it will plough land so wet and soft that horses would stick in it.

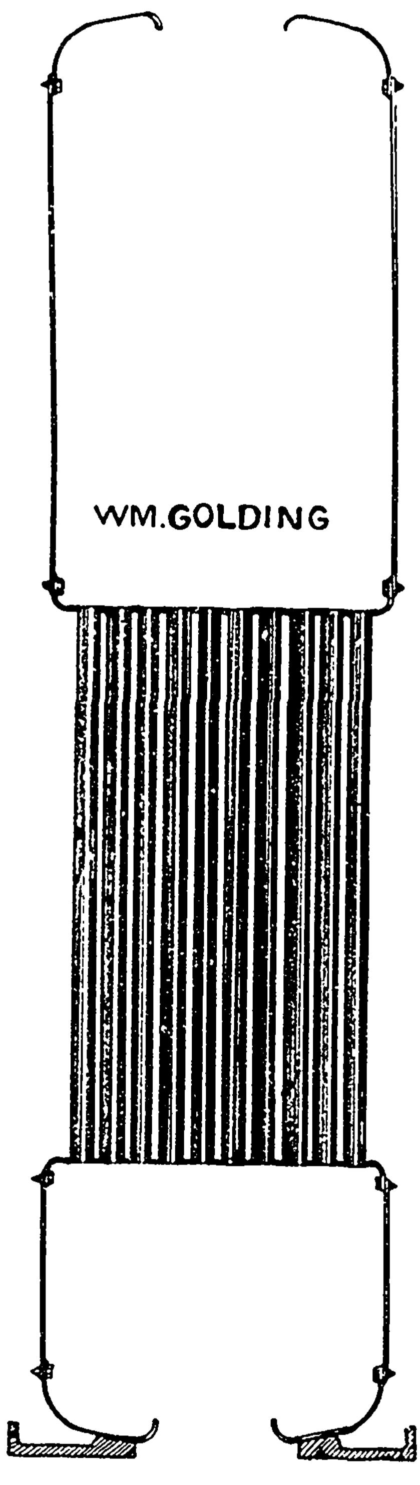
In many localities water power can be utilized to generate electricity for cultivating the surrounding land, and as electric roads become extended through the country the trolley wire can be used as the source of electric supply; but in order that the electric wagon should be independent in its movements, it will be necessary that it should have a portable boiler and engine with attached generator. This can be moved from farm to farm, the same as is now done with steam threshing machines, the wagon itself doing the hauling. Where a portable generating plant is used as the source of electricity, an engineer will be required in addition to the man that drives the wagon. With coal at $4.50 per ton,* the total expense of running this plant for 12 hours will not be more than $10, including wages, fuel, depreciation and interest on capital. This plant will develop a tractive or pulling power equal to 22 span of horses for that length of time.

For THE CANADIAN ENGINEER.

THE WM. GOLDING WATER TUBE BOILER.

BY WM. GOLDING, C.E.

The accompanying sketches illustrate a new type of steam boiler, the invention of Wm. Golding, of New Orleans, La. The leading feature of this boiler consists



in making the upper section sufficiently long to admit of renewing, cleaning, and repairing all of the tubes, and in making the lower section no longer than need be to roll the lower ends of tubes. One or more of these boilers will be placed in line as shown, and connected by steam and water pipe in the usual manner. Doors will be placed in the brick walls to admit of removing the dust and soot that may be deposited by the escaping gases. These boilers may be made of any size desired, preferably of the following dimensions:

Diameter, 36 inches, having 84 2-inch tubes, 6 feet long, thickness of plates 5-16 inch, there being 75 horse-power, which evaporate 30 pounds water per hour per horse-power.

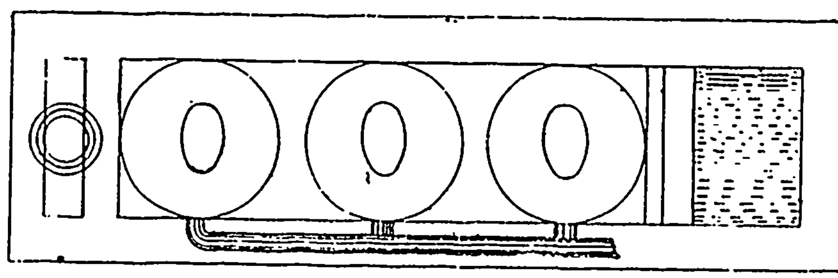
Diameter, 42 inches, having 112 2-inch tubes, 6 feet long, thickness of plates $\frac{3}{8}$ inch, there being 100 horse-power.

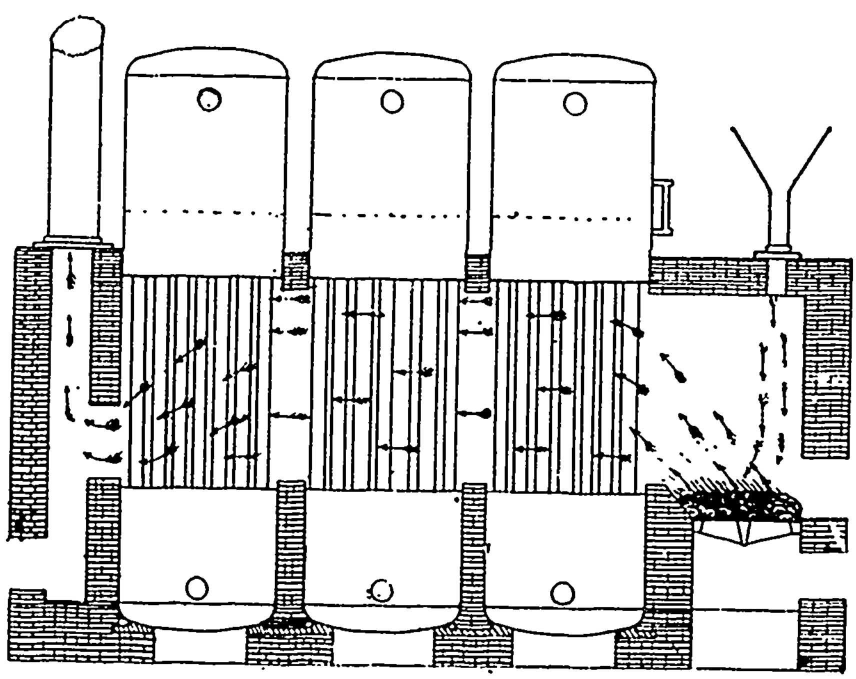
Diameter, 48 inches, 156 tubes, 2 inches by 6 feet, plates $\frac{3}{8}$ inch thick, there being 140 horse power.

Diameter, 54 inches, 204 2-inch tubes, 6 feet long, thickness of plates 7-16 inch, there being 180 horse-power.

Diameter, 60 inches, 248 2-inch tubes, 6 feet long, thickness of plates, 7-16 inch, there being 225 horse-power.

Diameter, 66 inches, 320 2-inch tubes, 6 feet long





thickness of plates $\frac{1}{2}$ inch, there being 288 horse-power.

Diameter, 72 inches, 388 2-inch tubes, 6 feet long, thickness of plates $\frac{1}{2}$ inch, there being 348 horse-power.

The plates will be made of the best material and double riveted. There will be a manhead in both the upper and lower section; the heads will be of the dished type, so as to dispense with bracing.

They will rest upon heavy cast iron plates, having openings to give access to manheads. These plates will rest upon the foundations of the two side walls, and will be securely bolted together so as to form one continuous plate. Safety valves, water glasses, etc., etc, will be of the usual type.

As will be observed, the heating surface is entirely in the tubes, the upper and lower sections being protected by the brick-work. For burning sawdust, wet tanbark, the furnace may be fed through the hopper. The piping, both steam and water, should be double, that is on both sides, and connected at the inlet and outlet. The feed water should enter at the water surface of the boiler next to the chimney. Each boiler should be tested in shop to twice the working pressure.

It is fast becoming recognized that steam boilers intended for service in costly buildings and manufactories should be of the safety type. If from neglect or other causes the water supply be insufficient in the ordinary type of boiler, disastrous explosion may follow, for the reason, as many people believe, that a very large proportion of the heating surface becomes exposed and weakened by low water. If from neglect of interior cleaning of the tubes, or from insufficient water supply, the tubes of the boiler herein presented should become heated, they would split in the direction of their length, and immediately extinguish the fire by discharging water or steam; there would be no further damage for the reason that the tube, although split, still retains its former holding power.

THE DESSAU STREET RAILWAY.*

The aim of the paper is to show the characteristic features of gas traction, to describe the recent experiences at Dessau, and to discuss the results obtained in that city. The three important elements of operating a gas road are the storage of gas, the motor, and the mechanical apparatus. That which presents the principal interest to the public is the storage of the gas and the imaginary risk of an explosion of it in the car. In the last 25 years more than 60,000 railroad cars in different countries have carried gas under high pressure to operate the Pintsch illuminating system, without ever having produced a single explosion or alarmed the passengers, the great pressure itself evidently preventing the possibility of the entrance of air into the cylinders to form an explosive mixture, and at the same time facilitating the discovery of any leaks. The use of the gas itself is even less dangerous in a car motor where the combustion takes place in a cylinder constructed to resist explosive forces, than it is for the illumination where the flame is protected only by a glass globe. The explosions of gas in the cylinder of the motor cannot produce a pressure above a certain limit for which maximum the cylinder is designed. The sole combustion in the Otto engine produces a pressure increasing not much more rapidly than that in the high-pressure steam cylinder, and the maximum gas pressure produced of 20 to 30 atmospheres is not comparable with the pressure of over 100 atmospheres developed by carbonic acid, and safely confined in steel cylinders. Railroads transport cylinders charged to 200 atmospheres, which is about ten times as high a pressure as is required for street-car service, therefore there need be no question or alarm concerning the safety of the gas stored.

In considering whether the cost and maintenance of gas motors is too high for the operation of street cars, it is admitted that the first six months' experience at Dessau are not sufficient to solve the question and indirect deductions must be drawn from the operation of older machinery. The careful investigation made by the company that I represent has produced a very favorable reply. Repairs were limited in most cases to replacing segments of the piston after continuous work or redressing the slide bar in the older machines. The expenses of repairs for the last 8½ years upon gas machine engines of 10, 30, 60 and 120 horse-power at the small central electric station at Dessau have only been $\frac{1}{100}$ of 1 per cent. per year of the initial cost. In reply to an inquiry concerning the gas motors of 50 horse-power at the electric-light station at Prague, the astonishing reply was made that the expense for eight years had been nothing. This probably means that the necessary repairs had been accomplished by their ordinary workmen without extra expenses. On some other gas engines the cost of repairs for seven to twelve years had been in different cases about $40 for one 12 horse-power machine, about $220 for 20 eight horse-power machines, and about $18 for one 12 horse-power machine. Therefore it is fair to conclude that the maintenance of gas motors is as cheap as of high-grade steam engines. The gas motor is not more sensitive to dust than is the steam engine, while in the Luhrig cars the motor is entirely protected from the dust. The cars in the Dresden system have crossed for many a year 26 times a day five lines of car tracks, so that each axle has received daily 260 violent shocks, but no special repairs have yet been required on the motor.

It has been feared that the transmitting and reversing gear would be very complicated, but in reality it is very simple. These gas motors are criticised for producing a disagreeable odor and vibrations noticeable when the car is at rest, but none of these was observed by the numerous visitors at Dessau, although their attention was especially directed to it. This was due to a careful regulation of the admission of gas and the use of automatic oilers. The importance of compressed coal gas is indicated by the formation during the last year at Havre of a company for the contract of boats between Havre, Rouen and Paris, with motors having coal gas compressed to 100 atmospheres in iron cylinders. The first boat of this kind has a 40 horse-power motor and carried 145 tons 72 kilometers without refilling the gas reservoirs. The work required to compress the gas does not increase proportionately to the pressure, but is relatively much less for high pressures. Thus to raise a pressure of 10 atmospheres to 100 atmospheres is only necessary to increase the power 2½ times. It is hoped that the distances run by gas cars at one charging of receivers may become much greater in the future so that gas motors may be employed on small local street cars, but there is no immediate probability that acetylene will be used in the motors, for although it has about 15 times the illuminating power of ordinary gas, it has only 2½ times its value for heating. The operation of the gas cars is maintained with regularity throughout the severe winter. If one car becomes stalled it is easily pushed by the following one.

Regarding the financial side of the question, the figures secured during the six worst months of the year are not very valuable, and the expenses for the commencement of operations are not a fair indication for the future, but the consumption of gas will be constant, and this expense has been determined not only for a half a year, but even for a single day, and the ease of establishing this principal factor of expenses is a special advantage of the new system. Two meters placed at the compressing station give the quantity of gas used by the compressor and

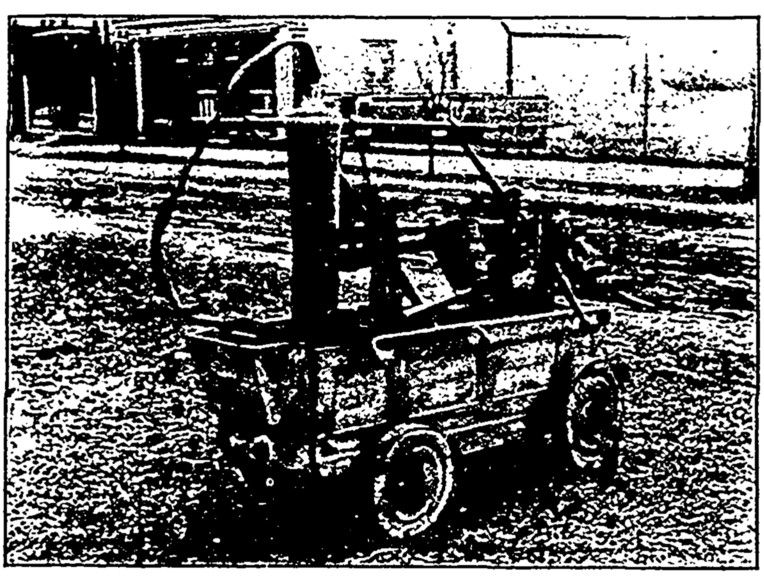
* Abstract of a paper by M. von Oechelhaeuser, Director of the German Continental Gas Company, presented to the Association of German Gas and Water Engineers in 1895.

the quantity of gas compressed; the capacity of the reservoirs is known, and each of them was furnished with a gauge showing the pressure at the beginning and end of a trip. If the quantity consumed is excessive, the car is carefully examined to discover the reason. During the first five months of this year, the mean consumption of gas, including that used by the compressors, *has been 546 litres per kilometer traveled* (about 31 cubic feet per mile). The compressors required 16.8 per cent. of the gas compressed, which was too high a proportion, and has since been reduced to 10½ per cent. The consumption, therefore, is less than was expected, and will be further reduced by more frequent trips. At Dessau the promoters of the railway had at first in consideration electric traction, chiefly because they had in the city a central electric station, but they found that the dynamos produced a current of 110 volts, and the expense to transform it to 500 volts would be heavy. New machines and new dynamos would be required and the old one would have become useless. Therefore, as it was impossible to increase the capital or to employ alternating currents, they adopted gas. Since the consumption of the car motor equals that of a large number of ordinary consumers, it will permit economical production of gas in quantity, and if the actual cost of the gas is taken instead of its selling price, its use on railways is very promising. The adoption of gas as a motive force for the street cars of Cologne would require a consumption of 1,960,000 cubic meters of gas per year.

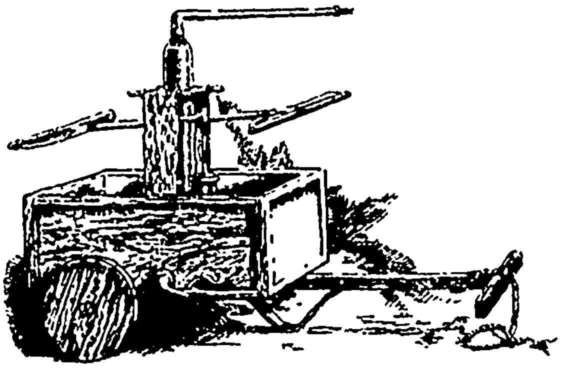
For THE CANADIAN ENGINEER.

OLD FIRE ENGINES.

Considerable interest centres about the fire engine shown in the illustration, not only on account of its great age and the important part it has played in the history of the town of Shelburne, Nova Scotia, but also because it was a royal gift. It was presented to the



town of Shelburne by His Majesty, King George III., and was landed from a man-of-war in 1786. It was only one of many favors which His Majesty showed his loyal subjects, who had emigrated from the older colonies rather than join in the Revolution. The name of the maker has, unfortunately, not been handed down. The pumps, etc., are chiefly of brass and iron, and are apparently in as good condition as ever, but the wooden parts are somewhat decayed. The tank is six feet long, two feet wide and twenty inches deep; pump cylinder four inches, stroke one foot. It has thrown a three-quarter inch stream a distance of 170 feet. There is no suction pipe, the water being lifted in pails and emptied into the tank.



R. H. Buchanan & Co., of Montreal, have an old fire engine which they purchased from Berthier, Que. It was built in 1776, and it is in thoroughly good order to-day. The town of Cote St. Paul has an engine built in 1774 by Phillips, London, Eng. This engine was bought in 1869 from an old iron dealer in William street, Montreal, for $75. It was put in thorough repair, and had new suction and leading hose. A fire company was formed. From all appearances the engine is as good as new to-day. It did good work at several fires. In appearance it is much the same as the Shelburne engine, but the alterations improved it considerably. After the company was formed, money was again raised, and the bell of the old "Protector" engine house was purchased. A company of about 30 men was formed, and at different trials did good fire duty with the engine "Rescue." W. P.

LOCOMOTIVE COUNTER-BALANCING.*

The purpose of adding counter-balance weights to the driving wheels of locomotives is to prevent or minimize the strains and vibrations caused by the momentum or inertia of the moving parts attached directly or indirectly to them. These are of two kinds, revolving parts and reciprocating parts. The revolving parts can be counter-balanced by weights attached to the wheel to which they belong. The reciprocating weights can only be balanced in one direction by adding weights to the driving wheels, as all weights added after the revolving parts are balanced over-balance the wheel vertically, exactly to the same extent that they tend to balance the reciprocating parts horizontally. This over-balance exerts a pressure upon the rail directly proportional to its weight and to the square of its velocity. At high speeds this pressure, which is added to the weight of the driver on the rail, may become great enough to injure track and bridges.

In consideration of the above, your committee have formed the rules which follow, after full consideration of *the following fundamental principles:*

1. The weight of the reciprocating parts that are left unbalanced should be as great as possible, consistent with a good riding and smooth working engine.

2. The unbalanced weight of the reciprocating parts of all engines for similar service should be proportional to the total weight of the engine in working order.

*From a committee report presented at the annual Convention of the American Railway Master Mechanics' Association.

3. Total pressure of the wheel upon the rail at maximum speed when counter-balance is down, must not exceed an amount depending upon the construction of bridges, weight of rail, etc., and when counter-balance is up the centrifugal force must never be sufficient to lift the wheel from the rail.

A majority of railways answering the committee's circular leave unbalanced one-third of the reciprocating parts. In order to see how nearly this method makes the unbalanced weight of the reciprocating parts proportional to the total weight of the engine, we have plotted on the accompanying diagram the relation between the unbalanced reciprocating weight on one side, and the total weight of 75 road engines in actual satisfactory service on seven different roads. On the same diagram are drawn lines, all the points in which are proportional to the total engine weights laid off on the horizontal. The first line marked 1-450 is drawn through about the average of all the points plotted, and indicates that the average unbalanced weight of the reciprocating parts on one side of engine as balanced on these roads is 1-450 of their total weight. The upper line marked 1-360 represents the ratio of unbalanced reciprocating parts on one side to the total engine weight, recommended by G R. Henderson, mechanical engineer of the Norfolk & Western R. R., in an admirable report on this subject made to R. H. Soule, about a year ago, and to which your committee is indebted for valuable data and suggestions. Mr. Henderson proposes the following formula for expressing the relation between the unbalanced reciprocating parts and the total weight of the engine:

Wr = the weight of the unbalanced reciprocating parts on one side;

Wt = the total weight of the locomotive in working order.

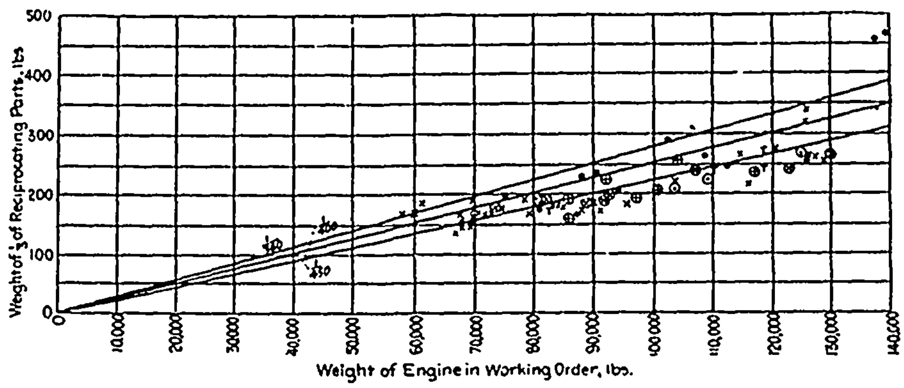
From the data obtainable, we believe this formula allows a greater proportion of the reciprocating parts to remain unbalanced than present good practice will warrant.

The intermediate line marked 1-400 on the diagram indicates the average maximum of unbalanced weight of reciprocating parts in locomotives now in service on various roads. From actual tests of locomotives so balanced in fast passenger service, we recommend it as a safe formula for the maximum limit of the weight of the unbalanced proportion of the reciprocating parts on one side.

In formulating the following rules it is assumed that the driving wheels are finished and mounted on their axles with pins in place.

In designing new locomotives the proper counter-balance weight should be calculated and cast into the wheel centres as follows: Place the centre of gravity of counter weight opposite the crank pin as far from the centre as possible, and have it come as near the plane in which the rods move as proper clearance will allow. To obtain weight of the reciprocating parts and detachable revolving parts, proceed as follows:

Reciprocating parts.—Take the sum of the weights of piston complete, with packing ring, piston rod, cross-head complete, and the weight of the front end of the main rod complete. Weigh each end of rod separately supported.



RELATION BETWEEN WEIGHT OF LOCOMOTIVE AND WEIGHT OF ITS UNBALANCED RECIPROCATING PARTS.

Revolving parts.—Weigh the back end of the main or connecting rod, and each end of each side rod complete, separately supported. The sum of the weights so found which are attached to each crank pin are the revolving weights for that pin.

Rules for counter-balancing locomotive driving wheels:

1. Divide the total weight of the engine by 400; subtract the quotient from the weight of the reciprocating parts on one side as found above, including the front end of the main rod.

2. Distribute the remainder equally among all driving wheels, adding to it the weight of the revolving parts for each wheel. The sum will be the counter-balance required if placed at a distance from the wheel centre equal to the length of the crank.

Counter-balance weights added to old wheels should be generally cast in two parts, fitted between spokes and securely bolted with the ends of bolts riveted over the nuts. Increased weight of counter-balance can be obtained when necessary by coring out cast iron and substituting lead, or in other ways replacing cast iron with a denser material.

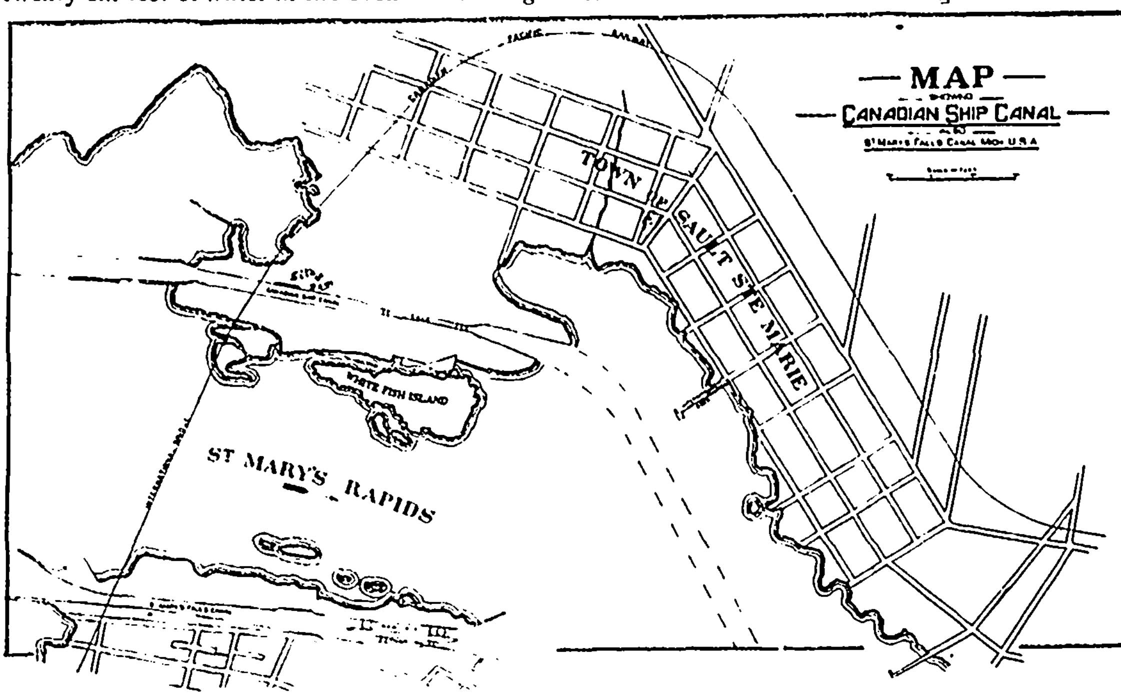
Cautions and limitations: If we assume that the maximum speed in miles per hour of the driving wheel of a locomotive equals its diameter in inches, it can easily be shown that if such wheel is over-balanced by an amount W, at its maximum speed, this over-balance will increase and decrease the wheel pressure on the rail each revolution 38.4 times W. Or if we denote such increased pressure by P, then $P = 38.4$ times W, or $P = 40\ W$ (nearly). Therefore, in order that the wheel shall never leave the rail, 40 times the portion of the weight of the reciprocating parts added to each wheel must not exceed its static pressure on the rail. To insure safety, it should not exceed 75 per cent. of such pressure. Nor should this amount, when added to the static wheel pressure, exceed the safe maximum pressure allowed on tracks and bridges. Locomotives with rods disconnected and removed should not be hauled at high rates of speed.

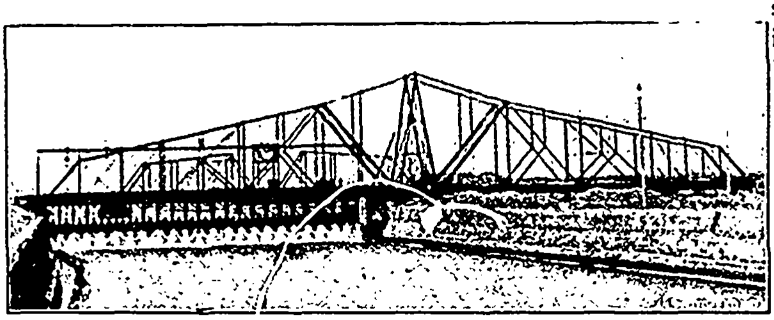
Make reciprocating parts as light as possible.

Spread cylinders as little as possible.

THE MOVABLE DAM AND SWING BRIDGE ON THE SAULT STE. MARIE CANAL.

The dam is built to shut off the water from the lower part of canal and is designed to withstand a static head of twenty-six feet of water in the event of it being operated for repairs or cleaning at the bottom of canal. It also reduces the flow of water in the canal, when the gates of the lock might be carried away by accident, to an extent which will permit the upper guard gates being closed. Such an accident might occur at any moment during the season of navigation, and might not occur for many years. The mean velocity or current produced in the canal, in the event of such accident, would be that due to the difference in level of the water between the head and foot of canal, some eighteen feet. The dam and all operating machinery are adapted to successfully manœuver the frames, wickets and the machinery of the dam under any conditions that may arise. The floor joists are of steel, and the bridge has a plank platform fastened to joists and of sufficient dimensions to operate the machinery and provide a roadway of 8 feet in width over its entire length.





Movable Dam, Sault Ste. Marie Canal.

The Lock, Sault Ste. Marie Canal. Three Large Steamers being Locked Through.

The dam, one hundred and fifty-two feet in width, consists of thirty skeleton frames, with sliding gates working on friction rollers, hinged to the down-stream lower chord, and when not in operation, the frames are suspended to up-stream truss by the manœuvering chains. The frames are lowered against a heavy oak sill which extends across bottom of canal and sustains its proportion of the stated pressure due to head.

The frames are lowered by the chains one by one to the sill; then the gates are run down between the guide and friction rollers in frame. When the last gate is lowered the structure becomes a close dam, with the exception of the leakage through the spaces left between the frames, so that they might not interfere when being operated in a heavy current. The weight of the frames or gates is counterbalanced by a counterweight of concrete built in the floor system of the shore arm. This dam is built entirely of steel, and is the largest of its character ever constructed. The contractors for the dam were the Dominion Bridge Co., to whose chief engineer, Mr. Duggan, is due many improvements on the original design.

Under the instructions of the chief engineer of the Dominion Government, the specifications of dam were prepared by Robert C. Douglas, hydraulic and bridge engineer of that department, under whose direction and superintendence the works were constructed and erected.

ANNUAL CONVENTION OF THE CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.

The stationary engineers throughout the country are looking forward with great interest to the annual convention, which assembles in Kingston, Ont., August 18th. No effort is being spared by the committees appointed by the local branch to insure the success of the convention, and the enjoyment and profit of all concerned. Mayor Elliott has consented to deliver an address of welcome to the delegates, who will be tendered a complimentary excursion, and also banqueted. All the delegates will be quartered at one hotel.

THE CANADIAN ENGINEER wishes the association an instructive meeting and a pleasant outing. A special representative of THE CANADIAN ENGINEER will attend the meetings of the convention, and prepare a full report of the proceedings, which will be profusely illustrated, and will constitute one of the leading features of the September number.

THE UTILIZATION OF ANTHRACITE CULM.*

BY EDWARD H. WILLIAMS, JR.

To the average reader the term "culm" conveys little meaning, unless he has passed through the anthracite regions, where huge mounds rise beside the railroads or form a black back-ground to the villages grouped at their feet. The term is frequently misapplied, as the original meaning, "knots" (Welsh *cwlman*), was applied only to those parts of the anthracite bed which were of a knotty shape; but a derived meaning applies as well to all small pieces of anthracite. In America the rock dumps which bordered the mine mouths contained little coal till in the early fifties, as the product from the mine was sent into the market without breaking or sizing, and the only coal in the dumps came from the dirt—pieces of "bony" or "slaty" coal which were broken down in dead work, or when room in the breasts was required, or when the cleanings from tracks, ditches, and sumps were sent outside.

At the date mentioned coal was first broken and sized, and the air spaces in the mass were thereby increased from 37.7 to 50 per cent. of the whole, and a freer burning resulted. The grates at that period were not fitted for burning small sizes, and the smallest coal marketed was "chestnut," with diameter varying from three-quarters of an inch to one and a quarter inches. The means for cleaning the broken masses were crude, and limited to hand picking, so that the smaller the size, the greater the difficulty in removing the dirt, and the smaller the demand. In many cases there were long periods when there was no sale for chestnut, or even for larger sizes, and these were thrown upon the dump, with all stuff below chestnut in size, all slate from picking, and all bony and slaty coal, so that the dumps soon received the name of "culm banks," which they still retain.

We can estimate the amount of stuff thus thrown away by taking the production during certain periods and comparing the methods of coal preparation. For instance, from the early fifties, when coal was first broken, to the early sixties, when "pea" coal was first shipped to the general market ("pea" is from three-eighths to seven-eighths of an inch in diameter), 80,000,000 tons were sold, while for every ton sent into the market, 1.3 tons went to the dump from the coal preparation alone, besides what was sent there from mining operations. The "culm" thus dumped is estimated at 100,000,000 tons.

From the early sixties to the early seventies "pea" coal was the smallest size shipped to the market, fine-barred grates having been devised for its burning. The cleaning was still by hand, and the "pea" was usually dirty and commanded a low price. The amount lost in preparation was much diminished; so that 144,000,000 tons were marketed while the same quantity went on the dump. In the early seventies mechanical preparation of small-sized coal was introduced by the employment of jigs; these machines effectually separated coal and dirt, so that the use of small sizes greatly increased, and has been increasing up to date, when we are sending to market four sizes of "buckwheat" and one of "rice" coal, smaller than "pea" and clean in condition. The coal shipped during the thirty years since the introduction of jigs has averaged 25,000,000 tons per annum, and the "culm" sent to the dump during that period has steadily decreased; but a moderate estimate will place it at one-fourth of the shipment, or about 187,000,000 tons. The grand total for "culm" is, therefore, 431,000,000 tons, dumped since 1853. Adding to this the slate, rock, ashes, dirt from strippings and other refuse, we have over 2,000,000,000 cubic yards, or sufficient to surround the world by a pile of triangular section and 20 feet high, or, estimating the workable coal that has been dumped, to cover the State of Rhode Island evenly with solid marketable coal 125 feet deep. Not all of this, and not even one-tenth of this, is now available, as will be shown later, and the loss has been in coal; the rock refuse remains. It can thus be seen that the land necessary for dumping purposes may be a serious expense when, as in the Wyoming vall[illegible] it is valuable for farming. It may further be seen that a large coal dump over a mine adds to the weight to be supported, and, when mixed with water so as to be "quick," may seriously menace the safety of miners, should settlings or incautious drivages, as in the case at Nanticoke, allow it to flood the workings and smother the men. The fine dirt from mining and coal preparation can not be dumped where ordinary rains will carry it into water-courses, as the covering of farm lands with culm during freshets always entails loss to the companies through lawsuits. It is to the advantage of the companies to get rid of their culm banks; but their intrinsic value was little thought of in the early days of mining, as the coal supply was thought to be inexhaustible, and wasteful methods were employed for mining and preparation. Now that Mr. Griffiths has shown that the next generation will see the exhaustion of the greater part of the now available coal, we are turning—but too late—to our culm banks, and find but little left. The loss is due to the permission given to the railroads to use the dumps as spoil-banks for grading and ballasting, or for filling deep caves whenever the underlying mines take a fancy to collapse, causing several hundred feet of track to hang across the opening like spider-webs till thousands of cubic yards of refuse fill the holes and bring back a resting-place for the suspended ties. In many cases entire dumps have been thus used.

A second method of disposal for similar reasons can be illustrated by the settling of the steeply-inclined mines under Shenandoah, Pa., where the openings were, in some cases, 70 feet high. Here the surface was pierced by numerous drill-holes, and pipes were sent down to the workings for the conveyance of culm and water to fill the workings and prevent further settling. The superincumbent water was pumped out after the solid stuff settled, and another volume of mixture was sent in till the openings were entirely filled. The mine water is highly charged with sulphate of iron, and this, being unstable and having a high affinity for oxygen, broke up into sulphuric acid and peroxid of iron (or iron rust), the acid attacking the alumina of the slates and forming

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alum, and iron and alum forming a solid matrix to bind together the mass, so that, after drying, the filling was found to be solid enough to sustain itself and allow drivages to be made through it without imber, as in solid coal. This method of disposal will doubtless be employed in future with the worthless material from the jigs, and combined with the underground workings, so that the coal can be removed. The method to be adopted will be: (1) the development of rooms of medium dimensions in a given panel; (2) the establishment of batteries and broken rock at their bottoms to form filters allowing the water to pass, but not the dirt, which will be run in through pipes along the upper gangway, with a pumping of the filtered water; (3) a drying of the filling in the panel, after a varying period of some length, (4) a removal of the original pillars, and filling of the spaces and the gangways, when abandoned, with culm. In this way, by sufficiently developing the lower workings of a mine, we can retreat toward the surface, and remove all the mine contents by the employment of what is now a nuisance.

Another cause of loss in the valuable portions of the banks is the habit of allowing the men who run out the waste during the winter to build fires on the surface to warm themselves. These fires, unless watched, invariably communicate to the interior. Some have been burning for many years, conclusively showing that not only coal and "culm," but even slate and rock containing small amounts of carbon, will burn, and persistently. It is a common thing to see the present waste run out over a steadily-burning and settling bank, from which abundant fumes of sulphur continually ascend, and whose white and cleanly-burned ashes show the thoroughness of the combustion. These burning banks have been a revelation to some as to methods of burning impure compounds of carbon. Further information in the same line has been derived from study of those portions of mines where underground fires have been finally extinguished. In these, as, for instance, in the celebrated case of the Butler mine, near Pittston, Pa., it has been found that the continuance of the combustion was due to the carbon in the slate, and the more porous and worthless portions of the coal, while the solid parts did not burn at all, unless chipped off by the heat, and accumulated in small heaps at the bases of the pillars. The slate burned freely, and even at distances from the external air—for example, throughout the partings in the pillars, and where the only supply of oxygen seems to have been that originally contained in the interstices of the rock. How this fact has been utilized will be shown later.

Careful estimates based on actual workings show that from 40 to 70 per cent. of the culm banks is available as marketable coal. The attention of the trade is directed to them as too valuable sources of heat to be wasted, and it will now be in order to briefly state some of the many ways of utilizing their heat contents. These can be grouped under three general heads:—

1. Burning culm in its ordinary state.
2. Reducing to an impalpable powder and burning.
3. Combining with some substance to form briquettes, etc.

Under the first, more than fifty patents have been issued; under the second, thirty; under the third, more than a hundred. These show that the subject has excited attention.

The first attempts to burn culm were unsuccessful, because the material experimented upon was too large, and the amount of carbon exposed was slight when compared with the surface of the particles; so that, while culm banks might smoulder for years, their material would not burn in grates, as the ash formed on the outside of the pieces prevented the fire from communicating with the carbonaceous particles in the centre rapidly enough to keep the temperature at the point of union of oxygen and carbon. In other words, the fire was chilled. As soon, however, as the attempt was made with small-sized culm, success was attained, as long as the fire was kept at a sufficient depth, and sufficient air was forced through the mass. The furnaces used are of three types—with fixed, oscilating and travelling grates.

The draught is by steam jet, or by fan.

The fixed grate, consisting of adjustable bars, did not fully succeed, and it was not till Mr. Wootten brought out his perforated plate through which air was forced that burning could be said to be successful. For stationary boilers the work of charging and raking is severe, while for locomotives it requires the greater portion of the time of the fireman, and increases with the poverty of the fuel. If the draught is too strong and the fuel fine, there will be an accumulation at the flue end, which must be frequently removed. The removal of the large amount of ash is difficult with the fixed grate, and on this account the modern types are movable.

The conditions to be filled by such a grate are permanency under exceptionally hard usage; freedom from burning out, and thoroughness and ease in the removal of ash. The best types of oscillating grates rock in such a manner that the fine fuel can not fall into the pit during their rotation, and the ash formed at the bottom of the fire is systematically cut off in sections and dropped into the pit by rotating the bars in one direction, while the reversal breaks up the clinker and renders the bed porous. The advantage of this grate over the travelling type is its greater stability, and freedom from getting out of order—the latter defect often characterizing the travelling type when old; but the disadvantage (shared by all ordinary types of furnaces) is that combustion is not so perfect as in the travelling grate, the charging of cold fuel upon the partly burned fire always chilling the lower part below the temperature necessary to combustion, causing this part to go into the ash-pit, where it is lost.

Probably the best type of travelling grate was invented by the late Eckley B. Coxe; its prominent features are the freedom of the bars from warping and their ready interchangeability. Travelling grates charge themselves, convey their burden to the place where it is to be burned, keep it there till fully consumed, and remove the ash. When the subject of draught is considered, the Coxe furnace presents another valuable feature.

As before stated, the depth of fire will be found to have a relation to the size of the fragments burned. To fully maintain a fire of large sizes, there must be too thick a bed for ordinary heating purposes. For this reason there has always been a waste in household stoves and furnaces, as the fire has been too thick for the grate area, and a large portion has gone off incompletely consumed; moreover, the thick clinkers are hard to remove, and the loss of good fuel in cleaning grates is considerable, as can be seen by examining the average ash-barrels. The experience of the writer has conclusively shown that fine grate bars and small, and even minute, sizes of coal will become the rule when people are educated to that standard; so that thin fires can be easily kept alight. With chestnut and pea coal a considerable amount of dirt will make little difference in completeness of combustion, so that, with a good furnace and a minimum draught, a single shovelful of coal every thirty-six hours will support combustion and comfortably warm a house during such chilly days as have occurred in April and May of this year. With furnaces for steam purposes, on the contrary, a forced draught must be maintained. This can be produced by a fan or steam. The former produces more complete combustion, but is more destructive to the grate bars; the latter cools the lower portion of the bed, softens the clinker, and prevents burning out of bars. The comparison between the two thus becomes an economic one, and is to be measured by dollars and cents saved during long intervals under as nearly similar conditions as can be obtained. The fan blast is more simple to arrange than that by steam, as steam and air must be fully combined before striking the fire, to prevent cold spots. The best device thus far is the "argand" jet, where steam escapes from a perforated ring of pipe, around and inside which the air enters. The ash-pit must be sealed in all forced draughts, and in the ordinary methods an equal pressure is supplied to all parts of the grate. This is not of much importance in the case of fixed and oscillating grates, if the fuel is evenly distributed; but in the traveling grate it becomes a source of loss, as that portion of the grate leaving the furnace carries almost consumed fuel, and air sufficient to consume the carbon in the fresh fuel is too much for portions half and wholly consumed, so that through these parts comes a blast which cools the gases of combustion in proportion to their want of carbon. The Coxe furnace avoids this by arranging the ash pit in compartments and providing each with its amount and strength of blast, so that the highest efficiency is maintained throughout.

The second general division is that in which the fuel is first reduced to an impalpable powder and blown into the combustion chamber. The ideal furnace is one in which the fuel is kept in suspension in the air till entirely consumed, and from whose chimney no smoke issues. All of the original attempts were unsuccessful, and, according to a statement lately made before the Franklin Institute of Philadelphia, the trouble has been in the regularity of feed. In all of these furnaces there must come a preliminary pulverization of fuel, so that they start with an added cost and promise a rapid and complete combustion. Their mechanism must be somewhat complicated and delicate, and the chances of disarrangement must be correspondingly good. At present they are not numerous.

The third general division is that in which culm is combined with some substance, inert or combustible, to form a fuel which will stand handling, and should resist the weather. As early as 1837, the subject was taken up, and a patent issued The inert substances used are clay, soap, plaster of paris, hydraulic lime, slacked lime, carbonate of soda, wood ashes, caustic soda, sulphate of ammonia, sulphate of iron, sand, silicate of potash, furnace slag, brown sandstone, geyserite jelly, black oxide of manganese, etc., either alone or combined with others; the combustible substances are legion, the principal ones being bituminous coal slack, asphalt, petroleum, dead oils from distilling the last, and some one of the hydrocarbons. The great objection to the products from any of these is that they do not sufficiently resist crushing, and so cannot be stored in large quantities; or they do not resist the weather. The history of the many industries which have started in this country with flaming prospectuses and have gone out of business would fill volumes, and at present there are not half-a-dozen plants utilizing "culm."

The banks, however, have been attacked in another and entirely different manner—by treating them as coal sent up from the mine and stocked. A number of "washeries" have been built of moderate height, with bars for separating the rock and allowing the culm to pass through, and go thence to the screens and jigs as in ordinary practice. The results are highly satisfactory, and, in a paper read before the American Institute of Mining Engineers in 1894 by Mr. Arthur W. Sheafer, it was shown that, in the four years between 1889 and 1894, there were shipped from the Stanton bank,

Stove coal	19,874	tons.
Chestnut coal	31,734	"
Pea coal	40,283	"
Buckwheat, etc.	118,479	"
Total	210,370	"

In this case, the product averaged 60 per cent. of the total volume of culm treated. In twenty-five months 120,440 tons of similar sizes were shipped from the Draper bank, which averaged 46 per cent. of the amount treated.

It has been held by the majority of writers that culm banks deteriorate throughout. As to the slate and bony coal, this is true; but not as to the solid benches which have been worked and sent to the dump. As already shown, solid coal will not burn, and still less will its fragments oxidize, as lately shown in some of the coal strippings, where bright crushed anthracite has been sent into the market from immediately under a loose glacial cap of the first and earliest ice advance of the glacial period. The writer has found that the amount of actual rotting of this solid coal has been three-fifths of an inch during these thousands of years. From this we can see that the solid coal dumped in the culm banks is in nearly its original state at present, and the changes in its character are due to fires and infiltrations of acid waters or stainings with iron. The fact that these old banks are now in active demand, and the further fact that leases are being taken for their reworkal, show that there is good coal in them after their many years of exposure. This seems to be one of the best ways of making culm available; but, as already stated, the finer sizes of coal need not be so thoroughly cleaned for complete combustion as must the larger ones, so that a larger percentage of marketable product will probably be obtained in the future. At any rate, there are fortunes in these old dumps, and they will be used no more for filling till they have been thoroughly reworked.

While this paper was being written, there came the wonderful discovery of Dr. Jacques, by which over eighty per cent. of the energy of the carbon can be obtained directly as electricity without the intervention of machinery, by a method as simple as wonderful. Dynamos will be sent to the attics, and it will be cheaper to heat and work by electricity than by fires. In a series of iron cells Dr. Jacques places caustic soda, which he fuses at 300° F., and in the fused alkali he places rods of carbon. Air being forced through the bath, the combination of carbon and oxygen creates electricity in such quantities that arc lights can be run for hours with little or no consumption of carbon. If this is all that it is claimed to be—and its sponsors are men who understand what they are saying—the old culm banks contain reserve energy sufficient to furnish us with power for many generations, and the coal now in the ground will be so mined that culm banks will cease to be the most prominent objects in an old anthracite district.

For THE CANADIAN ENGINEER.

THE CONSULTING HYDRAULIC ENGINEER.

BY WILLIAM PERRY, HYDRAULIC ENGINEER, MONTREAL.

The question has been frequently asked, and it has been of late more and more pertinent, What is the present and future of the hydraulic engineer, pure and simple—the consulting engineer, as distinguished from the contractor and the manufacturer? In other words, has the time come when the public realize that an hydraulic engineer should be engaged for putting up an important plant on just the same principle as an architect would be consulted if one were erecting a great building?

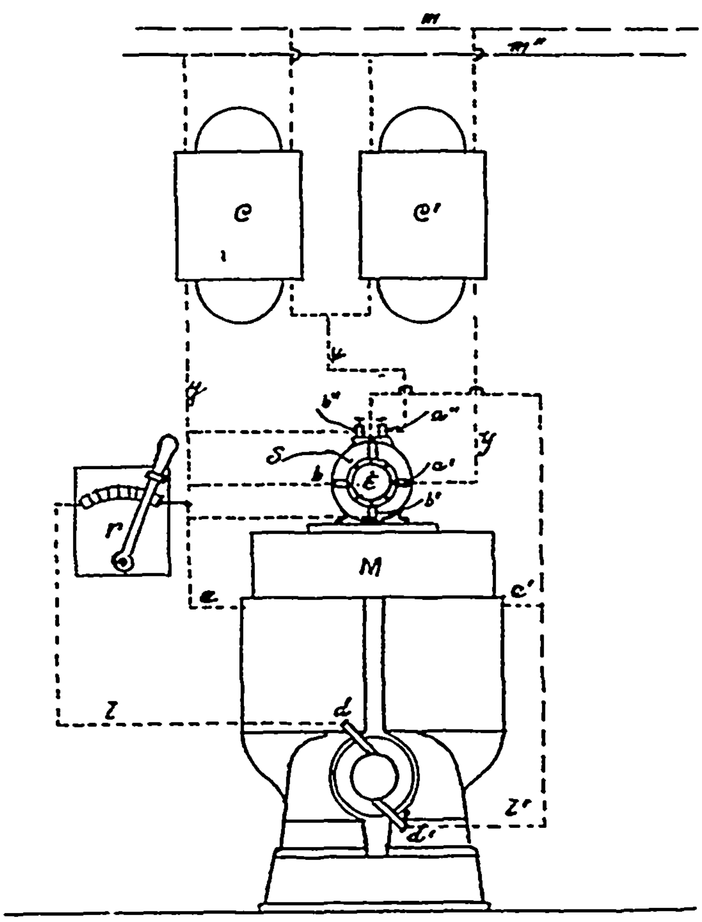
It is an easy question to ask, but a hard one to answer. There ought to be a good field for the consulting and supervising engineer; there will be unquestionably at some future time, but whether there is one now is anything but easy to determine, except by the heroic method of trying it. For instance, a capitalist contemplates the erection of a large building What would be thought of him were he to go to a number of contractors and say, "I want to put up a ten-story brick building on a ground space of one hundred by thirty feet, to have 440 rooms, front of stone, iron columns; what is the lowest figure you will do it for, with a guarantee?" And the same man becoming interested in putting in a pumping plant, will dicker with half a dozen or more manufacturers' agents for the installation of a thorough, reliable plant, having himself only the vaguest ideas of what would be required, and finally buying his machinery from the fellow who will make the biggest promises and take largest percentage in bonds for payment. The work may or may not be carried out as it should be; it is, of course, for the interest of the manufacturing companies to sell as much apparatus as they possibly can, and for the sake of their reputations to sell a good reliable article, but if there is an opportunity of pawning off discarded patterns which will give fair service under the circumstances, the contractor is more than human if he does not take advantage of it to a greater or less extent, just as the contracting builder would skimp whenever he saw a good chance in order to increase his profits. It is evident enough that the more reasonable course would be in the one case to engage an architect to make proper plans and see that the same are carried out, and in the other to seek the advice of a competent hydraulic engineer to arrange for the installation and superintend the execution of the details.

The public is gradually beginning to see all this, and the larger enterprises are not infrequently conducted on such a rational basis, although up to the present the handling of such matters has depended more on that indefinable but potent something now known among politicians as "boodle," rather than any clear recognition of the necessities of the case. The past few years have seen great changes in methods of putting in good work and in the quality of manufactured products. There is considerable to be learned, and the buyer requires to keep his eyes wide open, as there is a lot of inferior machinery on the market copied from first-class manufacturers, but reduced in price and material to secure sales. What form the business will take eventually is not for me to predict. The consulting engineer ought to have a wider province than has yet been accorded him.

OPERATING A DIRECT CURRENT MOTOR WITH A RECTIFIED ALTERNATING CURRENT.

BY J. B. HALL, B.A., SC.

Mention has been made in various journals of the utilization of a rectified alternating current to operate direct current motors in Germany during the past year. Three years ago a similar method was devised for the same purpose, which was installed at Wentworth, O., where it is yet running. The village was lighted by the alternating current, and the newspaper office where the motor was installed was going to purchase a small engine and boiler, but on the representations of the superintendent of the electric plant, entered into an arrangement to obtain electric power, which was employed as is here described.



The sketch accompanying illustrates the arrangement of the various parts. *M m* are the primary alternating current leads, 2,000 volts, 133 cycles, connected to the primaries of converters, *c c*, in multiple. The secondaries of the converters are in series giving 200 volts. A branch is run (*x*) to the synchronous motor, *s*, from the terminals of *c*, so as to have a difference of 100 volts across the terminals of the synchronous motor. The circuit from the terminals of the secondaries, *y y*, are led to two of the brushes, *b* and *a*, on the commutator, *t*, then from the two brushes, *b* and *a*, to the field circuit, *e e*, and through the armature circuit, *l l*, by way of starting rheostat, *r*. The converters were each 75 lights capacity of a standard make. The synchronous motor was of the earliest form (Tesla) and had been used before to drive a fan ; the fan was removed, and in its place was put the commutator *t*, which consisted of eight segments, fastened to a fibre back with air insulation between ; the brushes were of carbon, and the combination was very effective in minimizing the evil from the small spark that necessarily occurred. With mica between the segments, both the brushes and the commutator were burned, but without mica the brushes alone were disintegrated. The arrangement past the rectifying commutator was the same as is used in direct current installation. The method of working was to start the synchronous motor, and when it got up to speed (in five seconds) close main switch (located in wire *b*), thus exciting field coils, and then closing circuit of armature through rheostat *r*. The motor *m* was a 5 K.W. undertype, with a tested commercial efficiency of 83%.

To learn the efficiency of the combination, a 5-K.W. dynamo of 83% efficiency was directly coupled to the motor, *M*, and the current generated from it was passed into a water resistance. Measurements of that circuit were made by a Weston portable volt and ammeter and Edison chemical meter. The alternating circuit was measured by a Thomson watt-meter, and by a Westing-house (Shallenberger) alternating current meter. The test was of four hours duration, and the following results were noted: The synchronous motor required about 150 watts. The Thomson watt-meter registered 30,964 watt hours; the Westinghouse meter 31,236 watt hours, making an average of 31,100 watt hours. The ammeter recorded 26.8, the voltmeter 190, each the average of quarter-hour readings; the weight of the plates in the chemical meter indicated 20,980 watt hours. Considering the measurements as being correct, the efficiency of the combination would be about 66 per cent., or of the motor and rectifier 81 per cent. The fields of motor, *M*, became a little warmer with a rectified alternating current than with a continuous current, but no loss in efficiency seemed to be traceable to the eddy currents and hysteresis resulting therefrom.

Alternating current motors, be they single or multiphase, have low power factor, and are costly in construction, and it would seem that to utilize some modification of the method here described would be preferable.

METERS.*

BY JAS. MILNE.

Concluded from last issue.

As far back as 1881, it occurred to Edison that in order to satisfy the public, the meter should be arranged so that the customer could read it for himself. We therefore find, fifteen years ago, a self-recording chemical meter exhibited at the Paris Exhibition The resistances are so arranged that only a small known quantity of the total current will pass through the electrolytic cells. The meter as shown would not record so much like the recording meters of to day, but if we tilt the balance beam shown above, this kicks the beam below in the opposite direction, making contact through the mercury cup and sending a current round an electro-magnet, which registers one on the counter. Current now flowing through the cell on the right of the balance beam was tilted so that the left end was down, and after a certain quantity of current has passed the cathode (the weight on the beam) will get heavier and in time throw the beam the other way. When it is swinging, contact is broken in one mercury cup and made in the other, bringing the electro-magnet on the other side into play, causing another unit to be registered on the counter. The same action takes place in this cell as in the other, and every kick, or second kick, according to the arrangement of the mechanism, is registered on the counter. In the circuits leading to the cells reversing commutators are placed so that at the end of every month or so the direction of the current can be reversed, thereby reversing the deposit. By this arrangement the plates could be made to last for an indefinite period. In one description I have of this meter it states that the commutating devices were so arranged that when metal was being deposited on one plate the other was being dissolved, or when one plate was getting heavier the other was getting lighter by an equal amount at the same time. Take this style of meter and we will suppose copper plates in a sulphate of copper solution are used, and that the ratio of resistances is 1:99, and we will take it for granted that the beam tells at every .05 grams and that 94 is registered on the counter. The total deposit is 4,700 milligrams, and from this quantity the total current has to be determined. In calculating same out, we find that C in the high resistance amounts to 4 amperes for 1 hour or 4 amp hours. But this represents only what passed through the circuit in which the voltameter was placed ∴ 4 × 100 = 400 amperes for one hour would represent the total current passed through the whole circuit when the resistances are arranged at 1:99. We might adopt a constant of 4.277 to bring the reading ampere hours.

In the early Edison meters copper plates were used, which did not give very satisfactory results, and it led the inventor to try various metals, among which was amalgamated zinc immersed in a zinc sulphate solution. This gave excellent results and is used in the meter of to-day with perfect results. Every one is aware that the resistance of copper wire increases as the temperature increases, and if we wish to keep the resistance of a certain circuit constant, irrespective of temperature changes, something must be inserted in this circuit which has an equal and opposite effect to that of copper, that is to say, if we have a circuit of 50 ohms R at 60° Fah., composed of a spool of wire 46 ohms, and something else of 4 ohms, and if the temperature rises so that the spool now has 47 ohms then the R of this something else must be 3 ohms if we wish to have the total R constant at 50 ohms. In the Edison meter the resistance of the electrolytic cells decreases as the temperature increases, and to make up for the decrease in resistance a compensating spool of copper wire is put in series with same, which has an increasing resistance equal in amount and opposite to that of the cell. In Fig. 3 it shows the resistance of the "bottle" or electrolytic cell, and also that of the compensating spool. We see that the cell decreases and that the spool increases for increased temperature, and that the two combined give us practically a straight line. The resistances are calculated from 30° to 110° Fah. or a range of 80°, which is considerably more than is ever met with in practice. In the Edison meter the branch of low resistance is made of German silver and is called "shunt." The resistance of German silver varies .02 of 1 per cent. for every 1° Fah. In the smallest size of meters the shunt has a resistance of .04 ohms at, say, 60°, and we have no compensating devices: therefore for a rise in temperature we must have an increase in resistance, and if we have an increase in resistance an error must be the result. The greatest percentage of the error will be in the smallest meter, therefore we will just calculate what the error amounts to. At 60° the shunt is .04 ohms, at 105° it is .04040 ohms, and at 30° it is .039733, or a difference between 30° and 105° of .000667 ohms, making the maximum error that can come into effect less than 2 per cent., or, to be exact, 1⅔ per cent., or less than 1 per cent. above and less than 1 per cent. below. Taking the conductivities, we find that if 100 amperes are flowing in the circuits, .08161225 amperes go through the bottle at 60°. At 105° there are .082248 amperes, and at 30° .08109, which shows that between 60° and 105° we have less than 1°, and between 60° and 30° we have .6 per cent. as being the amount of the error.

Where meters are generally located the temperature in the summer rarely exceeds 70°, and in the winter never below 40°. Therefore in actual practice from 25 to 30 degrees would represent the greatest variation of temperature, which gives us .0400888 ohms as the R of the shunt at 70° = .2 per cent. error, and .039823 ohms at 40° = .5 per cent. error, or, in other words, the meter in the summer time would be one-fifth of 1 per cent. fast, and in the winter about two-fifths of 1 per cent. slow, making an average of about one-tenth of 1 per cent. slow for the whole year. In the larger sizes this loss decreases to almost nothing. Therefore for the variation in temperature due to the heating of the current or atmospheric variation, we see that the percentage of error is practically nothing, so small that it may be entirely neglected.

So far, we have assumed the lowest temperature to be 20° Fah., but there may be places where the temperature goes considerably below this. These places are very exceptional, however The zinc sulphate freezes at 27° Fah., and some means must be taken to prevent its freezing. In Fig. 4 is represented the arrangement as put in the present meter to prevent the solution from freezing. It consists of a strip of brass and steel riveted together and fixed at one end, the other being free to move. It is called the thermostat. When the temperature gets very low the brass contracts more than the steel and causes the strip to curve, making contact with the terminals leading to the lamp, which on completing the circuit lights it. When the temperature rises again the compound strip straightens and the circuit is broken A patent was filed in 1881 covering this temperature regulator, which at that time consisted of a resistance coil acting as the source of heat. Some few months later we find still another method of preventing the solution from freezing It consists, as in the former, of the compound strip which makes and breaks the contact. When contact is made current is sent round the electromagnet, attracting the armature to which is attached an arm operating a valve, which when open allows water to run into the cell underneath containing quicklime, the mixture causing heat. I might state that here in Toronto the temperature is so uniform (!) we have no thermostat in any of our meters, although they are all adapted for them. In practice we find that the transfer of zinc in each pair of bottles on the same side of a three-wire system in very many cases agree exactly to a milligram, and the maximum variation never exceeds a few milligrams This shows without doubt the great accuracy of the meter.

This is a recording electrolytic meter which was brought out some two or three years ago in England, which deserves mention. I have not had practical experience with it, but I am of the opinion that it should give satisfactory results. We have here the shunt as in the Edison, also the compensating spool. The mechanical part consists of a method of recording the volumes of gas produced by a small portion of the current used by the customer. Gas is accumulated in the collector and the registering mechanicism indicates the number of times this has been filled. The operation is very simple and is as follows · When a certain quantity of gas is accumulated it forces the fluid down the U-shaped tube until it comes to the bend, and just as soon as it comes to this bend it immediately starts up the other leg and escapes. It is then filled up with the liquid and descends by gravity for another charge of gas. Pure water is used for refilling the cells every three or four months This meter is very easily calibrated and is a coulomb meter registering in ampere hours. This electrolytic meter mentioned is only used for continuous current, but there is one called the Lowrie Hall meter in which the sameprinciple is used to measure alternating currents. In the secondary circuit a storage cell is placed in series with the electrolytic cell, and it is taken for granted that the alternating current does not deposit metal, therefore the transfer from one plate to the other depends on the conductivity of the circuit, i.e., the number of lamps turned on. The total current going through the circuit passes through the storage cell, and if no lamps are turned on no current from the accumulator will flow through the voltameter, and if the lamps are turned on current will flow from the cell to the voltameter, causing deposit, therefore the deposit will be a measure of the conductance from which the lamp hours can be arrived at

We will now take up motor meters, and in this we have an endless variety It would simply be out of the question to touch on them all, so we will just take up the most important and treat on them briefly In this kind of a meter there are a few advantages over those we have already described, but the disadvantages more than offset the advantages It has been claimed by some that they (some of them at least) require no attention. This is, as far as my experience goes, incorrect, for I find that motor meters require more attention than any other form, either chemical or clock Nearly all of them consume energy when not recording, that is when no power is being used by the consumer, none of them will record on very light loads—if they do when just installed, they are not so sensitive afterwards. There are, however, some very good recording motor meters, if we overlook these disadvantages, among which might be mentioned the Ferranti and Perry in England, the Shallenberger, the Duncan and the Thomson recording meters.

The Ferranti meter is an ampere hour recorder. If a current is passed through a fluid in a magnet field, this fluid tends to move in a direction perpendicular to the direction of the current and also to that of the field. It is on this principle that this meter depends. Current enters at the centre of the mercury trough and leaves at the rim, and in so doing gives motion to the mercury, the motion is communicated to a small aluminum fan which is connected to the recording mechanism. It is adapted for continuous and alternating currents.

If current is sent from one end of a cylinder (in a magnet field) to the other, the cylinder will rotate, and this is the principle of the Perry meter. Current is admitted to a mercury dish at the bottom edge of the inverted copper cup, which plows up the sides and leaves by the nickel rod at the top Friction is reduced to a minimum. The speed of rotation is very slow and the meter will register very small currents in some of the larger meters, say 60 amperes, it will start up with .1 ampere.

The Shallenberger meter is intended for alternating currents. It has been very successful and a large number of them are in use. It consists of two coils, one carrying the main current and the other is a closed coil. A rotary magnet field is produced by an induced current in this closed coil which drags the iron disc around. No brushes or commutator are required, the disc has no electrical connection whatever The retarding motion is effected by an aluminum fan fixed on the same spindle as the disc. It is an ampere hour recording meter, and consequently the speed is directly proportional to the current. The calibration depends on the angle of the closed coil to that of the main coil. The Duncan meter, of the Fort Wayne Co., has also made a good record, and like the above, has neither commutator nor brushes. The armature is an aluminum cylinder and the closed secondary is made of several copper punchings. This meter depends on the repulsion of a closed secondary from its primary. The primary coils are in a series with the lamp circuit. The retarding effect is obtained in the same manner as the Shallenberger.

One of the advantages claimed for the Thomson watt meter is that it is adapted for continuous and alternating currents. This may be an advantage and it may not. In so far as we have meters for alternating currents of a simpler design, it looks to me as if it would be better and cheaper to have the separate meters. This is more a matter of opinion, however. In the armature circuit is placed a high resistance coil, generally placed in the bottom or back of the meter and part in the field, the object of this latter part being to produce a field of sufficient strength to overcome the friction of the moving parts, brushes, etc., and it is perfectly clear that this current must flow whether current is being used by the consumer or not. The copper disc rotating in a permanent field acts as a drag, just the same as the little fan in the former meters, by generating an E M F. This E M F is proportional to the speed, therefore the retardation is proportional to the speed and the speed is proportional to C × E, therefore, the speed resulting from this is proportional to C × E, *i.e.*, the power at that particular time.

The working conditions of this meter are not favorable. A current is passing through the armature circuit 24 hours in the day, and even though a recent test showed that only 05 amperes passed, yet on a large installation, using, say, 2,000 such meters, it would probably represent an expenditure equal to the interest on a capital of $20,000 or $30,000. The meters when new register for light load, but are not so sensitive after the lapse of some months. They even fail to record the rapidly varying loads which are met with in electric elevator service.

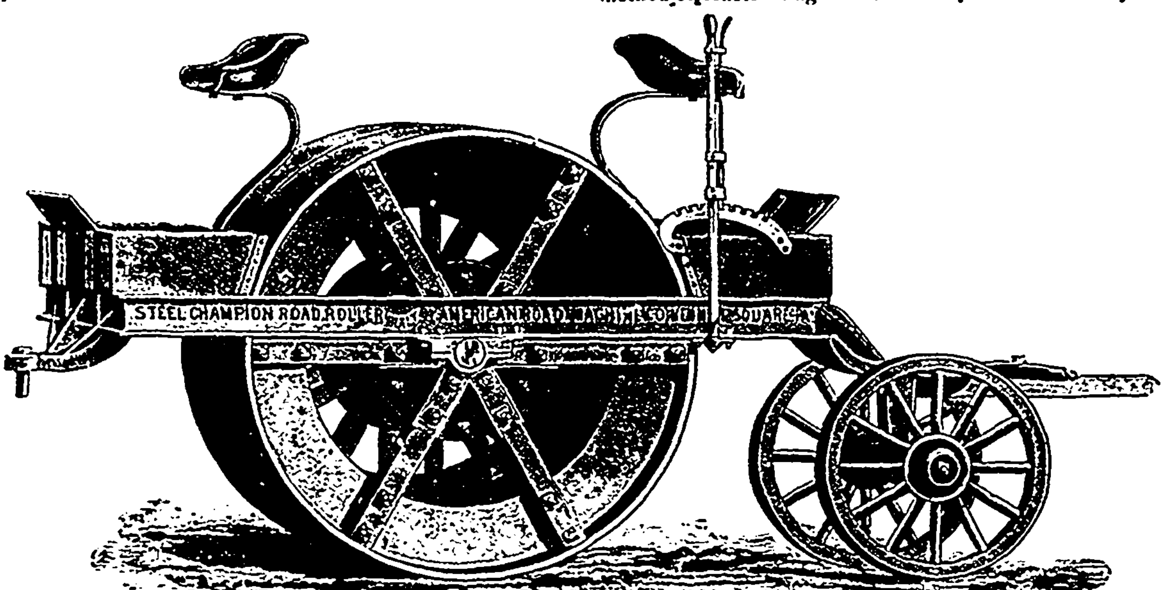
Of the clock meters the Aron seems to offer most advantages. We have several clock meters in this country, but not one of them can in any manner compare with this one. It is adapted for alternating and continuous currents and is made as an ampere hour or watt-meter. It is one of the most reliable meters in existence. It consists of two clocks, one keeping standard time and the other is retarded or accelerated, as the case may be, by the action of a coil or coils carrying the main current in which the "ball" of the pendulum, consisting of a permanent magnet, oscillates. When both clocks are going at the same speed the middle bevel wheel is turned around on its own axis, but if one is going faster than the other the middle wheel is turned around on its axis and also around on the axis of the spur gears. This motion is communicated to the wheels operating the pointers on the dials, and it is only where there is a difference in the speed of the clocks that the meter records. This meter possesses the great advantage of recording, no matter how small the amount of current is.

The advantages and disadvantages of the various meters are. The advantages of the Edison chemical meter: 1st, practically no loss; 2nd, no moving parts; 3rd, absolutely correct at all loads; 4th, will record the smallest possible amount of current; 5th, it is applicable to any pressure, 6th, low first cost, 7th, low cost of maintenance, 8th, readily repaired. The only disadvantage (if any) is that the consumer can't read it for himself. Motor Meters—The only advantage is that the consumer can read the meter. The disadvantages are. 1st, loss in overcoming friction in the moving parts, 2nd, incorrect at light loads; 3rd, incorrect at quickly varying loads; 4th, first cost high, 5th, cost of maintenance high; 6th, not readily repaired. Clock Meters—In the Aron type of meter we have the following advantages. 1st, correct at all loads; 2nd, will record the smallest possible current, 3rd, as a coulomb meter it is applicable to any pressure; 4th, practically no loss. 5th, can be read by the customer. The objections to this meter are 1st, liability to stop recording if clock stops; 2nd, first cost high

THE CHAMPION ROAD ROLLER.

The story is told of a man who always ordered his axe handles in the rough, as it was cheaper to wear them smooth with his hands than to have them sand-papered. Much the same idea of economy seems to govern the construction and repair of many country roads; they are made in the rough, so to speak, to be worn smooth by traffic; this plan may have its advantages, but they are not apparent to those who are obliged to jolt over the rough and unrolled surface of a newly made road.

The best authorities on road construction in this and other countries deem the road roller more nearly indispensable than any other appliance used in road construction and repair. As a matter of history horse rollers have been used in the work of road making in European countries for more than half a century, and, as the roads of France are pre-eminently superior to those of any other country in the world, it is interesting to know that road rollers were first used in that country, and French engineers, early seeing the advantages to be derived from their use, gave to the road roller their unqualified endorsement.



The road roller is not only absolutely essential to the proper construction of any road, but it is an economical implement as well; in spreading any material upon the road-bed, whether it be dirt, gravel or stone, unless it is promptly and thoroughly compacted it will not stay in place, but by the action of traffic and water will work over the road-bed toward the ditches, thus resulting not only in a waste of material, but in a road that is full of holes and ruts. There are two kinds of rollers used to a considerable extent in the work of road building, the horse-roller and the steam-roller; either will give good results, but in the judgment of many of our best engineers and practical road-makers the steam-roller is inferior to a good horse-roller in the following respects, say the manufacturers of the Champion road-roller. It is not so well suited for foundation rolling, which is a very important part of street or stone road construction. The diameter of the roller is too small for the weight, causing it to push the material, instead of compacting it under the roller as intended. It cannot roll brick streets, for this reason, without tilting the brick out of place. It cannot mount a steep grade of broken stone, and when used to roll soft limestone, it crushes it to a damaging extent.

One very valuable feature of the Champion roller is the fact that the horses may be hitched to either end, thus being much more convenient than a one-way roller.

The pole is not attached to the roller direct, but to a truck, which is attached to the steel frame of the roller by means of goose-neck irons. These goose-neck irons are attached to either end of the roller, and by simply removing a king-bolt and transferring the trucks from the front to the rear end of the roller, it is reversed. It is supplied with two seats, one at either end, and a brake which will effectually stop the roller on the steepest grade. The Champion rollers are all built the same size, but in four different weights, viz., 2½, 3½, 4½ and 5½ tons; each roller is supplied with two steel boxes on top, each one of which will hold about one ton of pig iron, thus converting each roller from a light weight to a medium or heavy weight. The economical advantages of this arrangement are great, as it will be conceded that a roller of any given weight cannot be used to the same advantage on all conditions of roads. Thus, a roller of reasonably light weight can be used to good advantage where the ground is soft and yielding, or where stone has been freshly spread upon the road, but this same roller would not answer for rolling moderately firm materials. One 2½ tons in weight will exert a pressure of 84 pounds per lineal inch on the road bed, and to arrive at the amount of pressure the heavier rollers would exert, add 34 pounds for each ton; thus, it will be seen that a roller 5½ tons in weight, with boxes loaded, making it 7½ tons in weight, will exert a pressure of 255 pounds per lineal inch, all that is ever desired. The Champion rollers cannot be excelled, it is claimed, for any class of road or street work, but they will be particularly appreciated in towns and townships where both earth and stone roads are used. Manufactured by the Copp Bros. Co., Ltd., Hamilton, Ont.

THE STORAGE OF WATER IN EARTHEN RESERVOIRS.*

BY SAMUEL FORTIER, M. CAN. SOC. C.E.

The large number of earthen reservoir embankments in use, the widely differing opinions held by engineers in regard to the best method of constructing them, and the fact that the subject has not heretofore been considered by the Canadian Society of Civil Engineers, must plead as an excuse for this paper.

Very many earthen embankments, chiefly known as tanks, have been built in India to store water for irrigation purposes. The high prices of structural materials, the inability to procure and operate modern machinery, and the low wages paid to workmen, have favored this kind of construction.

It costs but little† to build an earthen embankment of even large dimensions where the materials are abundant and convenient, and where laborers can be procured for eight cents a day for each man, four cents for each woman, six cents for a donkey, and fifteen cents for a pair of bullocks. A structure requiring skilled labor and modern machinery, with coal at $20 per ton, timber scarce, and iron and steel from $8 to $15 per cwt., would be much more expensive. These peculiar conditions may, in a measure, account for the 37,000 tanks to be found in Mysore, and the 53,000 in Madras, besides smaller numbers in the other presidencies. The past history, however, of these tanks, many of which were built centuries ago, seems to prove the suitability of this material to retain water, and where failures have occurred they were in nearly every case traceable to imperfect outlet conduits or to faulty design.‡

Not only in India, but in all regions where the rainfall is insufficient to mature crops, and where water has to be artificially applied to make up for the natural deficiency, it is only a question of time when the storage of water becomes a necessity. In the Western States of the United States, for example, the average annual run-off from the drainage areas, not to speak of the flood discharges, is from five to ten times greater than the run-off during the dry period of summer, when it is most needed for the raising of agricultural products. It is thus evident that only a small percentage of the total water supply can be utilized without the aid

*A paper read before the Canadian Society of Civil Engineers.
†H. M. Wilson, in 12th Annual Report, U.S. Geol. Survey, p. 533.
‡Proc. Inst. C.E. vol. xxxiii. Gordon on the value of water in India.

of storage reservoirs. For many centuries these reservoir dams have been built of earth, and there is good reason to believe that in the centuries to come the same material will be used. Upon this assumption the irrigated countries of Cape Colony, Egypt, Spain, Italy and France, and on this continent those of South America, British Columbia, and two-fifths of the United States are, and will continue to be, more or less dependent upon earthen dams to conserve and equalize the flow of the scanty water supply.

In reference to the use of earthen dams to store water for domestic purposes, it may surprise some to learn that the increase in the number of waterworks plants in Canada and the United States has been greater than that of railways. In 1830 there were in the United States only 31, and 58 years later there were 1701, while in Canada during the same period the number increased from a few insignificant plants in the larger cities to 68 in 1888 § Since many waterworks systems have each a number of earthen reservoirs, it is probable that the increase in the latter has been equally great.

The diversity of opinions among engineers on this subject is remarkable and difficult to explain. The wide differences in the kind and quality of the materials used may partially account for it, but apart from this, one is forced to conclude that the opinions held by many engineers regarding the best way to design and construct earthen embankments to impound water are erroneous. For any given case the problem is: to store with safety to life and property a certain volume of water, on a particular site, within walls of earth. The task seems easy and simple, but in its design and execution the plans and specifications from a dozen or more competent engineers would show great dissimilarities. The general form, content and particular dimensions might differ 100 per cent. One engineer would be willing to incur considerable expense in procuring clay for the entire embankment, another would use clay only as a centre core; while a third would reject it as the most treacherous material in existence for that class of work, and would build a homogeneous wall of a mixture of fine and coarse materials. Some would specify that the materials be packed dry, others that they be dampened, while some would call for an abundance of water. In regard to lining or paving there would likely be as many different kinds recommended as there were specifications. Some would be positive that the structure would be insecure without a heavy masonry core wall, while the advocates of a homogeneous embankment would consider it a waste of money. The task of reconciling so divergent views is too great for the writer of this paper. The most that he can hope for is that the opinions herein expressed, the suggestions offered, and the consideration of a few practical features relating to reservoir dams and the storage of water, may aid, in some measure, our younger brethren.

Earth dams are composed of varying proportions of gravel, sand, silt, clay, organic matter and water. The same ingredients which constitute the cultivated fields and their underlying strata are in nearly every case the most convenient and also the most suitable materials to use. A consideration, therefore, of the nature of the materials forming a reservoir embankment leads us directly to that of soils and sub-soils. For this purpose, the physical and mechanical properties of soils are of much more importance than their chemical ingredients. It is not essential, for example, that we know the amount of potash, phosphorus or lime in any given case, but the size and weight of the grains, the amount of air-space they enclose, the percentages of air and water contained in these open spaces, and the effects produced by moisture, heat and frost, as well as the action of such forces as gravity, capillarity and evaporation, are of great importance. To such an extent is this true that one might say without exaggeration that the success of works of this character rests mainly upon the fact that they were designed and built in accordance with an intimate knowledge gained from a close study and carefully made tests of the physical properties of the materials. For twenty years and over men have been testing the physical qualities of iron, steel, cements and the various kinds of timbers, and this knowledge, when coupled with the correct application of the principles of mechanics, has given us our modern structures composed of a minimum amount of materials with a maximum of strength and efficiency. Reservoir embankments, on the other hand, have been built in most instances without the requisite knowledge, upon mere guess work, brawn and not brain predominating.

The site having been determined upon, samples of the underlying strata can best be obtained by test pits. They cost more than samples obtained by boring, but the additional information gained much more than compensates for the extra cost.

To avoid danger to workmen and shoring, the writer makes these pits elliptical. By having the major axis, say 18 feet, and the minor about six feet, it is possible to dig with picks and shovels to a depth of 30 feet by leaving a berme of six feet one-third the way down and a second berme of the same width two-thirds of the distance from the top. Samples can then be taken from each pit at every change in the formation. Sieves graduated from five meshes to the linear inch downwards in fineness to 10, 15, 20, etc., meshes may be used to grade the materials as to texture. When a portion of each of these graded samples is washed and afterwards examined by a good lens, the size and mineral character of all the larger particles can be determined, whether lime, quartzite, slate, shale, etc. The finer particles of sand, silt and clay, or all less than say one-hundredth of an inch in diameter, can be classified only by some mechanical soil separator like those invented by Drs. Hilgard and Osbourne

The following classification as to the size of particles contained in soils and sub-soils is now used by most authors on soil analysis. The dimensions are given in both millimeters and inches:

TABLE I.

Conventional Names.	Size in M M.			Size in inches.		
Coarse gravel......	—	to	6	—	to	$\frac{1}{4}$
Gravel.....................	6	to	2	$\frac{1}{4}$	to	$\frac{1}{12}$
Fine gravel................	2	to	1	$\frac{1}{12}$	to	$\frac{1}{25}$
Coarse sand	1	to	.5	$\frac{1}{25}$	to	$\frac{1}{50}$
Medium sand..............	5	to	25	$\frac{1}{50}$	to	$\frac{1}{100}$
Fine sand	.25	to	.05	$\frac{1}{100}$	to	$\frac{1}{500}$
Silt	.05	to	.01	$\frac{1}{500}$	to	$\frac{1}{2500}$
Fine salt	01	to	005	$\frac{1}{2500}$	to	$\frac{1}{5000}$
Clay	.005	to	.0001	$\frac{1}{5000}$	to	$\frac{1}{250000}$

That the reader may get a clearer idea of the approximate proportions of gravel, sand, silt and clay in the soils commonly cultivated, the following table, compiled chiefly from the published works of Prof. Whitney, is herein given. No. 1 is the red clay tile of the Potomac Valley near Baltimore, and No. 2 is a blue clay of the same locality used for making stoneware pipe. No. 3 is a "clay" soil so-called taken from a truck field on James Island, S Carolina. No. 4 is a heavy loam, from Hatfield, Mass., and No. 5 a close retentive soil. No. 6 is a sample of the lightest grade of sandy land of Southern Maryland. Nos. 7 and 8 a e early truck land from the same State:

TABLE II.

No.	Kind of Soil.	Organic Matter.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very fine Sand.	Silt.	Fine Silt.	Clay.
1	Red clay	6.24	0.00	0.00	0.50	2.63	9.62	25.13	13.44	42.34
2	Blue clay	2.61	0.00	0.00	0.29	1.27	8.93	20.16	16.72	50.02
3	Clay land	1.62	0.00	0.54	1.03	83.20	3.22	3.22	3.58	3.59
4	Heavy loam ..	3.45	0.00	0.00	0.20	0.43	21.88	67.00	3.41	2.61
5	Meadow land ...	4.75	0.00	0.00	0.05	0.50	32.64	49.32	5.46	6.79
6	Sandy land.	0.24	0.45	10.33	46.29	20.15	8.17	7.11	2.29	4.77
7	Light truck soil...	0.00	0.49	4.96	40.19	27.59	12.10	7.74	2.23	4.40
8	Gravelly loam ...	3.18	6.06	22.09	29.87	9.82	6.52	10.71	3.86	7.89

According to Schubler the average weights of one cubic foot of various soils as they exist in nature, are as follows:—

Dry silicious, or calcareous sand	110	pounds.
Half sand and half clay	96	"
Common arable soil....................	80 to 90	"
Heavy clay	75	"
Garden mould rich in vegetable matter ..	70	"
Peat soil	30 to 50	"

The difference in weight between a clay and a sandy soil, for instance, is due largely to the greater number of open spaces in the former, and not to any material difference in the specific gravity of the grains A cubic foot of a very sandy soil contains about 40 per cent. by volume of air space, while a soil derived from limestone contains about 60 per cent. air space.

According to Whitney, the percentage of open spaces in the following typical soils of Maryland are.

TABLE III.

Light truck land	37.3	per cent.
Pine barrens, chiefly sand................	40.0	"
Sandyland.............................. .	41.8	"
Wheat land	42.7	"
Tobacco land	50.0	"
Gummy land	58.5	"

Outside of the laboratory it is impossible to find soils completely saturated, *i.e.*, with all the spaces filled with water. These open spaces contain air and water in varying amounts. In dry soils there is a large proportion of air, and a correspondingly small proportion of water, while in wet soils these proportions are reversed.

§ Eng. News, vol. xxi.

In irrigated regions, where it is possible to control the soil moisture, long experience has shown that the best crops can be raised when the open spaces contain nearly equal volumes of air and water. Thus the water-holding capacity of heavy clay soils is about 44 lbs of water in every 100 lbs. of saturated soil, and the most favorable condition for plant growth in such soils is when they contain from 16 to 24 lbs. of water in 100 lbs. of moist soil.

The following table gives the approximate number of grains in each classification of similar weights:

TABLE IV.

Fine gravel	1.4 grains	
Coarse sand	17 0	"
Medium sand	139.0	"
Fine sand	1370.0	"
Very fine sand	17360 0	"
Silt	274000.0	"
Fine silt	17280000.0	"
Clay	449280000.0	"

The belief is prevalent among laymen and engineers inexperienced in this kind of work, that any country road foreman who is familiar with the handling of earth, is qualified to superintend the building of earthen dams. They fail to understand the difference between an embankment capable of withstanding a load and one compact and stable enough to retain water. In highways, or railroad fills, little, if any, attention is given to packing the materials. The fill when completed is nearly as porous as the soils and subsoils of which it is composed. When a cubic yard of earth is removed from the pit to the fill, its bulk is increased by about one and one half in sandy soil to six per cent. in hard clay soil, and the subsequent shrinkage of from 5 to 15 per cent. finally reduces it from 90 to 95 per cent. of its original volume. But soils and subsoils in their natural state contain from 35 per cent to 60 per cent by volume open space, and the ordinary highway, or railroad fills are thus shown to be porous masses wholly unfit to impound water. In the building of earthen dams something more is needed than the piling up of a mass of porous materials. The hydraulic engineer who desires to build a safe dam with a minimum amount of earth, must attend closely to the following features:

1. The relative sizes of the grains.
2. The percentage by volume of open space.
3. The proportions of air and water contained in these open spaces.
4. The best mode of filling the interstices between the larger grains with the smaller grains.
5. The best mode of expelling the greater part of the air contained in the open spaces.
6. Making the embankment proof against the action of extreme drouth, or excessive saturation.

As the hydraulic engineer of the Experiment Station of Utah, the writer recently began to make some experiments on the best mode of compacting soils and sub-soils. On account of cold weather these experiments have not been completed, but enough has been done to show the general trend of the investigations.

Sand suitable for cement concrete was carted from a bank, placed under cover and allowed to remain for about two months until quite dry, when it was separated by graduated sieves into four grades – coarse sand, medium sand, fine sand, and very fine sand. In the same way bank gravel was obtained in two sizes. Grains that would pass through round holes one-quarter of an inch in diameter and be retained by holes one-sixth of an inch, were classed as gravel, and the grains left between sieves one-sixth to one-twelfth inches were classed as fine gravel.

The silt was a mixture of vegetable matter and extremely fine sand. The clay was a brick fire clay and was air dried, ground and passed through graduated sieves.

Boxes were made containing some even part of a cubic yard and graduated from bottom to top. The smallest box used was one foot in height and contained .01 cubic yard. The materials were poured into the boxes through a funnel five-eighths inches in diameter from a height of 0.85 feet, and the weight of each determined.

To determine the percentage of open space in each, a given volume was poured from a height of 0.85 feet into a known volume of water, and the volume of water thus contained in the interstices gave the percentage by volume of open space.

In the following table the percentage by volume of open space in the clay is not given on account of its tendency to "swell" when immersed in water. Assuming the specific gravity of the solid particles of the clay to be 2.40, the percentage of open space would be about 0 65:

TABLE V.

Material.	Size. Inches.			Weight per cub. yard. lbs.	Percentage by volume open space	Temperature of materials.	Temperature of water.
Gravel	1/4	to	1/6	2550	45.0	48° F.	35° F.
Fine gravel	1/6	to	1/12	2275	45.7	48° F.	35° F.
Coarse sand	1/12	to	1/30	2200	47.7	46° F.	44° F.
Medium sand	1/30	to	1/100	2150	50 8	46° F.	44° F.
Fine sand	1/100	to	1/200	2150	48.3	46° F.	44° F.
Very fine sand	1/200	to	1/1200	2025	47.7	46° F.	44° F.
Silt	1/1200	to	1/2200	1925	51.7	46° F.	44° F.
Clay	1/2200	to	1/10000	1380	....	....	....

CLAY CONCRETE.

An embankment formed of gravel would be stable and unaffected by the actions of frost, drought or moisture. but the 45 per cent. of open space in gravel would allow the water to pass through it. Sand would be more impervious, but less stable, and more affected by drought and excessive moisture. Soils containing a high percentage of organic matter might make an impervious embankment, but the necessary weight and compactness would be wanting. The same is true of all clays. Clayey soils are often styled heavy soils, but, as we have seen, such soils are the most porous, and are capable of absorbing large percentages of water. The tendency of clay to swell when wet, and shrink and crack when dry, renders it a treacherous material for reservoir embankments when used alone.

Since there are serious objections to each class of the materials named when used alone, the writer has made a few tests of compactness with various mixtures of the above, which he has termed *clay concrete*, the object sought being to mix sufficient silt or clay with the sand to more than fill all the open spaces in the sand, and to mix with the gravel a sufficient volume of sand and silt or clay to more than fill all the open spaces in the gravel.

The results of the tests are as follows:

CLAY CONCRETE NO. 1.

Gravel	1.00	cubic yards.
Coarse sand	0.25	"
Very fine sand	0.27	"
Clay	0.43	"
Total	1 95	"

(*a*) When No. 1 mixture was thoroughly mixed dry and poured from a height of 0.85 feet, its volume was 1.546 cubic yards.

(*b*) When thoroughly mixed and tamped dry in one-tenth of a foot layers, its volume was 1.240 cubic yards.

(*c*) When poured slowly into water and mixed, its volume was 1.26 cubic yards.

(*d*) When moistened sufficiently to form a stiff paste and tamped in one-tenth of a foot layers, its volume was 1.312 cubic yards.

CLAY CONCRETE NO. 2

Fine gravel	0.90	cubic yards.
Fine sand	0.56	"
Silt	0.42	"
Total	1.88	"

(*a*) When No. 2 mixture was mixed dry and poured from a height of 0.85 feet, its volume was 1.526 cubic yards.

(*b*) When mixed dry and thoroughly tamped its volume was 1.294 cubic yards.

(*c*) When mixed dry and poured from a height of 0.85 feet into water, mixed but not tamped, and the excess of water drained through holes covered with canvas in the bottom of the box, its volume was 1.256 cubic yards.

(*d*) When mixed dry and moistened with 0.277 cubic yards water at a temperature of 41 degrees Fahr. into a stiff paste and well tamped, its volume was 1.296 cubic yards.

CLAY CONCRETE NO. 3.

No. 3 is identical with No. 2 except that 0.58 cubic yards of clay is substituted for 0.42 cubic yards silt.

Fine gravel	0.90	cubic yards.
Fine sand	0.56	"
Clay	0.58	"
Total	2.04	"

(*a*) When No. 3 mixture was mixed dry and poured from a height of 0.85 feet, its volume was 1.604 cubic yards.

(*b*) When mixed dry and well tamped, 1.324 cubic yards.

(*c*) When mixed dry and poured from a height of 0.85 feet into water, mixed but not tamped, and drained of excess water, its volume was:

1.432 cubic yards after experiment
1.420 " " 1 day
1 360 " " 2 days
1.356 " " 4 days
1.324 " " 15 days

(a) When mixed dry and moistened with 0 307 cubic yards of water into a paste and well tamped, its volume was 1 348 cubic yards, which shrunk but slightly in four days.

CLAY CONCRETE NO. 4

Fine gravel	1 00 cubic yards
Medium sand	0.51 "
Silt	0.26 "
Total	1 77 "

(b) When No 4 mixture was mixed dry and tamped its volume was 1 26 cubic yards.

(c) When mixed dry and poured from a height of 0 85 feet into water, and mixed but not tamped, its volume was 1 204 cubic yards

(d) When mixed dry and moistened with 0 30 cubic yards water into a stiff paste and well tamped, its volume was 1 212 cubic yards

Water, sewer, and gas mains are laid in trenches excavated in materials somewhat similar to those which may be used in earth dams Of trenches for water mains the writer has superintended the filling in of over 100 miles. Formerly, city engineers required the trenches in all public streets to be filled in in three-inch layers and well tamped. In the three systems of waterworks recently constructed by the writer in this State, permission was granted to fill the trenches under water instead of tamping the earth in thin layers. The method followed was to keep separate while excavating the road metal, gravel, or paving, and the ordinary earth. After the pipe was laid in the trench and caulked, care was taken to tamp sufficient earth beneath, and at the sides of the pipe to give it a continuous and uniform bearing; then earth bridges were thrown in at intervals to prevent flotation and the trench partially filled with water from the hydrants or from irrigating canals. The ordinary earth was then ploughed, shovelled, or scraped into the water and the road metal or gravel placed on top.

Trenches filled with dry earth and tamped invariably settled more or less after a heavy rainstorm, but trenches filled under water, although quite soft for a few days, behaved much better and seldom settled.

The foregoing statement does not apply to clay soils, since it requires too long for the wet mass to become sufficiently dry to bear up the weight of a horse.

There is every reason to believe, however, that trenches filled with clay placed under water in the manner indicated, would, when freed of the excess moisture, be more stable and less liable to subsequent changes.

In building a distributing reservoir for Ogden City, Utah, the writer adopted a mode of compacting the materials somewhat similar to that outlined in filling in trenches under water. The location was below the old beach line of Lake Bonneville, a name given by geologists to the large fresh-water lake of which the present Great Salt Lake forms only a small remnant. The materials were, for the most part, fine sand, with an occasional stratum of coarse gravel, cobble rock, clay or silt. The capacity of the reservoir is 7,000,000 U.S. gals., width of embankment at flowline 30.5 feet, water slopes one and one-half to one, outer slopes two to one, depth of water 20 feet.

After removing the surface soil, a trench from 4 feet to 6 feet wide and 6 feet deep was dug along the entire centre line of the proposed enbankment. The base of the enbankment was then formed and allowed to slope slightly towards its centre Instead of filling in the trench at once, it was allowed to remain nearly full of water, and it became the origin of a canal in the centre of the entire embankment The most impervious material was deposited on the inner half of the embankment, while the cobble rock and more porous material were deposited near the outer edge. The inner, and to some extent the outer, half of the embankment, was built up in layers, moistened and packed in the usual manner. The central portion was built up by emptying the wheelers at each edge of the canal and shovelling the material into the water. Fig. 1 shows a sketch of the partially completed reservoir embankment.

The mode of compacting reservoir embankments, almost universally followed by American engineers, is to specify that the earth shall be spread evenly over the surface in layers of from four to six inches in depth, then moistened and rolled with grooved rollers weighing from 100 to 300 lbs. per inch of tread. In most instances the number of times each layer is rolled is left to the decision of the engineer, but some specify a minimum roller travel in miles for each 1,000 cubic yards excavated. Opinions differ as to the amount of water to use. In gravel puddle, or what the writer has termed clay concrete, in which the percentage of clay is small, a large amount of water can be used with good results This mixture unquestionably makes the safest embankment. To those who persist in using chiefly clay, it may be said that the addition of water to moisten the layers is of doubtful benefit. The effect of water on comparatively dry clay is to increase its bulk, and no amount of rolling will make it quite so compact as it would be if rolled to the same extent in a dry state. In reference to compacting materials by depositing them under water, as was done on the Ogden reservoir, by means of a canal in the centre, the reader will note that this method is applicable only to gravel puddle or clay concrete containing less than 25 per cent. clay. A higher percentage of clay would render the embankment so soft that it could not be traversed by teams, but the method is particularly well adapted to earth containing either no clay or very little

In so far as the author knows, this method has never been tried before If the reader, however, compares tests No. 1c, No. 2c, No. 3c, and No. 4c, with corresponding tests (b) and (a), he will find that, when the percentage of clay is small, as compact a mass can be made by simply pouring the earth into water and mixing as by moistening with water and thoroughly ramming.

It is, however, from practical experience rather than from the few preceding experimental tests, that the writer bases the following conclusions:

1 Earth deposited under water is freed from the greater part of the air confined in the open space.

2 Earth containing grains of different sizes packs better under water than in air

3. Embankments built of dry earth, or earth moistened and packed, are more liable to be injuriously affected by capillary action than embankments, or portions of embankments, built under water.

4 Making provision during construction for a canal holding water in the centre of the embankment, is a practical test, before completion, of the safety of the structure.

5. Most of the advantages of a centre core are gained by this mode of construction, without the disadvantage of having distinct lines of separation between an earth and a masonry wall

6. Where water is abundant and easily applied, the middle portion of earth dams can be more cheaply compacted under water than by sprinkling and rolling.

The proper widths and slopes to adopt in the building of earthen dams cannot as yet be determined by mathematical calculations. Our knowledge of soil physics is too meagre to admit of limiting the amounts of materials used to the same extent as one would in the construction, for example, of a railroad bridge, or a roof truss. The dimensions in each particular case must be left to the good judgment, practical skill and the knowledge gained from experimental tests of the designing engineer.

The character of the materials, the purposes for which water is stored, and the natural conditions surrounding each site, differ so widely, that it is impossible to lay down precise rules Generally speaking, however, the dimensions of each embankment will depend to a greater or less extent upon the following conditions:

1. The danger to life and property in case of failure.
2. The depth of water to be impounded.
3. The height and force of the waves.
4. The angle of repose of the materials.
5 The pressure which the materials can safely withstand.
6. The necessity of a roadway on top of the embankment
7. The slope paving.
8 The imperviousness of the materials.
9 The existence of a centre core.
10. The manner of construction.

When teams are used to convey the materials the smallest top-width must be at least six feet, since it requires that space to prevent horses, and particularly mules, from crowding. It is usually desirable to have a roadway paved with rolled gravel and a fence around the reservoir, in which case a top width of twelve feet or more would be required. Where stability and security alone are concerned the top-width depends upon the elevation of high water

(To be Continued.)

THE new wood-working factory for Geo. Loud, Sherbrooke, Que., is to be built by Loomis & Sons. The dimensions are 100 x 50 feet, and it will be three stories high. The first story will be in stone and the other two in brick.

A. W. CAMPBELL, C.E., PROVINCIAL INSPECTOR IN ROAD-MAKING FOR ONTARIO.

A. W Campbell, C.E., who has been appointed Provincial Instructor in Road-making for Ontario, was born at Wardsville, Middlesex county, in 1863, and is the son of J. C. Campbell, a farmer in the township of Ekfrid. Young Campbell thus spent his boyhood on the farm, and received the usual education of country lads at the common school. A knowledge of the farm and of the conditions under which the farmers of Ontario work, must be of great service to anyone whose duty it will be to assist the farmers in a very important direction in helping themselves. In 1885 he graduated in engineering and surveying from the School of Practical Science, Toronto, after which he was in partnership for several years with James A. Bell, of St. Thomas, the firm doing an extensive business as municipal engineers. In 1891 he was appointed City Engineer of St. Thomas, which position he resigned to accept the office of Provincial Instructor in Roadmaking from the Ontario Government During his term as city engineer he gave special attention to road-making. Few men in the country have had so large and varied experience in constructing and superintending earth, gravel and macadam roads in town and country. For many years Mr. Campbell has had practically complete charge of the street improvements of the city, with the result that from being a place of notoriously bad streets, St. Thomas has to-day a greater mileage of permanently improved streets than any other Canadian city or town of its size In a few years about ten miles of perfect macadam roadway have been laid down It is largely through the influence of Mr Campbell and others associated with him that the county of Elgin has much better roads than are to be found in most parts of Ontario Mr Campbell has been during these years a very busy man. In addition to his work as city engineer and engineer for many municipalities adjoining St. Thomas, he was one of the editors of *The Municipal World*, dealing in his department each month with municipal engineering, and more particularly with the good roads question.

When the Ontario Good Roads Association was formed three years ago, Mr. Campbell was appointed a member of the board of directors, and is at present one of its vice-presidents. In this connection he has taken an active interest in addressing farmers' institutes, dairy and other meetings in the rural sections of the province, urging the necessity of more systematic and uniform work, and endeavoring to create deeper interest in the subject among the people at large, by conveying information on the correct methods of modern road-making. A year ago he was appointed a member of the Ontario Toll-Roads Commission, and as such visited different parts of the province.

The Provincial Instructor in road-making is under the direction of the Minister of Agriculture. His duties will be entirely educative in their character. He will give instruction in the building and maintenance of highways to pathmasters and others. He will collect from this and other countries all information available on the subject and distribute it and prepare it for distribution to the public. It is proposed that he shall personally meet with the members of township, town and village councils, boards of trade, and other bodies interested in the question of highway improvement, and discuss with them the best means of proceeding in the circumstances in which they are placed. He will be prepared to superintend sections of road in order to give road overseers and others patterns or ideals to which they may work. It is understood also that he will lecture on the subject of road-making at the Agricultural College, and probably at other educational institutions. In addition to his excellent training and wide experience, Mr. Campbell is an enthusiast on the subject of road reform. He is young, active and progressive. He is a man of fine address and an excellent speaker. He is especially at home among the farmers, from whom he has come and with whom he has been associated during his whole life.

A. W. Campbell, C. E.

The following topics are taken up in the Road Bulletin No. 1, which is the first of a series to be issued by Mr. Campbell for the public information :—

DRAINAGE.

Perfect drainage, first, of the foundation of the road-bed; secondly, of the road surface, are the points in road-making on which too much stress cannot be laid.

The first is accomplished by underdrainage, tile drains being laid at a depth of three or more feet below the surface on each side of the road-bed at the foot of the grade and parallel to it. Care should be taken to fit and settle the tile in the trench so that, when refilling with earth, they will not be displaced. As a rule two and a half-inch to four-inch tile will be sufficient. The joints should be close and the grade a true line. Loose joints and an uneven grade allow silt to pass into the tile and remain there, destroying the drain.

Surface drainage is accomplished by open drains on each side of the grade, having sufficient capacity to drain, not only the road-bed but the land adjoining. With open drains and with tile drains make and maintain a free outlet to the nearest water course. A drain without an outlet is useless. In constructing a good road a dry foundation is the matter of first importance.

CROWNING THE ROAD.

The graded portion of the road should be wide enough to accommodate the travel upon it, and not greater, the slope being uniform, not heaped in the centre. The crown should be well above the overflow of storm water, and should have a grade sufficient to shed water readily to the open ditches on either side. Do not round it up so as to make the grade steep and dangerous, under the mistaken impression that better drainage will thereby be secured. Nor should it be so low as to allow water to stand upon it in depressions. Under ordinary circumstances one inch or one inch and a half to the foot is a proper grade; that is a road-bed twenty-six feet wide should be from thirteen to twenty inches higher at the centre than at the side.

QUALITY OF GRAVEL.

The gravel should preferably be sharp, clean and of uniform size. Pit gravel usually contains too much earthy matter, and where the latter is in excess, the gravel, as a road-making material, is useless Lake gravel is apt to be rounded, water-worn and lacking in the necessary earthy matter to make a solid and compact surface, but is generally a better road metal than pit gravel. A coating of pit gravel with a surfacing of creek gravel is a good combination All large stones should be removed, as they will work to the surface, and will then roll loosely or form rough protuberances.

PLACING THE GRAVEL.

The gravel should be spread evenly over the surface of the sub-grade to a depth of six or eight inches, and to the required width, then rolled with a heavy roller. Rolling should be performed in showery weather, as it is impossible to consolidate dry earth or gravel The heavier the roller the better will be the results, but if a heavy roller cannot be obtained, a light roller is much better than none The roller should be passed over the surface until the gravel or earth is so compact as not to be displaced and rutted by the wheels of a wagon passing over it with an ordinary load. The surface must be maintained smooth and hard, to shed water and resist wear Every municipality should have a roller, but whether one can be obtained or not the gravel should not be left in a heap just as it falls from the wagon. Spread it evenly.

REPAIRS.

Gravel roads already constructed will need repair. By the use of road machinery scrape the surface and cut off the corners, which will have formed at the foot of the grade by the washing down of dusty material from the crown of the road. Loosen the surface, particularly that part of the travelled portion and where the road is rutted, with picks, or, if possible, with road machinery, then apply a coating of gravel and roll thoroughly. It is of more importance, however, to see that the drains are not obstructed in their course and that their outlets are free and open.

MOTOR CYCLES IN ENGLAND.

BY W H. BOOTH, LONDON, ENG.

There is every appearance at present that the question of mechanically propelled road vehicles will soon be one of great prominence in this country. I have previously pointed out the limitations under which we have labored In the first place, no mechanically propelled carriage has been allowed to travel at a speed of over four miles per hour and secondly, it has been necessary for a man carrying a red flag to walk a certain number of yards ahead as a warning. In spite of this, and because of this also, we have seen a growth of the heavy traction engine, suited to haul heavy loads at a slow speed. Though so hampered by legal enactments, these traction engines are used to the number of 7,000, or one for less than every three railroad locomotives. But the new movement is almost wholly given to lighter vehicles for passenger purposes. The several trials in France of gasoline vehicles have given a great impetus to the motor car generally, and there have been several small exhibitions of them here, and there is one now n progress at the Imperial Institute, where not only gasolene motors are shown, but also electrical. No doubt, at present, for lightness and endurance, the gasoline motor holds the field for country work, but I very much doubt if it will do so in the cities.

It would scarcely be thought safe to allow gasoline motors using low-flashing-point oils, or rather spirits, to run about in London, because of the risk of fire. With the electrical car there is no risk. A vehicle of four wheels at the Imperial Institute, and with a seating capacity for four, does not, after all, weigh anything very much—perhaps a matter of 1,500 pounds. The accumulator cells which furnish the necessary energy are not filled with liquid acid liable to spill about and become a nuisance, but simply with some porous and absorbent powder which surrounds the leaden plates closely, and is saturated with acid. The cell can be turned upside down with perfect safety, and the car seemed to be capable of very good control, turning in its own length and running fast or slow at the will of the driver. The accumulator will store current sufficient to run forty miles, so that the car could always run between town and town wherever there was an electric light station. Indeed, in a country like this, where towns occur in the crowded centres from two to five miles apart, and in the country rarely more than ten or fifteen miles apart, the problem of day load for electric light stations will be to some extent in process of solution should the electrical carriage come much into use. At present the one great difficulty to overcome is that of the cells. Ordinary accumulator cells cannot be discharged at a rapid rate with safety to the plates. What is wanted is a cell that will discharge much more rapidly, so that a given weight of cell will turn out energy in shorter time. Thus equipped, a car would carry a much less load of cells in the proportion of the greater rapidity of discharge. It could not, of course, run so far on a charge, but that would, perhaps, not matter very much.

If we assume that, on an average, the use of a horse adds 100 per cent. to the length of a vehicle, it follows that the streets would be able to accommodate double the present traffic when the horses were removed, and that alone is an item deserving of serious consideration in places like London or New York, where traffic is simply a continuous procession of vehicles. There is, however, one important point that is usually overlooked, and that is, that it is far easier for a horse to follow its own nose than for a man to guide a vehicle by means of any mechanical gear. A very considerable degree of skill is required to drive a motor vehicle, or rather to guide it properly, whereas a horse is an animal of some intelligence and requires no skill to guide it. At slow speeds the guiding difficulty does not amount to much with the motor, but at higher speeds the lateral departure for a very slight angularity of front wheels is rapid and demands close attention. In driving a horse, all attention is concentrated on the horse at one point through a single medium. In driving a motor car, the mind has to attend to two distinct mechanisms—one through the left hand, namely, the regulating of the forward motion; the other through the right hand, namely, the guiding mechanism The most apt to require skill in the double art will probably be people who have been accustomed to use both hands upon different and distinct operations. A pianist, who has to employ two hands upon hammering out sounds depicted on entirely distinct lines, ought to be quick to acquire the requisite skill.

The popular imagination is being inflamed as much as possible, and a good deal of money will be squeezed out of the public for rotten enterprises in connection with motor cars. As an example of what is being attempted, an American is here and is figuring largely in an advertisement for an ærial torpedo to drop dynamite about in an unpleasant manner. There is a picture of a flying torpedo in an engineering paper, in full operation, the inference being that the thing is already accomplished. I fear that the man is trying to work off his double-spark business for all it is worth, and there is such a lot of idle money that any wildcat scheme to promise a fortune gets support; but it is as difficult as ever to get support for genuine paying undertakings, requiring only ordinary business push and attention to yield really good dividends.—*American Machinist.*

CHARLES MCKAY, a native of Truro, N S., who was engineer on the steamer "Telephone," was drowned at Vancouver last month.

SIR JOHN PENDER died July 7th. He will be remembered as being one of the pioneers in laying ocean cables, and through him Cyrus W. Field was enabled to bring to success the first Atlantic telegraph. He was knighted for his services in 1888.

THE SEWERAGE OF VICTORIA, B.C.*

BY E. MOHUN, CAN. SOC. C.E.

For over a quarter of a century after the capital of the Province of British Columbia had been laid out as a city, its inhabitants either failed to see the need of, or to provide for, a system of sewerage. Without the commonest precautions having been taken to guard the public health, the death rate was not excessive, and it is thought that the comparative immunity from epidemic disease was to a great extent attributable to the favored situation, and the purifying influence of the sea breeze, which almost invariably prevails for several hours each day. This fortunate state of things could not naturally last for an indefinite period; and as the soil became contaminated, and the waters of the harbor polluted by a constantly increasing deposit of filth, a demand arose for the construction of sewers, and the maintenance of the waters of the harbor in a reasonably pure condition. From 1885 to 1889 this demand occupied the attention of successive city councils. On two occasions by-laws were submitted to the ratepayers for the purpose of providing funds to build a combined system, but failed to receive the assent of the property owners. The author, with others, was opposed to the introduction of the combined system; firstly, because the site of the city, nearly surrounded by salt water, and sloping easily towards it, offered ample facilities for the discharge of surface water by its natural channels; secondly, because during the summer months the rainfall is so light that the sewers would not receive sufficient water to render them self-cleansing; and thirdly, because the expense of construction would be enormous if not prohibitive.

Considering that violent rainstorms are rare in Victoria during these months, and that the summer rainfall is generally made up of moderate showers at infrequent intervals, it is obvious that no useful supply from this source can be reckoned upon during the dry season. The great cost involved in the construction of large brick sewers, as originally contemplated, in a country where very inferior brick for such a purpose had alone been produced, and where it was well known that a large proportion of the necessary excavation would require to be made in a very hard trap rock, proved a powerful argument in the hands of the opponents of the combined system.

In 1890 the corporation called for competitive plans on the separate system, covering the area bounded by Cook street on the east, Bay street on the north, the waters of the harbor on the west, and the Straits of Fuca on the south. In response nine sets of plans were received, two from England, two from New York, three from Ontario, and two from British Columbia. Rudolph Hering, M. Can. Soc. C.E., was selected by the corporation to examine and report upon them, and it was the good fortune of the author to be awarded the premium, and the appointment of chief engineer, with E. A. Wilmot, M. Can. Soc. C.E., as resident engineer.

The better to elucidate the succeeding remarks, it will not be out of place here to make a few statements as to the general design and its construction.

The egg-shaped sewers which were constructed were of concrete, the smaller radius being in all cases three inches. A segment of a six-inch pipe was laid in each to form the invert; this was found a very useful arrangement, saving the green concrete from erosion and affording a firm support for the centreing of the arch. The pipes were the best quality of vitrified pipe, capable of standing all the usual tests. The joint was the well-known Stanford Joint, and was cast on the pipes at the corporation shed by the city workmen. The sewers were laid at sufficient depth to provide for the sewerage of basements.

An important condition of the competition was that no sewage should be discharged into the harbor; and the author believes that his was the only design which entirely fulfilled that condition. As a considerable portion of the suburb, locally known as "James Bay," lying to the westward of Beacon Hill Park, is not of an elevation to permit its drainage by gravitation except into the harbor, the sewage from that area is to be raised by Shone ejectors and discharged through steel rising mains into the system of sewers discharging by gravity. At the north end of Government street, and also near Point Ellice, are two low-lying areas, the sewage of which is to be similarly dealt with. With a view to the economical working of this part of the system, it was suggested that the compressors should be run in connection with the electric light plant owned by the corporation. It is to be regretted that this suggestion has not been considered, although new electric light works have recently been erected by the City Council.

The flow of sewage to be provided for was estimated upon the following assumptions: (a) That each individual represented a flow of five gallons an hour; (b) that each house represented five individuals, or twenty-five gallons an hour; (c) that each twenty-five feet of frontage in the closely built area, and each sixty feet of frontage in the residential, or suburban localities, represented a dwelling, or twenty-five gallons an hour.

A proportion of the roof water was to be admitted to the sewers, particularly at their upper ends. It was proposed to provide automatic flush tanks at the head of each sewer; and the Doulton syphon, which the author has used with success, was adopted. Man-holes and ventilators, which are also used as lamp-holes, provided for access, ventilation and inspection. The outlet works and the following lengths of sewers, viz:—

2' 10" × 4' 3"	concrete sewer	3,290	lineal feet
2' 4" × 3' 6"	" "	3,414	" "
2' 0" × 0' 0"	" "	2,640	" "
20"	pipe "	3,610	" "
18"	" "	4,750	" "
15"	" "	1,590	" "
12"	" "	2,000	" "
10"	" "	3,300	" "
9"	" "	7,730	" "
8"	" "	57,630	" "

together with 113 man-holes, 218 ventilators, and 66 flush tanks, were comprised in the first contract.

Prior to this a by-law to raise the sum of $300,000 for sewerage purposes had been approved by the ratepayers after an opportunity had been afforded them of inspecting the general plan. This by-law provided that three commissioners, the Honorable H. Turner, now Premier of the Province, Thos. Earle, M.P., and J. Teague, should have the sole control of the funds and the work. This proved to be a wise arrangement, as it prevented interference on the part of the aldermen with the contractor. It is a wonderful provision of nature that no sooner does the ordinary individual fill the office of alderman, than he becomes, in his own opinion at least, a thoroughly competent consulting engineer. With a few bright exceptions this was the case in Victoria. To the hearty co-operation and assistance the author received from the commissioners is to be attributed the complete success attained.

At Clover Point the outlet sewer, two feet ten inches by four feet three inches, terminates in a concrete house, in which the sewerage, after falling through a grating, is conveyed in a 22-inch steel pipe and discharged at a point below L.W.M., distant 240 feet from the shore. There is also a 16-inch steel overflow pipe, 120 feet long. Both these pipes are laid in and covered with concrete, the channel for them having been excavated in rock. It was the intention to protect the outlet ends of these pipes with gratings, but when in 1892 the Municipal Council terminated the contract, subject to a six months' term of maintenance by the contractor, two lengths of the 22-inch pipe still remained to be laid, and since then nothing has been done to complete this portion.

Leaving the outlet and following the 2 feet 10 in. x 4 feet 3 in. sewer upwards for 696 feet, the south end of the Moss street tunnel is reached. This tunnel had eight shafts, now converted into man-holes and ventilators, and was 2,038 feet long with two curves. Of this distance 921 feet were in earth, 319 feet in hard-pan and 798 feet in rock. Its depth below the surface is from 20 to 50 feet. From the north end of the tunnel the same sized sewer is continued to the intersection of Moss and Snowden streets, where it is joined by an 18-inch pipe from the east and a 12-inch from the north. At this point the sewer decreases to 2 feet 4 inches x 3 feet 6 inches (Fig. 2) and runs west to Cook street, where there is a large flush tank, thence it runs north to the intersection of Cook and Southgate streets; its length is 3,394 feet. Here it again decreases to a 2 feet x 3 feet (Fig 3) and is continued westerly, partly along a right of way purchased by the city to McClure street, a distance of 2,605 feet. The fall in these sewers is 1 in 1,200. At McClure street the James Bay 18-inch pipe and the Humboldt street 20-inch pipe connect with the 2 feet x 3 feet sewers. The latter from east of Gordon street to the intersection of Fort and Wharf street, is laid in a continuous rock tunnel. This main is 3,583 feet long to the corner of Store and Johnson streets, where the Store and Johnson street mains connect with it. The 18-inch Store street main is continued to the intersection of Chatham and Government streets, where the sewage from the low-lying area before referred to, enters it. Beyond this again the sewer is laid east and north, at various points receiving subsidiary mains. Returning to the intersection of Cook and Southgate streets, an 18-inch pipe has been laid on the former street to its intersection with View street; beyond this street it will be seen that several smaller mains and their branches are tributary

*A paper read before the Canadian Society Civil Engineers.

to it The residential district of James Bay, south of the harbor, is treated in a similar manner. Considerable difficulty was experienced in the alignment of the pipe sewers, large fire tanks were found sometimes in the middle of the street, sometimes at the sides, water and gas pipes erratically wandered from side to side, old box drains, some running, some choked with filth, were continually encountered, blasting was frequently necessary within a few feet of these obstructions, and it speaks well for the care and vigilance exercised by the contractor that in no instance was any damage done to water or gas mains.

The principal quantity of concrete used was, of course, in the construction of the egg-shaped sewers and man-holes. This was in the proportion of 2½ shingle, 2½ sand, and 1 best English Portland cement. The shingle and sand were both from the sea beach and were perfectly free from impurities. Very great care was exercised in mixing. On a roomy platform a rectangular frame, without top or bottom, was placed; in this was deposited 2½ barrels of shingle, which was spread to an even depth; on this 2½ barrels of sand were similarly spread, the two layers aggregating 6 inches in thickness; on top of the sand one barrel of cement was evenly spread, and the frame removed; the whole was then turned over with shovels two or three times while dry till thoroughly mixed, after which the turning was continued, while water was gradually added through a rose nozzle until a sufficient consistency was attained, when it was immediately wheeled into place, deposited on thin layers and immediately rammed. All surfaces unfinished at the close of the day were left rough and porous, and well grouted on the resumption of the work During the construction of the concrete sewers malicious reports were constantly being circulated to the effect that the sewers were leaky, that the grades ran in the wrong direction, etc, yet, upon the completion of the work, when men were sent through for the special purpose of detecting any flaws, it was found that the sewer from invert to springing line was a monolith 9,244 feet long without crack or flaw, at the junction with the arch a few small leaks were discovered which were easily stopped with a little cement As the ground water was higher than the crown of the sewer, it is thought impossible that a leak in the invert or sides should have remained undiscovered.

The method adopted in building the concrete sewers was as follows.—

In earth the trench was excavated four inches wider than the outer measurement of the sewer, and nine inches below the level of the invert, and the sides planked with two-inch lumber. In fine sand a plank bottom nine inches below the invert was also placed. In rock or hardpan the planking was altogether omitted, and the concrete was in this instance to be not less than six inches thick.

In the bottom of the trench the concrete was well rammed to a sufficient height to allow the channel pipe to be laid with absolute accuracy, both as to grade and alignment, lightly resting on the channel pipe, and secured to the planking on each side, moulds shaped to the lower section of the sewer were placed, and the concrete well rammed between them and the plank wall with a T-headed iron having a slightly curved handle. These moulds were allowed to remain thirty-six hours; that is to say, the moulds placed on Monday would be removed on Wednesday, another set being used for Tuesday's work. Upon the removal of the moulds the surface was rendered perfectly smooth with two to one cement mortar, after which centres for the arch, resting on the channel pipe, were placed, and the top of the walls having been well grouted, the work was carried on in a similar manner. In order to give some employment to Victoria brick-yards it was originally proposed to build the arch of radial brick, but the difficulty of obtaining thoroughly good material caused this plan to be abandoned, after between 1,700 and 1,800 feet of brick arch had been built, and concrete was substituted. As the work proceeded water was pumped into the sewer to prevent the concrete drying too rapidly. The concrete for the man-holes was handled in a similar manner. It may be stated that the man holes and flush tanks were made rectangular to save the heavy carpenter's bill which would have been incurred in making oval or circular moulds, as many different ones would have been required, the man-holes varying much in size and shape, particularly on the main sewers By using the rectangular form the frames of rough plank could be set by common labor, and, if not used again for the same purpose, could be utilized in timbering trenches, etc.

In rock trenching the excavation was carried down six inches below the invert, and the bed brought to its true grade with 14 to 1 concrete. When unsound ground was found in the bottom of a trench, it was, with the exceptions hereafter noted, removed and replaced with 14 to 1 concrete. In 1890 a company was engaged in the vicinity of Victoria in the manufacture of drain pipes, etc., but at that date had not placed any sewer pipe on the market. This company, however, contracted to supply the pipe required, partly from its own works and partly from San Francisco. The pipes were delivered by the company at the corporation yard, when they were culled, tested, provided with the Stanford joint, and delivered to the contractor's teams. To show the small probability of a defective pipe reaching the sewer, let us trace one through the ordinary course. Having been delivered at the yard, it was accepted or rejected, if the former, it was stacked, if the latter, it was carted away or broken up. Its next appearance was in the pipe shed, where the joint was cast on it, and if thought a little inferior it was placed on one side to be used in the ventilators, after which it would be ready for delivery to the contractor. On its arrival at the trench it would be again examined by the inspector on duty before it was laid. It is confidently believed that there are no damaged pipes in the sewers, with the exception of a few slightly cracked large ones, which, having retained their shape, the contractor was permitted to surround with concrete. (Trans. Can. Soc. C.E., vol. viii., part 1.)

The Stanford joint, first introduced by the author on the Pacific Coast eight years ago, is so well known that it is needless to describe it. The kettles for boiling the tar, to evaporate the ammonia, and for melting the "compo" ready for casting, were heated by gas at a cost for each of about 13½ cents a day. The "compo" was made of crude rock sulphur, clean sharp sand (not sea), and coal tar. The proportions of the materials varied with the size of the pipe, a greater proportion of sand being used for the larger sizes than for the smaller. An average mixture would probably be about four of sulphur, six of sand, and one of tar by measure. The cost, owing to various circumstances, proved larger than was anticipated, but the results have proved so satisfactory that the author would not hesitate to employ the same joint again. It must be remembered that the cost of laying is less than when a cement joint is used, that a defective pipe can be removed and replaced, or a junction substituted for a straight, or an absolutely water-tight joint made in a wet trench, or under water, with reasonable care, and with great rapidity. No separate account was kept of the time occupied in jointing, and that spent in receiving, culling, testing, and delivering; but the author is under the impression that one-third of the cost of the yard may reasonably be deducted for the latter Upon this basis the following would approximate the cost of jointing per lineal foot of pipe, viz.: 8 inches, 6½ cents; 9 inches, 7½ cents; 10 inches, 8¼ cents; 12 inches, 10 cents; 15 inches, 12¼ cents; 18 inches, 15 cents; and 20 inches, 16½ cents. The contract prices for laying was 6 cents for 8, 9, 10, 12 and 15 inches, and 10 cents for 18 and 20 inches per lineal foot; this price included loading, hauling, and unloading.

Man-holes have been placed at all junctions of sewers, and at all changes of direction, whether horizontal or vertical. In leading the subsidiary into the larger stream the former follows a curve, the radius of which is five times the diameter of the sewer, and the tangents of which are the directions of the two sewers. The invert of the smaller sewer is in all cases raised above that of the larger, and the fall is slightly increased on the curve to compensate for the increased friction. At the outlet of each man hole a flushing groove provides for the accumulation and instantaneous discharge of a considerable volume of water or sewage, should a flush be required. The inlets in man-holes are provided with vulcanite flap valves. All man-holes act as ventilators, being provided with perforated cast iron covers, beneath which are suspended dirt trays. Through these covers access is obtained to the sewers, step irons of the usual description being built into the walls.

Ventilators, which also act as lamp-holes, are provided at not less distances than 300 feet They consist simply of a vertical pipe, proportioned to the size of the sewer, but in no case less than eight inches in diameter. The pipe is surrounded by seven to one concrete, three feet square, the surface of which is one foot below the level of the street, on this stands a cast-iron curb, fitted with a perforated cover, the top of the pipe rises six inches above the concrete, and is protected by the unperforated part of the cover. Dirt falling through the cover drops upon the concrete, whence it is easily removed, while water drains off under the curve.

It will be remembered that provision was made for an automatic flush tank at the head of each sewer. Were the author in charge of the works at the present day, it is probable that many of these tanks would be dispensed with as not vitally necessary to the efficiency of the sewers, at all events at points where the upper ends of the sewers could be connected with the hydrants. On this subject the reader is referred to a paper by Mr. Odell, published in Trans. Am. Soc. C E., Volume 34, No. 3. The tanks, however, are economical in construction and in consumption of water, while from their position they benefit those portions of the sewer receiving but small and intermittent supplies of sewage. One large flush tank has been constructed for flushing the egg-shaped sewers when necessary. It is furnished with an ordinary tilting flush gate having an area of 6½ square feet and discharging 2,800 gallons If thought advisable, this tank could be easily rendered automatic.

When, as is frequently the case, the main sewers are considerably below the depth required for a branch, the latter has been laid at its proper depth and connected with the former by a ramp.

JOHNSON STREET RAVINE

In crossing the ravine on Store street, it was found that a hollow about 50 feet wide and 25 feet deep had been filled with earth and rubbish. It was considered advisable to carry the 18-inch main across it on a concrete rib. Near the uthern side of the ravine the filling was penetrated by an old brick culvert three feet four inches by five feet; the filling round this was removed and replaced by concrete forming the southern abutment thirteen feet long and three feet wide; the northern abutment was three feet five inches long and of the same width; a central pier six feet six inches by three feet divided the rib into two spans of nineteen feet six inches each in the clear, having rises of one-tenth the spans. At the crown the thickness was two feet; on this the 18-inch pipe was laid in fourteen to one concrete, up to the haunch.

The centreing was made of one-inch plank sprung to the curve and securely spiked to cross scantlings affixed to the side planking of the trench. The View street bog is a quaking peat morass about 700 feet long and 20 to 25 feet deep. This was crossed on piles driven in pairs supporting a plank floor on which the pipe was laid in concrete. At the end of the first three months a slight settlement, about 3½ inches, if the author's memory is correct, was found to have taken place; but as in the following six months no further change could be detected, and the lights in the lampholes could be seen from the manholes, it was not thought necessary to take steps to bring it to its true grade. The Snowden street sewer, 2 feet 4 inches × 3 feet 6 inches, passed through a water-charged running sand, which necessitated lining the trench with plank floor and sides, and keeping a powerful centrifugal pump constantly running. Below the level of the sewer a small box drain was run to a sump at the pumping engine. After this no difficulty was experienced in construction. The Humboldt street sewer was laid, as stated before, for a considerable distance, some 1,200 feet, in a rock tunnel: the bottom was excavated six inches below the level of the invert of the pipe, which was laid in 14 to 1 concrete. Access to the tunnel and its drainage was provided for at the man-holes. At all points where junctions for house sewers were, or were likely to be required, a side trench was blasted out for about five feet before the main was laid. In making the connections, the main is protected by sacks of earth from the effect of shots until the trench or tunnel is ready for the reception of the house pipe. No difficulty has been experienced hitherto in making these connections, nor has any injury resulted to the main,

HOUSE CONNECTIONS.

Curved junctions for pipe and slants for concrete sewers were placed at all points where house connections were, or were likely to be, required The upper ends of these junctions were at such a level as to preclude an overflow of sewage through them unless the sewer itself became choked. As many of them were not required for immediate use, they were provided with earthenware stoppers, through which the ground water was allowed to percolate into the sewers; this was considered advisable, since the system was designed for a considerable add''on to the existing population, and it was thought that the small amount of sewage available could hardly be depended upon to render them self-cleansing. At each junction a piece of 2 × 2-inch scantling was brought up to the surface.

In order to have a trustworthy record of the positions of the junctions, plans on a scale of 50 feet to one inch were prepared, showing all man-holes, ventilators, flush tanks, and junctions, with the measurements of the last from fixed points On these plans are also shown all buildings, with the position of the house pipes, and the points at which they enter the buildings to connect with closets, baths, sinks, etc. They also show the nature of the subsoil, whether earth, hardpan or rock. The drainage of basements, and the admission to the sewers of subsoil water, and the exclusion of sewage from the basement drains was a matter which received serious consideration. To attain the foregoing results a special trap was designed, which so far has been found to answer the purpose. This trap is sometimes placed under the sidewalk, sometimes in the basement in a sump hole below the level of the floor, in which the subsoil water is collected. Its body is of cast-iron; it is provided with ventilator and fresh air inlet; the subsoil water enters through a brass flap valve with ground faces. The valve can only open to admit the subsoil water when the head exceeds that of the sewage pressing against its inner side. To prevent foreign substances entering the trap through the valve a fine grating is provided, indeed the author has suggested that in addition to the grating the water should pass through a filter of small shingle. Several of these traps have been in use for the past two or three years, and it is believed have given general satisfaction. The method of hanging the valve has proved simple and efficacious. The flap is suspended from two hooks, which allow it a slight horizontal play, so that when pressure is applied from the inside, the ground faces are immediately brought into close contact.

ABSTRACT OF COST.

Excavation other than trenching ....$	3,225 14
Filling	891 06
Trenching, tunnelling and back filling........	106,371 85
Concrete	62,207 40
Bricks, radial in cement	3,659 12
Pipe laying and haulage	2,524 51
Timbering left in trenches, tunnels, etc.	9,037 75
Cast iron....................................	6,307 52
Wrought iron........	1,237 45
Steel pipes	1,377 00
Vitrified pipes	28,325 09
Sundries	126 35
Purchase of right of way	3,044 37
Two man-holes, 3 vents, 1 flush tank, additional	1,023 00
	$229,958 01

The cost of the pipe shed, 80 feet by 40 feet, and plant, and fencing the yard, 180 feet by 160 feet, was $1,711 53. The ground was rented by the corporation at $240 per annum.

The following table shows the percentages under the different classifications, together with the total and average cost per lineal foot of trenching, tunnelling, and back filling. The average is in earth 77 4, hardpan 1.7, rock 20.9 per cent. .

Sewer.	Length in feet.	Percentage. Earth.	Hard-pan.	Rock.	Average cost per foot.	Cost.
2' 10" × 4' 3"	3,245	47	16	37	$8 69	$28,202 40
2' 4" × 3' 6"	3,394	100			0 74	2,517 96
2' 0" × 3' 0"	2,605	100			0 65	1,686 90
20"	3,837	35		65	10 20	39,131 42
18"	5,027	82	1	17	3 01	15,146 00
15"	1,342	88		12	1 28	1,711 90
12"	1,977	100			0 73	1,447 13
10"	4,428	84		16	1 45	6,429 73
9"	926	47		53	3 35	3,105 79
8"	7,944	91		9	0 88	6,992 52

Of the excavation for man-holes, etc , the rock amounted to 18 per cent.

BRITISH COLUMBIA.

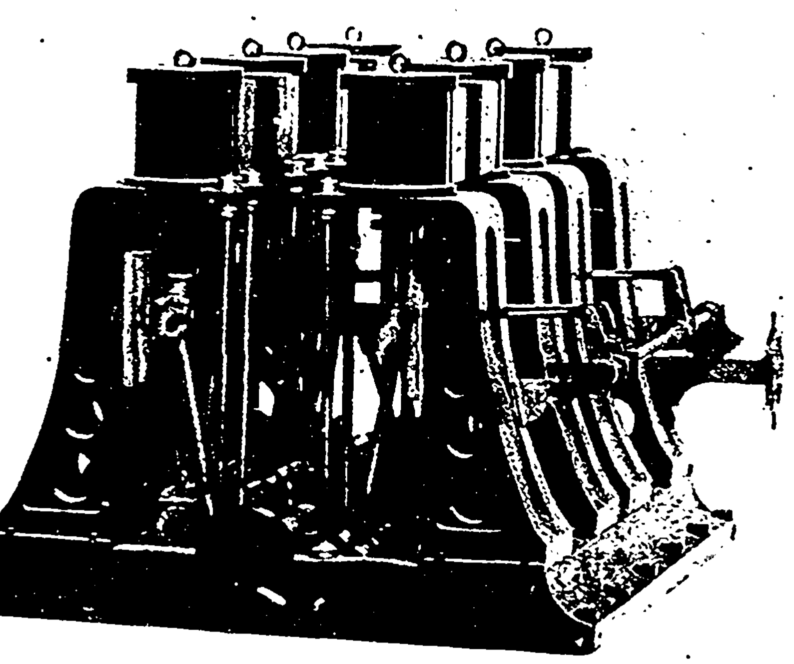
The attention that is now being paid to British Columbia as a promising and safe field for the investment of capital in mining enterprise is fully warranted by the past few years' development work carried out under great difficulties. These difficulties have consisted firstly, in the inaccessibility for many months in the year, under ordinary conditions, of some of the best mining territory, and secondly, even in the summer months, want of continuous communication by water and rail. The latter obstacle is being rapidly overcome, and the most important camps before snow comes again will be in much better shape for regular shipments and at fair freight rates, instead of those they have hitherto experienced. The former drawback, viz., that of a long and severe winter, cannot be changed, but it will be materially mended in the future by the railroad extensions now being carried out, and which will be kept open just as are the Canadian Pacific and other northern roads.

Trail Creek, with Rossland for its central point, has made already a remarkable record; in 1894 the total value of ore shipped was $125,000, coming from three mines; while in 1895 the value of the shipments was more than $1,000,000, and to judge from work now going on and shipments already made, it would not be surprising to see an aggregate of $4,000,000 during the present year. Smelters are in successful operation, which will aid development materially, as hitherto only the higher grade ores have been able to stand the expense of freight, smelting charges and in some cases duty, by shipping to Helena, Tacoma, Kansas City and Omaha. Nelson is also showing up as a most prosperous centre, to which the properties of the Hall Mines, Limited, most decidedly contribute in an important degree. The cost of fuel is not prohibitive, and the Hall Mines Company is sensible in matting its product before shipment, and we have no doubt that the example of this company will be followed by others, and that both cost of treatment and freight to market will thus be materially reduced owing to increased and heavy tonnage over the railroads.—*The Engineering and Mining Journal*

For The Canadian Engineer.

MULTI-CYLINDER AND MULTI-CRANK STEAM ENGINE.

We present our readers in this issue with an engraving of a type of steam engine, the invention of Wm. Golding, of New Orleans, La., and described by him as follows: Upon a common bed-plate there are erected eight standards, upon which are placed as many cylinders, through the bed-plate there runs a central shaft. At the four corners of the bed-plate there are four smaller shafts, which have a crank on either end, which are placed at right angles, thus constituting four pairs of engines, each pair having cranks at right angles to each other, and forming a succession of cranks in eight consecutive positions, a division of the circle into eight parts. The four pairs of engines actuate the main shaft by means of two sets of gear wheels, all of same diameter. The bed-plate is ten feet long by five feet wide; from the bottom of bed-plate to the top of cylinders is six feet. The total weight of the combination is ten thousand pounds. The cylinders are ten inches in diameter by twelve inches stroke.



Multi-Cylinder.

This combination is said to have developed by brake test two hundred horse-power without any sign of strain or heating of the journals, and during continual service develops in actual work performed one horse power for one and three-eighths pounds of coal per hour, taking steam from a common return tubular boiler. The actual work referred to was the lifting of 500,000 gallons of water one hundred feet high, during continuous service, with 350 pounds of coal per hour.

In this system the steam is cut off in each cylinder at one-eighth of the piston travel, each cylinder receiving and exhausting, independent of each other, but not into each other, as in compound engines. There is no fly-wheel, none being required; the revolution is perfect, whether revolving one revolution or two hundred. It is claimed that when working under the brake test the engine may be stopped and started without slacking up the clamps and without any external assistance.

The economy of this engine is due to the fact that the rotative effect is being made simultaneously from eight parts of the circle.

The Niagara Falls Power Company was recently visited and inspected by Nicola Tesla, Edward D. Adams and William B. Rankine, of the Niagara Falls Power Company, and Paul D. Cravath, New York; George Westinghouse and H. H. Westinghouse, of the Westinghouse Electric Company, of Pittsburg; George Melville, Chief Engineer of the United States Navy, and Theodore N. Ely, superintendent of motive power on the Pennsylvania Railroad.

NEW IDEAS.

TESTS ON PILES.

In *Machinery* for July, S. Ashton Hand gives some interesting data on piles driven into hardpan. Comparison is made between piles with conical cast iron points, pyramidal cast iron points, and unshod piles. The penetrations were respectively 8 feet, 10 feet and 9 feet, with the same number (300) blows. The piles were then pulled out, and in doing this the unshod piles gave much higher results, showing that the brooming of the point had helped to lock the pile in place.

HOLLOW SHAFTING.

In an editorial in *Machinist* for July 2nd, the prediction is made that hollow shafting will soon replace solid; this is based on the statement that keys do not help to keep pulleys from turning, but that it is the friction on the cylindrical surface which is the chief factor, and that this can be caused by clamping on by bolts better than by keying; this would do away with the chief difficulty in the use of hollow shafting by removing any tendency to distortion. The manufacture of seamless tubes by the Mannesmann process makes the manufacture of hollow shafting practicable, and should this kind of shafting be found feasible, a great advance will be made, as the torsional value of metal varies as the fourth power of its distance from the centre, thus effecting a great saving of metal.

NEW LUBRICANT FOR CAR AXLES.

The Prussian State Railways have invented a new lubricant composed of a mixture of oils and fats which lessens the expense of lubricating car axles about one-half. The composition costs the Prussian Government fifteen cents per pound, and the consumption is only twelve grains per car, per 100 miles; there is also an economy in attention, as it requires renewing only once every 5,000 kilometers (3,500 miles) run, and it is also much cleaner, not dripping as our ordinary oils do. The method of application is that of top, bottom and front impregnated cushions made of some shoddy felt material, the remainder of the space being filled in with the composition.

ADULTERATION OF ENGLISH PORTLAND CEMENTS.

The report of Dr. W. Michaelis, the eminent German cement expert, to the London Chamber of Commerce, shows by an elaborate series of tests that the addition of Kentish ragstone (an argillaceous limestone) to English Portland cements is as bad in fact as any one with knowledge of the chemistry and action of cements in general might expect, and as the using public has suspected. While the addition of 15 or 20 per cent of any coarse, hard adulterant does not affect neat tests, the sand tests made on the adulterated article gave much lower results than those with pure cement and sand. This will, we hope, put a quietus on those dishonest manufacturers who, relying on neat tests to justify them, have produced this inferior adulterated article for some years past.

X-RAY LIGHTS.

Tesla and Edison seem to have about perfected a light produced by Crooke's tubes, in which the vacuum—a high frequency current and a fluorescing substance—give a brilliant light of high candle power. Pine knots, tallow dips, kerosene oil, gas, incandescent lights—X-ray lights. What next?

ELECTRIC WEEDING.

Weeds along the Illinois Central R. R. were electrically killed by means of a wire brush conveying the current to them from a dynamo mounted on a gondola, the return circuit being through the rails. The weeds during the day following the application showed no signs of change, but afterward were dried up and quite dead.—*Electrical Engineer*

BEST INSULATION.

Recent experiments have proved that ordinary red paper is a better insulator than cotton or linen fabrics, under a variety of conditions.

RESISTANCE OF BISMUTH

When placed in a magnetic field, the resistance of bismuth is materially increased; and if, under these conditions the metal is cooled to 186° C., its resistance is 46 times greater than at ordinary temperature — the above temperature being obtained by immersion in liquid air.—*Electrical World.*

DIRECT CONNECTED GENERATORS IN ENGLAND

Mention is made in the various English journals of the installation of the first direct connected generators used in railway work there. The plant is at Hartlepool, and includes Willans engines and overtype dynamos, the engines being placed on a pedestal to permit of coupling the shafts.

MULTIPLE EXPANSION ENGINES UNDER SMALL LOADS.

Contrary to popular opinion, Prof. Durand has found that multiple expansion engines are more efficient under small loads than compound; the change of view has been caused by the more intelligent analysis of the various losses from the coal pile to the electric generator.—*American Electrician.*

LAMP EFFICIENCY.

According to Palaz, the light-efficiency of the incandescent lamp is three to five per cent., and of the arc light about fifteen per cent.—*American Electrician.*

HIGH VOLTAGE IN LIGHTING.

The tendency to higher voltage in every branch of the electrical business has been followed in the use of 220-volt incandescent lamps. Their efficiency are slightly less than 110-volt lamps, but an advantage is gained that less trouble is had with consumers. The fire risk is not greater with the higher voltage, provided proper attention is paid to fittings. Cut-outs appear to act more suddenly and certainly at higher voltages. Anchored double filaments are the best for long life, and there has been less blackening of the glass. Only two plants utilizing them are in operation in America, but England seems to lead in the adoption of the higher voltage.

GARBAGE DISPOSAL.

The tendency of modern practice in European cities for the disposal of city refuse is growing towards cremation as the safest and least expensive method, says the *Engineering News.* The city of Hamburg, directly after the terrible cholera epidemic of 1892, found itself placed in a peculiar and trying position. On account of the danger of infection from cholera germs which might be lodged in the garbage and house refuse, nobody could be found who was willing to receive it, as had been done before; and the city was therefore driven to provide some means for speedily and economically getting rid of it. Destruction by fire offered them the only solution, and as a result their present efficient and compact plant was evolved from the studies made under the direction of their chief engineer, Mr. F. Andreas Meyer. At the time of my visit to this plant, in November, 1895, only six cells were in operation, but the results from these were so encouraging that thirty new cells were under construction, and, I understand, have since been finished.

Many other continental European cities are debating this question, and watching the results of the Hamburg and Berlin experiments.

In Great Britain destruction by fire is the universal practice for the inland towns and for many seaports as well. There are more than 47 towns having destructors, with a total of over 500 cells. The list cannot be made complete, as many of the plants are constantly adding new cells as they are needed. Manchester has 68 cells;* Leeds, 50 cells; Birmingham, 37** cells; Bradford, 35, and so on.

*Some of these are Galloway boilers in which they burn mechanically sorted refuse, for steam power.
** In 1894.

The Hamburg plant is one of the largest garbage destruction plants in the world, and has a greater number of cells in one combination than any other.

The experiments in Hamburg, the results of which are not yet made public, promise to be very interesting and valuable. They go into the determination of the proper dimensions to be given to the various parts of the furnaces and flues to produce the best results. They include, among other things, a determination of the quantity of air required for the combustion of a ton of garbage, pyrometer tests and anemometer and barometer tests of the draft below and above the grates, as well as in the flues and stacks; also the relative efficiency of combustion with steam draft and with air blast. With either of these forms of artificial draft the quantity of oxygen supplied to the fires can be regulated at will, the difference between the two being in the amount of moisture supplied with the draft.

The process of burning is entirely chemical in action, and is most complete when the conditions are proper for just a sufficient supply of oxygen to the fire and when the sections of the furnaces and flues are just sufficient to remove all the products of combustion as they are formed. It is the province of the Hamburg experiments to determine some of these factors, so that the designing of destructors may be based on scientific investigation.

The Hamburg destructors are built by the Horsfall Company, under their patents, and embody many improvements suggested by the Hamburg authorities, as a result of their studies.

In the article referred to above, the analysis given in the first Berlin progress report, for English refuse, might be considered as representative of the composition of the average ash-bin refuse of England. It is the analysis made by Professor Forbes of the Paddington refuse. Below is given Joseph Russell's* analysis of the average composition of the London ash-bin refuse, which I have arranged in the same manner as that given in the Berlin analysis, for purposes of reference; it will be seen that the London refuse is exceedingly rich in the products of imperfectly burned fuel; even more so than that given in the Berlin report for English cities:

Coal and coke	.84
Breeze (cinders and ashes)	63.69
Paper	4.28
Rags	.39
Bones	.48
Straw and other fibrous material	3.22
Vegetable, mineral, etc	4.61
Fine dust	19.51
Broken glass	.47
Iron	.21
Broken crockery	.55
Tins	.79
Bottles	.96
	100.00

The city of Leeds, in June, 1894, made a series of interesting tests of their destructors to determine their capacity and what it would cost to burn different quantities of garbage per day.

The results of these tests are set forth in a very interesting paper read before the Public Medicine Section of the British Medical Association, August 2nd, 1894, by J. Spottiswoode Cameron, M.D., D. Sc., etc. It was published in the *British Medical Journal* and also in *Public Health*, November, 1895.

A short abstract from this paper may not be uninteresting here. Before giving this extract, however, it may be well to state the disposition which they make of the different classes of city wastes. The horse droppings on the streets are largely cleaned up by farmers' lads sent in for the purpose. Each has a small cart and a pan and brush, and the city allows them the privilege, without cost to either party. What these lads do not collect the city gathers up and mixes with the stuff from pans and closets and sells it for manure. The sweepings from the paved streets they take to certain localities and stack in piles to use as a binding material for the surface of newly macadamized roads. Sewage sludge they pump into piles about 50 x 60 and 2 feet deep, surrounded by an earthen embankment. The water is allowed to drain, and then the farmers come in and take the sludge away. The city used, formerly, to get five shillings a ton for this partially dried sludge. After a while they were glad to get one shilling for it, then sixpence, and now they are glad to be able to get rid of it without expense. The ash-bin refuse is taken to the destructors and burned, together with the refuse from markets and manufactories. The sorting of the ma-

* In a paper read before the Sanitary Institute, Feb. 11, 1892.

terials at the destructors is done by hand, and consists merely of removing the pieces of iron and other large incombustible materials.

The following is a description of the cells in which the tests were made, taken from Dr. Cameron's paper;

"The cells are placed back to back and fed from the top. The material passing over a bull-nose division to the two sets of cells, passes on to the concave side of an arc of a circle of fire brick. At the lower part of the curve the material reaches the fire-bars. These are sloped at an angle of about 30°, and have an area of 7 feet wide by 5 feet long. The walls of the furnace are lined with fire-brick, and just above the bars a strip of iron is fixed, but not in contact with the brickwork, to prevent the clinkers from fusing into the latter."

Underneath the fire-bars steam jets are introduced, two to each cell. These jets are made of two frustums of cones joined at the small ends, at which point they are 6 inches in diameter; at the larger ends they are 9 inches in diameter, the total length being 3 feet. The jets of steam vary in size from ⅜ inch in diameter to ½ inch, with the boiler pressure of 60 lbs. per square inch. Dr. Cameron continues as follows:

EXPERIMENTS IN 1894 WITH DESTRUCTOR CELLS AT LEEDS, ENGLAND, BY MESSRS. DARLEY & PUTMAN.

(Area of grate bars, 7 x 5 feet; jets, 2 to each cell, pressure, 60 lbs.; wages at rate of 5 shillings for 8 hours.)*

Date	No. cells.	Duration experiments, hrs.	Diameter steam jets.	Frequency clinkering once in.	Tons burnt.	Temperature flue.	Men employed.	Wages firemen.	Tons burnt (per cell day)	Men employed (per cell day)	Wages paid (per cell day)	Wages per ton burnt (per cell day)	Clinker.
1. June 12..........	4	12	⅜-in.	2 hrs.	20.4	1,500°F.	3	$3 75	10.20	1.5	$1 87	$0 17	36.5%
2. June 13..........	4	12	None	2 "	16.5	1,050 "	3	3 75	8 25	1.5	1 87	0 21	35.5%
3. June 25 and 26 ..	4	24	½-in.	1 hr.	63.1	2,000 " †	12	15 00	15.78	3.0	3 75	0 23	35.4%
4. June 26 and 27 ..	4	24	½-in.	1 "	60.15	2,000 " †	12	15 00	15.04	3.0	3 75	0 24	32.2%
5. June 27 and 28 ..	4	24	⅜-in.	1 "	54.35	1,500 "	12	15 00	13.59	3.0	3 75	0 26	37.0%
6. June 28 and 29 ..	2	24	½-in.	½ "	53.50	2,000 " †	12	15 00	26.75	6.0	7 50	0 27	35.9%

*Figures for cost have been reduced to American money by allowing 25 cts. per shilling, and 2 cts. per pence. The tons are doubtless long tons. †Frequently 2,000° F., i.e., melted copper.

"In 1891 experiments were made at the Kidacrestreet destructor to ascertain, amongst other things, what the difference in temperature was with the steam jets and without, with the following result. The experiments extended over two periods of 24 hours each, similar material being used on each occasion (19 hours dry ash-bin refuse and five hours wet ash-bin refuse), and temperatures taken hourly. It was found that the ten cells burned 6.2 tons per cell without, and 6.7 tons per cell with steam jets. The same number of men were working in each case. The temperature without the jets averaged 1,118° F., counting three observations when the pyrometer index touched its maximum as 1,500° F. With the jets the average was 1,464° F., but these included 17 observations when the pyrometer could register no higher. It is possible that the excess of temperatures of 346° F. would have been more like 500° if we could have registered it."

These temperatures are presumably in the cells, although the record of the experiments does not say so.

In Liverpool, H. Percy Boulnois writes me that a set of temperatures recently taken in his destructors gave the following values:—

	Degrees F.
Temperature in the cells	900 to 1,000
In flue close to cells	900 " 1,000
In flue before cremator	600 " 700
In cremator	1,500 " ....
In base of chimney	675 " ....

They have a natural draft only, from a tall chimney.

Quoting again from Dr. Cameron's paper on the tests at Leeds —

"The amount of work done by our destructors in 1894 was equivalent to the burning of 63,132 loads of rubbish, weighing 65,151 tons.* Some of the cells were not working full time, but the quantity named was burned in 11,644 cell-days, which is equivalent to nearly 5.6 tons per cell per day."

The experiments made in June, 1894, by Messrs. Darley & Putman, at the request of Mr. Hewson, City engineer, were conducted under the following general conditions:

"The furnaces . . . had a grate area per cell of 35 square feet were in full go, and were clinkered immediately before the commencement of the tests. The tipping floor was cleared; all the material placed upon it afterwards was weighed, the material at the end of the experiment being weighed and deducted from the gross amount placed there. The clinker removed was also weighed, but no computation was made as to the increase or decrease in the amount of flue dust. The experiments lasted for either 12 or 24 hours each, and ended with a clinkering of the cells. The wages were calculated at the rate of five shillings per working day of eight hours. The steam jets (used in all experiments but one) were two for each cell.

"The general lesson from these experiments, not carried out for the purpose of exploiting any patent, but merely to test our own existing plant, is to the following effect: 'The amount consumed per cell increases with the frequency of clinkering, but the cost per ton burned is increased at a more rapid ratio. The frequency of clinkering can be rendered practicable by increasing the rapidity of combustion. This can be done by steam jets, and the most frequent clinkering and the greatest amount burned per cell was accomplished with two ½-inch jets at 60 lbs. boiler pressure. The cost in firemen's wages, however, in obtaining these tremendous results (26¾ tons per cell, per day) was nearly 53 per cent. higher per ton burned than when the clinkering was every two hours and the consumption ten tons per cell per day. It must also be added that the wear and tear of the plant is much greater at the higher output, though exactly in what proportion the experiments do not enable us to say. On the whole, the high output method of working the destructors is not economical.'"

The writer visited these works (Leeds) last December, and was informed that the most economical rate of combustion appeared for them to be about 6½ tons per cell per day, but that the rate would vary greatly with the varying composition of the refuse. On market days, for instance, it would not burn nearly so well as when it was ordinarily dry and contained much coal. The stuff which they were called upon to dispose of varied considerably; sometimes they would have large quantities of spoiled canned goods and occasionally large quantities of condemned meat. On one occasion they had a lot of condemned hogs which they put into the furnace whole. They burned very rapidly, a whole hog disappearing into ashes in about half an hour.

In Cambridge, England, the writer visited the new destructors built under the direction of John Wood, C.E., of Liverpool. These furnaces are remarkable in the results obtained in the development of power from the burning of garbage. It must be said that the composition of the garbage is very favorable for such purposes, containing, in the writer's opinion, a large quantity of paper, straw, rags, wood, unburned coal and cinders. The destructors are arranged so as to develop the greatest possible heating qualities for the purpose of generating steam, to pump the sewage of the city to the farm, two miles distant, where it is spread over the surface. The destructors are alternated with Babcock & Wilcox boilers in such a manner that each boiler has two destructors to furnish it heat. Cremator fires can also be built in the fire-boxes under the boilers, in order to destroy the unconsumed gases resulting from the loss of heat in heating the boilers and to supply extra heat for the boilers if necessary. The work which they get from their plant is sufficient at present to pump 1,250,000 gallons of sewage per day, with a lift of 40 ft. The pumps are in duplicate, made by Hawthorne, Davey & Co., of Leeds, and are of about 70 h.p. each. They

*This is equivalent to about 325 lbs. of refuse per person per annum.

run now on 50 lbs. steam pressure, which is generated by the heat from two destructors. They run the pumps in two shifts of six hours each per day. They do not get enough garbage at present to run all day and night too, and so they are obliged to use coal under the boilers at night, until the morning collections come in. The cells are fitted with Boulnois & Brodie's patent charging cars. They burn from eight to ten tons per day per cell, with forced draft, supplied by a fan blower forcing air under the grates. They develop about 30 h.p per cell in this way. Southampton also has recently made plans for increasing its present destructor plant with four new cells arranged on the same lines as these Cambridge destructors, and they are anticipating an addition of 120 h.p. therefrom.

THE LATE WM. HASKINS, MEM. CAN. SOC. C.E.

The late Wm. Haskins was born May 29, 1828, at Coolkeno Hall, county Wicklow, Ireland. He was a son of Abraham Haskins, who came from England and settled in the county of Wicklow, and Margaret Fitzmaurice, daughter of Col. Fitzmaurice. Her father and three brothers were military and naval officers: her youngest brother, James, the late Commander Fitzmaurice, having served under Lord Nelson at Trafalgar. Mr. Haskins was educated in Dublin, Ireland, where he studied his profession of civil engineer at Trinity College, under Sir John McNeill. In 1852 he married Catherine Murray, daughter of Hugh Murray, of the county of Carlow, Ireland. He came to Canada in 1852, and obtained a position as assistant engineer on the survey and construction of the Great Western Railway. In 1856 he was appointed city engineer of Hamilton, Ont., which post he held at the time of his death.

In addition to the important duties of city engineer, which Mr. Haskins so ably discharged for forty years, he was frequently called in to confer with engineers in charge of important works in different parts of the country. He was engaged as consulting engineer on the following waterworks systems: St. Thomas, Brantford, Woodstock, Ont., and was employed by the Bank of Hamilton at Ingersoll, Ont., to estimate the value of the waterworks before the town took them over from the company which had constructed them. He was employed with City Engineer Keating, of Toronto, to report on various systems of waterworks at Victoria, B.C.; and he was engineer of the Hamilton and North Western Railway on the location of its line.

FIRES OF THE MONTH.

July 8th—Miller & Pigot, Basket factory, Stony Creek, Ont.; loss, $5,000.——July 16th—Lawson's brass foundry, Queen and Lyons streets, Ottawa, Ont.; damages small.——July 18th—A. W. Cooper's copperine foundry, Port Hope, Ont.; damages about $4,000.——July 23rd—Belleville Box and Basket Co.'s factory, Belleville, Ont.; loss, $12,000; insurance, $7,000.——July 27th—The Canadian General Electric Co., Peterboro, Ont. The compound room and brass moulding department damaged, but fully insured. ——Howden, Stark & Co., hardware, Montreal; loss about $50,000.——The Exhibition buildings, Montreal; loss about $50,000. ——Park and Island Railway, Montreal, Power House and equipment, also cars.

Industrial Notes.

Watford's, Ont., water service has been improved by the addition of a steam fire pump.

A cathedral to cost $100,000 is to be built by the Roman Catholics of Charlottetown, P.E.I.

Jas. King is to rebuild his flour mills at Sarnia, Ont., which were destroyed by fire a short time ago.

The proposed sewage farm for London, Ont., is to be located on the south side of the river Thames, below the city.

The Hobbs Manufacturing Company, of London, Ont., is making arrangements to largely increase its premises.

John Damp has the contract for a $29,500 enlargement to the Normal School buildings, St. James Square, Toronto.

L. B. Montgomery is suing the Toronto Mineral Wool Company for $1,000 for injuries received while in their employ.

The Rathbun Co., Ltd., is building twenty-five cars for the Intercolonial Railway at its car works, Deseronto, Ont.

The boiler of the sawmill at Warwick, near Sarnia, Ont., exploded recently. No one was injured, but the mill was wrecked.

Notre Dame Hospital, Montreal, will probably be rebuilt on a new site more distant from the new east end station of the C.P.R.

T[illegible] site and water-power of the Buckingham Pulp Company h[illegible]e been purchased by Walter Williams, of Buckingham, for $15,000.

T. L. Willson promises to extend the manufacture of calcium carbide by the establishment of additional plants at points where water power is cheaply available.

The medal and diploma awarded to John Abell for his automatic engine at the Columbian Exposition, Chicago, 1893, was on exhibition in Toronto, recently.

The contract for an iron bridge over the river at Rockwood, Ont., has been let to the Montreal Bridge Company, at $650. It is to be completed by September 1st.

D. G. Loomis & Sons, Sherbrooke, Que., have taken a contract from the Gardner Tool Company for the erection of buildings and additions for their works in Sherbrooke.

Woodstock, Ont., will manufacture lighting apparatus for acetylene gas, says the *Sentinel-Review*. There is a successful machine now in use in the residence of F. Maundrell.

Dr. A. T. Watt, secretary of the British Columbia Board of Health, has been in Rossland recently investigating the sanitary condition of the town. It is said that water works are to be constructed.

Joseph Hobson, chief engineer of the Grand Trunk Railway system, has notified City Engineer Keating, of Toronto, that the company approves of the amended specifications for the widening of the Queen-street subway, Toronto.

The stock of the Erie Iron Company, of St. Thomas, Ont., valued at $9,590, has been sold to James Wright & Co., London, Ont., at 26 cents on the dollar. Wright & Co., will continue the works, with William Risdon as manager.

Robert Donaldson & Sons, Montreal, machinists and iron workers, have assigned at the demand of Charles Cushing, with liabilities of about $23,000. The principal creditors are J. W. Pyke & Co., $6,314; A. C. Leslie, & Co., $2,353; C. Cushing, $3,728; W. Smith, $1,000.

The business of Holmes, Moore & Courtwright, manufacturers of staves, Inwood, is to be wound up. The unsecured liabilities are about $34,000. Mr. Courtwright refuses to sign the assignment, and Van Tuyl & Fairbanks, of Petrolea, have seized the goods to satisfy their execution, holding that no legal assignment has been made.

A writ for $25,000 has been served on the Dominion Construction Company, the T., H. & B. Railway, and E. B. Wingate, engineer, by Bracey Bros., contractors, for work and material supplied for the part of the line between Hamilton and Cainsville. The plaintiffs also seek to have it declared that the final certificate of Engineer Wingate is not necessary before payment of the money called for under the contract for the work done by the Bracey Brothers; also to have Engineer Wingate removed from the position of umpire.

THE Maritime Nail Works have been compelled to close down owing to the break down of the engines.

THE general hospital, Hamilton, Ont., is to have two new steam boilers put in, also hot water heaters.

THE business of Geo. Howe, paints and oils, Ottawa, Ont., is to be wound up; assets $10,725, liabilities $14,649.

RHODES, CURRY & Co., Amherst, N.S., are turning out a number of open cars for the Moncton electric street railway.

THE town of Deseronto, Ont., is calling for tenders for waterworks construction. Reference to our advertising columns will afford information to those interested.

AT a meeting of the shareholders of the Hamilton Iron and Steel Company, it was decided to transfer the smelting works to the Hamilton Blast Furnace Company.

J HOODLESS & SON, Hamilton, Ont., have been awarded the contract for the interior woodwork and fittings of the Royal College of Dentistry, which is now in course of erection on College street, Toornto

THE Ottawa, Arnprior and Parry Sound Railway has created a new town, Madawaska, Ont. About one thousand acres of land have been secured, and there will be a divisional point and workshops; roundhouses are to be erected.

THE Burrell-Johnson Iron Co. have accepted the contract for the engines for a new steamer being built by John Millard, of Liverpool, N.S., and also for the engines of a new steamer being built for the Insular Steamship Co. at Westport, N.S., by J. A. McGowan.

THE Grand Falls Water Power Company, Grand Falls, N.B., has recently taken steps to develop its property, and C. LeB. Miles, the company's resident engineer, is surveying the route of the proposed canal. This move was made after consultation with Messrs. Manchester and Baird, of St. John, and a number of experts from the United States.

THE director of the Ontario Bureau of Mines, Archibald Blue, has received word from Sault Ste. Marie that the Lake Superior Power Company will go exclusively into the production of calcium carbide, the substance from which the new acetylene gas is manufactured. This, if various predictions are anywhere nearly correct, is likely to prove a most important Canadian industry.

A PARTY numbering about one hundred of the leading merchants and business men of Sherbrooke, Que., accepted the invitation of Messrs. D. G. Loomis & Sons to visit and inspect their brick works at Ascot, recently. The works, which have all the latest improvements, are about ten miles from Sherbrooke, on the Quebec Central Railway. Great interest was taken by the visitors in the complete system as explained to them by their guides, D. G., Wm. and Fred. Loomis. Messrs. Loomis & Sons are at present engaged in making two large additions to the Dominion Cotton Mills at Montreal, an addition to the Magog Mills, and other undertakings.

M. R. DAVIS, doing business in his own name and also under the firm name of Davis & Son, boatbuilders, Kingston, Ont., assigned last month to Robert J. McKelvey, of Kingston. Mr. Davis has the sympathy of his creditors in his difficulties, and a compromise at 40 per cent. has been arranged, time being given for payment. The principal creditors are: Thomas Myles & Son, $391. McKelvey & Birch, $500. Kingston Foundry, $281; S. Anglin & Co., $248; Canada Locomotive and Engine Co., $200; Booth & Co., $141; Rathbun Co., $234; Ontario Bank, $100; W Mitchell, $100; Chas. D. Durkee, $100; preferred claims, $1,278. There are some thirty odd creditors of amounts under $100, the total liabilities being about $4,850, with assets valued at $2,800.

JUDGE PURCELL rendered judgment recently in Montreal in the case of Cliffe vs Manning This was an action for the recovery of fees and expenses in connection with the inspection of defendant's boiler. The plea to the action was that, although Manning did not object to the inspection, still he warned the inspector that, as he had not required his services, he would not pay the costs of the work. The law is silent on the subject of the expenses connected with such inspections, but the court held the intention must have been that some arrangement should take place between the parties. No such arrangement having been made in the present instance, the action must be dismissed. In a similar action taken by the same person against the G.T.R. Co., the company made offers which the court considered sufficient, and judgment was rendered accordingly.

JAS. WILSON, Merritton, Ont., is running his foundry night and day.

J. M. KERR, carriages, Thomasburg, Ont., has assigned to A. A. Macdonald.

THE town council of Amherst, N.S., is anxious to correspond with capitalists wishing to promote a grist mill and a woolen mill in that town.

THE Edmonton Milling Company has decided to build an elevator in connection with their flour mill at South Edmonton, Alberta.

THE "Thornycroft" water-tube boiler is the subject of a neat descriptive pamphlet, which sets out many valuable features of these famous boilers.

THE ratepayers of Goderich, Ont., have voted to expend a large amount on water works improvements, sewage, and incandescent lighting systems.

THE harbor improvements, at St. John, N.B., will be carried out by the city, and the wharf, etc., built on plans to be prepared by the C.P.R. engineers.

THE Messrs. Shaw contemplate building a flour mill at Dauphin, Man., 100 barrels capacity. They now own a small mill and also a lumber mill at that place.

GIESBRACHT & WIENS, of Plum Coulee, Man., will build a 100 barrel flour mill at that point, and have let the contract for plant to Stewart & Harper, of Winnipeg.

HUMPHRIES & ROHAN, of Canton, Ohio, brass founders, are in correspondence with the Toronto Board of Trade relative to the establishment of their industry in Ontario.

THE Dominion Cold Storage Company is making some alterations in the old drill-shed building, to cost $7,000, to adapt it to their purposes as a storage warehouse in Toronto.

THE McLaren Match Co., Ltd., of Buckingham, Que., is now placing its products on the market. The stockholders are the sons of the late Jas. McLaren, of Buckingham.

THE Fensom Elevator Works, Toronto, have issued a neatly illustrated circular setting out the claims of their safety elevators. It should be in the hands of all intending builders.

J McMARTIN, railway contractor, has purchased an interest in the Clemes & Currie saw mill at Sandon, B.C. A planer and shingle machinery are to be added as soon as possible.

BELLHOUSE, DILLON & Co., manufacturers' agents in cement, chemicals, etc., Montreal, have opened a branch office at 47 Wellington street east, Toronto, with S. G. Grinston in charge.

WRIGHT & CUNNINGHAM, St. Catharines, Ont., have been awarded the contract for supplying one hundrd hydrants for the system of waterworks now being put in at Niagara Falls, Ont.

JAMES BURRIDGE, manager at Winnipeg of the Gurney-Tilden Company, is having plans prepared for a new warehouse for the company; dimensions 40 feet by 100 feet, four stories and basement.

W P. McNEIL & Co., of New Glasgow, N.S., are putting in a new cupola and boiler, which are to be ready for operation this month. Among other things they propose to make steel castings for ore crushers.

NOTHING but distance and the too swift lapse of time prevented THE CANADIAN ENGINEER'S accepting the kind invitation of the Penberthy Injector Co. of Detroit, to celebrate the manufacture of the one hundred thousandth injector by taking part in an excursion on Lake St. Clair on July 25th.

THE McAnulty Mill Co., of Manheim, Pa., U.S.A., offers to locate a flour mill machinery manufactory, employing one hundred and fifty men, and a roller flour mill of 1,000 barrels' capacity, at a total outlay of $300,000, for a free site, exemption from taxes for ten years, and $30,000 cash bonus.

THE Lamont Glass Company, of New Glasgow, N.S., manufacturers of glass chimneys, fruit jars, bottles, etc., have doubled their works during the past two years, and now employ 70 hands, with a pay-roll of $500 a week. They contemplate going into the manufacture of electric light bulbs and shades.

ALLISTER McKay, contractor, Chatham, Ont., has, after much experimenting, succeeded in perfecting a mammoth steam plough, which is now in successful operation on his Point Pelee farm. The plough is propelled by a steam engine at each end of the field, and performs its work effectively.—*London Free Press.*

THE Truro, N.S., Condensed Milk Company finished this year a new wing, built to provide an increased output for their products. The new building is now fitted up with improved machinery for condensing the milk and filling the cans. The condensed milk and condensed milk and coffee made by this company are now exported.

THE Canada Paint Co., of Montreal, is to develop the graphite mines in New Brunswick, says the St. John *Sun*. The mineral has been worked in the City of St. John, at intervals during the past forty years Previous operators of these mines have shipped the mineral in its native state; but the Canada Paint Co. propose to place it on the market as a constituent of several of their well known products.

EXTENSIVE improvements have been commenced at the M.C.R. shops at St. Thomas, Ont A new roof is being put on the old blacksmith shop, and all the buildings will be re-roofed. The smoke stalks are being renewed, and pneumatic hoists put in for all the large machines. It is reported that new machinery, the latest up to date, will shortly be put in, and the shops equipped for turning out a great deal more work than at present.

Electric Flashes.

TORONTO JUNCTION is going to buy a new 40-light dynamo.

THE Holmes Electric Protection Co., Montreal, is being wound up.

AN electric railway is proposed to rnn between Richmond and Ottawa, Ont.

THE Island of Orleans will shortly be connected with Quebec by telephone.

DURING June the Galt, Preston and Hespeler Electric Railway carried 23,000 passengers.

THE construction of the Quebec Electric Railway is to proceed. Montreal capitalists are interested.

THE prospects of the Cornwall Electric Railway are good. It carried 10,000 people on a recent holiday.

THE Cataract Power Company offers to supply Hamilton with power to pump her water supply for $13,000 yearly.

THE Listowel, Ont., Gas Co. intends soon installing an electric plant when the present contract for lighting the town expires.

JAMES REID, cabinet-maker, Kingston, Ont., is putting in an electric motor to run his machinery instead of employing steam power.

THE standpipe at the waterworks, Chatham, Ont., has been struck by lightning three times in a month and the electric alarm burnt out.

A PERMIT has been granted to the Toronto Electric Light Co. to erect a large power-house on the Esplanade, south of Scott street, to cost $5,000.

G. C. HINTON, of Victoria, B.C., has installed a 500-light incandescent plant in the Victoria Lumber and Manufacturing Co.'s mills, at Chemaines, B.C.

ON July 1st the formal transfer of a portion of the C.P.R. was made to the Hull Electric Railway Co., and traffic was opened between Hull, Que., and Aylmer.

THE Hamilton Radial Electric Railway Company has closed a contract to fit a number of its cars with the brake manufactured by the Standard Air-Brake Company, New York.

THE Owen Sound Electric Light Co. is about to supply incandescent light as well as arc lights, and S. J. Parker, president of the company, is planning the enlargement of the plant to supply power.

THE Canadian Electric Railway and Power Co. seeks power to build an electric railway from Cobourg via Port Hope, Bowmanville, Oshawa, Whitby, Toronto, Oakville and Hamilton to Suspension Bridge and Niagara Falls.

AT the coming session of Parliament, application will be made for a charter for the Toronto Railway and Radial Co. It is proposed to convert the Belt Line which the G.T.R. found unprofitable into an electric road, and to build branches to outlying towns.

THAT taxes must be paid by the Bell Telephone Company on its poles in the town of Arnprior, Ont., at a valuation of $1,000, is the decision of Judge Deacon recently given. The company claimed exemption on the ground that its income in the town was less than $400.

THE Sherbrooke Telephone Co. is building one hundred miles of new lines.

MICKLE, DYMENT & SON have placed an electric lighting plant in their saw mill, at Severn, Ont.

THE heavy storm on July 20th, disabled the Gorge Electric Railway, but did no injury to Niagara Falls Park and River Railway.

THE Lachine Rapids Hydraulic Power and Land Co. are to erect poles along the aqueduct to bring in the power from Lachine to Montreal.

THE City of Toronto received tenders for the telephone privilege up to July 15th. Only one tender, that of the Bell Telephone Co., was received.

THE Hamilton, Grimsby and Beamsville Railway has received the grant of a free right of way from the municipality of Beamsville, Ont., which will be connected with Grimsby Park.

THE Niagara Falls Park and River Electric Railway Company has asked the Ontario Government to grant permission to lease 750 surplus horse-power which it cannot utilize, to Clifton and other corporations near Queen Victoria Park.

DELAYS which the promoters attribute to difficulties in obtaining a charter, have compelled those interested in the proposed Lanark-Perth, Ont., electric railway to ask for an extension of the time in which the bonuses voted might be earned.

JUDGE DAVIDSON, of Montreal, recently ruled that the street railway company had a right to use the earth for return circuit and dismissed the action for $27,000 taken by the Bell Telephone Company. A great deal of expert evidence was heard.

THE Canadian Telephone Company, with a total capital stock of $10,000, headquarters at Sawyerville, Que., applies to be incorporated for the construction and working of a telephone line in the County of Compton and other counties in the Province of Quebec.

THE Smith Vaile Company, of Dayton, Ohio, which has the contract for the plant of the Lachine Rapids Hydraulic Power and Land Company, has been awarded the contract for the plant to be put in on the Richelieu River, at a cost of $550,000, not including the generators.

SURVEYS are now being made on the line of the Huron and Ontario Electric Railway between Port Perry, Walkerton, Kincardine, Meaford and Goderich, Ont The work will be completed in about sixty days from the start, and track-laying will then be proceeded with immediately.

ROSS & MACKENZIE, of Montreal and Toronto, are to transform the street railway system of Birmingham, England, into an electric one, and to operate it. It is said that the Canadian syndicate is given control of the system for a period of 21 years upon the payment to the city of an annual rental of £5,000.

THE Montreal S reet Railway has placed an electric street sweeper on its line. In the June number THE CANADIAN ENGINEER gave an illustrated description of this new means of street cleaning, which is the invention of A. J. Reynolds, of Montreal. The car was built at the works of the Rathbun Company, Deseronto, Ont., and is a success in every way.

THE daily papers all contain the following statement by Nicola Tesla, the electrician: "Yes, I did state that electricity can be transmitted long distances upon a commercial basis over a distance of at least five hundred miles. I will stake my reputation and my life upon it. I only qualify it by adding that the amount of power transmitted must be quite considerable."

MR. BURRILL, of the Drummond Lumber Co., Forest Dale, Que., recently worked out an ingenious device for lighting a country road at night. Having to travel through dark forest roads he constructed a storage battery in his wagon, and ran fine flexible wires along the reins to the head of each horse, where an incandescent light of small candle power was fixed to the head piece of the bridle. Thus wherever the horses looked they threw a stream of light in front of them—not strong, but enough to light the way and show any obstacles ahead.

FRANK J. WATSON, who has been connected with the G.T.R. for a numbers of years, has recently been appointed chief clerk in the offices at Hamilton, Ont Before leaving Montreal, Mr. Watson was the recipient of a testimonial from the clerks in the Montreal offices, which took the form of a gold locket, set with diamonds, and an elaborate bookcase The presentation was made by John J. Cunningham, assistant general freight agent of the Grand Trunk, who spoke in very flattering terms of Mr. Watson's ability as a railway man and the services he had rendered to the company.

Railway Matters.

THE Woodstock and Centreville Railway is to be built at once, it is said.

THE Shenango ferries have been given the contract for handling 50,000 tons of coal for the Canada Southern division of the N.Y.C. Railway.

THE Columbia and Western Railway is now completed between Trail and Rossland, and trains are running regularly in connection with the steamboats plying between Trail, Robson and Arrowhead.

THE C.P.R. is replacing a number of trestles with large stone bridges and arches. This work is in progress over the Surprise and Illecillewaet rivers in British Columbia, and is the heaviest construction work undertaken for some time.

THE Grand Trunk Railway system no longer makes locomotive repairs in the various round-houses along the road, and has laid off a large number of men in consequence. The repairs are now all made in Stratford or Montreal.

THE Canadian Pacific Railway Company, which has been operating the Qu'Appelle, Long Lake and Saskatchewan Railway practically since its building, has entered into a fresh agreement with the Q ,L. L. and S for the operation of its system for a period of five years from August 1st.

THE Canadian Pacific and Grand Trunk Railways have, it is understood, been asked by some American railroads to co-operate in a scheme looking towards a uniform height in freight cars The object is to make all cars in the future equal This will prevent many accidents to brakemen, and will cause a great saving in life.

THE first sod for the building of the Cobourg, Northumberland and Pacific Railway, was turned at Cobourg, Ont., July 8th. C. H. Bowen, the contractor, is superintending the road, which is to be completed within two years, and will extend from Cobourg to a point on the C.P.R. called Springbrook, twelve miles north-east of Campbellford, Ont

GOVERNMENT Engineer McCallum, returned recently from a trip of inspection of the Irondale, Bancroft and Ottawa Railway. He says that the road is now complete for some 45 miles, as far as Baptiste Lake, in the township of Herschel, Hastings, and but eight miles yet remain to be laid before Bancroft is reached, where several mills are working, and valuable water-power is located.

THE contractors hope to build one hundred miles of the Dauphin Railway this year, but the wet season has retarded the work, and it seems hardly possible to build more than fifty miles. The Kingston Locomotive Works are building four locomotives, and the Crossan Car Works, of Cobourg are turning out fifty box cars. The rolling stock is ordered early to be used in constructing the line.

THE South Shore Railway (better known as the Montreal and Sorel) has just opened a new bridge over the Richelieu River at Sorel, which is 500 feet long, consisting of two stationary piers, each 130 feet in length, and of a centre turnstile, 240 feet long, It was designed by James McCarthy, C.E., was built by the Dominion Bridge Co., Montreal, and was placed in position by Hyacinthe Beauchemir, contractor. It cost about $150,000 The directors of the South Shore Railway propose to rapidly push on the work of construction as far as Levis, passing *en route* Yamaska, St. Francois du Lac, Pierreville, La Baie and Nicolet, bridging the Yamaska, Nicolet and St. Francois.

IN the railroads of the United States stock to the amount of $3,475,640,203, or 70.05 per cent. of the total outstanding, paid no dividend, and $904,436,200, or 16 90 per cent. of funded debt, exclusive of equipment trust obligations, paid no interest during the year covered by the report. In no other year since the organization of the Division of Statistics has so large a percentage of stock passed its dividends, or, except in 1894, has so large a percentage of funded debt defaulted its interest. Of the stock paying dividends, 6.89 per cent of the total stock outstanding paid from 4 to 5 per cent ; 5 39 per cent of this stock paid from 5to 6 per cent.; 4.41 per cent. paid from 6 to 7 per cent., and 3 99 per cent. paid from 7 to 8 per cent. The total amount of dividends was $85,287,543, which would be produced by an average rate of 5.74 per cent. on the amount of stock on which some dividend was declared. The amount of bonds paying no interest was $624,702,293, or 13.41 per cent.; of miscellaneous obligations, $54,498,288, or 12.24 per cent.; of income bonds, $225,235,619, or 91.52 per cent.

THE G.T.R. is turning out Pullman sleepers from its shops in Montreal which are equal to those of the famous Pullman works.

THE G.T.R. is effecting a great saving in the handling of coal in its yards at Point St. Charles, Montreal, by putting up overhead trucks to take the place of the old time carts.

THE British Pacific Railway Company will seek incorporation with power to build a line from Victoria, B.C., to Winnipeg, via Butte Inlet, Cariboo, Edmonton, and Prince Albert.

THE Tobique Valley Railway, New Brunswick, is again in operation. It is being run by J. E. Stewart and James McNair, who have secured an engine from the I.C.R. and cars from the C P R , and expect to run a train on the line daily.

IN following out his policy of economy and concentration, General Manager Hays of the Grand Trunk is said to have decided on removing the workshops from Toronto and centring the locomotive repairs at Stratford, Ont., and the car repairing at London, Ont.

THE Dartmouth branch of the Intercolonial Railway at Halifax is now complete. This will be the only construction work carried out by the I.C.R. this year ; but some maintenance work will be accomplished, among which is a new stone and brick station at Moncton to cost $40,000 or $50,000.

NOTICE is given by the Canadian Pacific Railway that application will be made to Parliament for an Act confirming and giving effect to an agreement between the Canadian Pacific and the Grand Trunk Railway for running powers by the former over the tracks of the latter, between Hamilton and Toronto.

THE Parry Sound Colonization Railway and the Ottawa, Arnprior and Parry Sound Railway have been amalgamated under the name of the O.A. & P.S. Railway. Wm. L. B. Ross, the cashier of the O.A. & P.S. Railway, is to be treasurer of the amalgamated lines. The Parry Sound Colonization Railway extended from Emsdale to Parry Sound, and is about sixty miles in length.

THERE is now a prospect of the Orford Mountain Railway being finished, the Quebec Government having decided to extend the time for the building of several unfinished lines till December, 1898, among which is the Orford Mountain, whose claim to the Provincial subsidy expired in June last. The likelihood now is that the bridge to cross the St. Francis, so as to connect the line with Richmond, will be built at an early date.

Marine News.

THE International Trading Co., Kaslo, B.C., launched its new steamer, the "City of Kaslo," on July 7th.

THE new pleasure steamer "Assiniboine," which has been under construction at Winnipeg, is completed.

THE steamer "Westport," of Westport, N.S., has been sold to parties in Yarmouth, to ply on the Cape Breton route.

THE company owning the "W. Hunter," New Denver, will build a new steamer 110 feet long to run on Slocan Lake, B.C.

THE railways and canals department has prepared plans for the enlargement of the Galops Canal at Iroquois. The work will cost about $1,750,000.

THE ore steamer "Rustler," belonging to D. D. Mann, contractor for the Dauphin Railway, was wrecked in Kootenay River when carrying ore from the North Star mine to Jennings, B.C.

THE Richelieu and Ontario Navigation Co., with its usual enterprise, has made soundings in the St. Lawrence River between Coteau and Beauharnois, and has discovered a new channel, which will simplify the navigation of the Split Rock rapids greatly.

Canada is the fifth maritime power in the world. The total number of vessels on the register book of the Dominion, on Jan. 1st last, including old and new vessels, steamers and barges, was 7,262, measuring 825,836 tons registered tonnage, being an increase of 17 vessels, and a decrease of 43,788 tons register, as compared with 1894.

THE Canadian Association of Marine Engineers, St. John, N B., recently closed a very successful season of meetings. During the winter season (Dec. to April), Geo. R Davitt, of the St. John Grammar School gave the benefit of his services to the association in conducting a series of lessons in mathematics, which proved of great value to the members.

Ed. Williams, Dartmouth, is building a wooden steamer for the Acadia Sugar Co., to take the place of the "Mascotte"; the "Mascotte" engines, with new boilers, will be placed in her.

The notice in the *Official Gazette* that the Ottawa Valley Canal Co. would apply for an extension of time to commence operations has drawn public attention once more towards this great enterprise. Marcus Smith, C.E., is about to make a new survey, and will, it is said, run the line of the canal through the southern channel at Allumette Island, passing the town of Pembroke. Mr. Smith estimates the cost of the canal at fifteen millions. It is thought that the motor power developed by the construction of the canal would be sufficient to operate all the industries in Eastern Ontario, the Ottawa, Arnprior and Parry Sound Railway, and the C.P.R. from Quebec to Winnipeg.

Among the members of the joint-stock company of the "Royal William," built at Quebec in 1830 and 1831, the first vessel to cross the Atlantic under steam, was Sir Samuel Cunard, of Halifax, Nova Scotia, who followed up this Canadian enterprise by building four steamships in 1838, the "Britannia," "Acadia," "Caledonia" and the "Columbia," which formed the first of the splendid fleet that since has been known as the Cunard line. It is the boast of this company that during fifty-six years, in which their vessels have transported people continuously to and fro between Europe and America, it never lost the life of a passenger. In an address recently given by Mr. Sandford Fleming, C.M.G., before the Royal Colonial Institute, a comparison of the "Britannia," the first Cunard ship launched in 1840, with the latest Cunard liner "Lucania," launched in 1893, is made in order to show the marvellous advance in construction of ships during the half century. The "Britannia" was a paddle-wheel steamship constructed of wood. The "Lucania" is a double-screw steamship constructed of steel:

"Britannia."		"Lucania."	
Length, feet	207	Length, feet	620
Tonnage	1,139	Tonnage	12,950
Horse-power	740	Horse-power	30,000
Speed per hour (knots).	8½	Speed per hour (knots).	21½

The "Britannia" had accommodation for ninety passengers; the "Lucania" for six hundred first class, four hundred second class, and seven hundred to a thousand third class passengers.

Mining Matters.

It is reported that extensive beds of rock salt have been discovered in the city of Toronto by boring.

The Bullion Mining Company of Rat Portage has been launched to do developing and general mining business. William Hamilton Merritt is consulting engineer.

"From what I have seen and heard, I consider that British Columbia is probably the finest gold mining country in the world"—*P. A. Peterson, chief engineer of the C.P.R.*

J. Reeb & Sons, have bought the Mutual Gas Co.'s wells and plant. This gives Messrs. Reeb & Sons control of the gas supply in Welland, except the Greenwood line and the wells of the Ontario Silver Co.

The drill plant for the Trail Mining Co., Trail Creek, B.C., is now being placed in position at the Copper Jack mine. The plant weighs 107 tons and $5,000 was spent in building suitable foundations for it.

Col. Engledue, of the South African General Development Company of England, which was organized in 1894, with a capital of $300,000, for the exploration and working of mining properties in South Africa, has recently visited the leading centres of mining interest in Canada, and has secured options on a number of fine properties in British Columbia and the Rainy River district for his company.

In the month of June the Hall Mines, Ltd., smelted 3,420 tons of silver ore, which produced 283 tons of matte, containing 135 tons of copper and 70,847 ozs. of silver, says the Victoria *Colonist*. The value of this is estimated at about £14,510, while the outgoings will not exceed at most £6,000. This means an annual profit of £100,000 on the paid-up capital of £300,000. As late as March last the shares could be bought for 10s. They now stand as high as 50s., and look like going to £3.

That mining stock, even at five cents a share, may not be a good bargain, is shown by the following from the Rossland *Miner*: "In connection with the Gold Hill swindle, all the labor on the mine was paid in stocks at a nominal value, we believe, of 6 to 10 cents a share. At 10 cents a share, the men would be entitled to 20 shares of stock a day and their board, or at 5 cents a share to 40 shares of stock a day and their board. At the price for which the mine was sold these men will get about one-eighth of a cent a share, or from 16 cents to 32 cents a day."

The Le Roi Mining and Smelting Company is sinking a shaft from the 450-foot level, and will continue it for 100 feet. When this is completed, it is said that if the ore continues there will be $7,000,000 in sight, and that there is now in sight between the 350-foot and the 450-foot levels, where the present work is being done, $2,000,000. If there is no mistake in these figures, the Le Roi is all that has been claimed for it, the biggest gold mine in North America. One hundred tons of ore are being taken out of the mine daily, and there is said to be 10,000 tons on the dump ready to be taken to the smelter. Eighteen months ago the stock of this mine sold at 10 cents per share, last month an Ottawa capitalist is reported to have bought 12,000 shares at $5.

The North Brookfield Mining Association of Queen's county, N.S., are putting in a $15,000 crushing plant from the Truro foundry and Machine Co., in addition to a chlorination plant. This company took hold of a property which was abandoned some years ago, and now they are working at a good profit, and are said to have $120,000 of ore in sight. Three other Nova Scotia companies, who are making handsome profits are the New Glasgow Gold Mining Co., the Egerton Gold Co., and the Blue Nose Gold Mining Co. The first named are going to put in an additional ten stamps, while the last named company of New Glasgow capitalists, who have got control of the Springfield, Cobourg and Caledonia mines, are puting in an elaborate plant, having both formerly been worked only by the old methods. Fraser Bros, of New Glasgow, are putting in some of the plant. The Egerton Company, operating at Fifteen Mile Stream, are now putting in fifteen stamps, making a total of thirty stamps. They have been taking out 350 to 400 ounces a month since July, 1895.

Among the new mining companies gazetted last month in British Columbia are: California Gold Mining Company; head office Spokane; capital, $2,500,000, R. H. Pope, president. The Columbia Mining Company, of Victoria, B.C., Ltd.; capital, $100,000, in 200 shares of $500 each; directors, J. C. Davie, surgeon, B. W. Poarse, gentleman, A. P. Luxton, barrister, F. B. Pemberton, financial agent, A. C. Flumerfelt, merchant, Victoria. The Interstate Mining Company; head office, Spokane; capital, $750,000; no names of directors. The Kootenay-London Mining Company, Ltd.; capital, $1,000,000 in $1 shares; directors, E. Pritchard, London, Eng., mining engineer; W. Bennison, Everett, Wash.; A. J. McMillan, Liverpool, Eng., and J. W. Cover, W. A. Campbell, C. O. Lalonde, J. W. Boyd, J. S. Paterson, Hiram Kildea, of Rossland; the company is formed to buy the Comet No. 2 and Annie (fraction) claims at Rossland, and general mining. The Pittsburg Gold Mining Company, Ltd.; head office, Rossland; capital, $750,000 in $1 shares; directors, L T Schooley, Winnipeg; A. D. Clabon, J. McLaren, W. R. Hall, M. J. Brown, D. Thoroton, David McBeath, T. H. Armstrong, all of Rossland; the company is formed to purchase the Pittsburg No. 1 and Yellow Copper claims, and general mining. The San Francisco Gold Mining Company, Ltd.; capital, $1,000,000 in $1 shares; head office, Rossland; directors, W. W. Davis, grain broker, Rossland; Joseph Harris, grain merchant; John Dick, lumber manufacturer, Winnipeg; J. B. McArthur, Q.C., C. O'B. Reddin, broker, of Rossland; the company is formed to purchase the San Francisco mineral claim, and general mining.

LITERARY NOTES.

The Statistical Year Book of Canada for 1895 contains its usual wealth of information. It contains the first of a series of biographical notes of advocates of the principle of Confederation, the third of a series on "Countries with which Canada Deals," and an extended analysis of the industrial, mechanical and manufacturing return of the Census by provinces. A digest of the treaties Canada has made with her Indian tribes is appended to the synopsis of the treaties made by the Mother Country, in which Canada is specially interested. The Abstract contains gleanings from and analyses of the return made to the Government through the several Departments, the whole being arranged so as to give, first, an idea of the wealth derived from the soil and the waters—agriculture, fisheries and minerals (forest having been dealt with in the first part); then the trade and commerce created by the distribution of these products, third, the means by which these products are transferred from producer to consumer - money and banks, fourth, the modes of transportation Canada possesses - railways, canals and shipping, and, fifth, the facilities provided for communication --post offices, telegraphs and telephones The volume is an additional tribute to the already well known ability of the Dominion Statistician, Geo Johnson

"Press Working of Metals," by Oberlin Smith, Mem. Am. Soc Mec. E., C.E., M.E ; associate member Am. Inst. of Electrical Engineers, is a most interesting and well written treatise on the principles and practice of shaping metals in dies by the action of presses, together with a description of the construction of such implements It is illustrated with over four hundred engravings "Press Working of Metals," by Oberlin Smith; Jno. Wiley & Sons, New York; Chapman & Hall, Ltd, London, Eng.

The department of public works of the city of St. John, N B, which is under the care of Wm Murdock, C E, has issued a neat pamphlet, "Sewage and Water Supply," which contains the engineer's and superintendent's report for 1895, and a large amount of valuable information

Some time ago the *American Artisan* offered prizes amounting to $300 for essays on house heating by means of hot water, steam and hot air. The prize essays have now been given to the public in a 300-page volume, bound in cloth, and are a most fertile source of information for enquirers in this department of mechanical science. The *American Artisan* is to be congratulated on its enterprise

One of the most elaborate catalogues issued by any hardware firm during the past year is that recently published by Wood, Vallance & Co., wholesale hardware dealers, Hamilton. It has 930 pages 8 x 11, and contains 3,600 illustrations

Personal.

Wm. Booth, of London, Ont., was killed in a collision at Thamesville, Ont, July 17th.

Angus Nicholson, foreman of bridge construction on the C.P.R., died at Port Arthur, July 5th.

Mark B. Thomas, manager of the gas works at Dundas, Ont., is to be manager of the Hamilton & Dundas Railway.

August Prestren, of Hespeler, a contractor, was killed by falling between two cars on the Galt, Preston and Hespeler Railway, July 17th.

H. B. Spencer, formerly in the Ottawa office of the Canadian Pacific, has become managing director of the Hull-Aylmer electric railway.

Geo. A White, an engineer on the T.H. & B. Railway, was killed recently by his engine turning over after leaving the track, near Chantler, Ont

T. H Taylor, manager of the Riordon paper mills, Merritton, Ont., has resigned his position and will live in England as the representive of the Canadian wood pulp syndicate

John Wilson, manager of the Brunette Mills, New Westminster, B C., died July 21st, after a lengthy illness Deceased was a native of the County of Lanark, Ont., and was well known in the lumber industry on the Ottawa River.

W. T McClement, M A., science master of the London, Ont., Collegiate Institute, has been appointed professor of chemistry in the Armour Institute, Chicago, and will commence his new duties in the fall He is an honor graduate of Queen's University, Kingston, Ont.

E G. Barrow, who has been a most efficient assistant city engineer in Hamilton, Ont., for some time, has been appointed to the position of city engineer rendered vacant by the death of the late William Haskins. J. H. Armstrong, Toronto, J W. Tyrell and J. A. Peterson, of Hamilton, and V G Marani, of Cleveland, were also applicants.

Ebenezer McKay, B.A., Ph.D., has been elected to the McLeod Chair of Chemistry and Mineralogy in Dalhousie University, Halifax, N.S. Recently he has been lecturer assistant to Dr. Ira Remsen in his course in organic chemistry to graduate students at Johns Hopkins, and is now pursuing special studies at Harvard University.

A. B. Youngston, of Meadville, Pa., assistant grand chief of the Brotherhood of Locomotive Engineers, is on a tour through the Dominion in the interest of the brotherhood, and reports a prosperous condition of things everywhere.

Moses Parker, who carried on an extensive business as owner of a foundry on Dalhousie street, Montreal, died recently at the age of fifty-six Mr. Parker was widely known and was a constant contributor to the different schemes and institutions for the relief of the poor and unfortunate.

Francis Belanger, engineer on the steamer "Reliance," was killed July 21st, while the boat was at the wharf, at L'Orignal, getting ready to start for Ottawa Through some misunderstanding of the captain's orders, Belanger was drawn into the wheel-box and instantly killed. His head was smashed, one arm and one leg badly broken

Capt. Hugh Chisholm died in Meaford, Ont., July 6th, at the age of seventy-two He was one of the pioneer shipbuilders and navigators of Canada, and built at Port Credit the first centre-board schooner on the north shore of Lake Ontario, the "Credit Chief." In 1850 he built the steamer "Woodman" at Port Perry, the first steamer on Lake Scugog and adjacent lakes. He was master of the vessel for three years, plying between Port Perry, Lindsay, and Fenelon Falls. For the old Northern Railroad Company he built in 1854 the steamer "J. C. Morrison," named after the late Judge Morrison, at a cost of $60,000 She ran on Lake Simcoe "Emily May," owned by the late Capt May, was built by the deceased at Belle Ewart. Captain Chisholm was part owner and master of the steamer "Her Majesty," the first steamer to make direct trips from Toronto to Halifax. A few years ago he built the "City of Parry Sound," of the N.S.N. Company, now running between Collingwood and North Shore ports

METAL IMPORTS FROM GREAT BRITAIN.

The following are the values in sterling money of the metal imports into Canada from Great Britain for June, 1895 and 1896, and the six months to June, 1895 and 1896:

	Month of June.		Six months to June.	
	1895	1896.	1895.	1896.
Hardware and cutlery	£3.554	£4.618	£24.465	£32.111
Pig iron	2,766	2,086	8,637	9,866
Bar, etc	1,386	2,202	6 243	8,501
Railroad	4.739	25.437	31.307	47.475
Hoops, sheets, etc	5,165	4,446	17.216	16,142
Galvanized sheets	9.440	7,682	30.683	23.354
Tin plates	10,616	11,435	59.509	67.554
Cast, wrought, etc., iron ..	6 390	4.535	22,116	26,103
Old (for re-manufacture) ..	1,084	5,865	1.587	8,926
Steel	7,092	7,680	26,406	44,407
Lead	2,764	2,113	9.330	7.556
Tin, unwrought	3.177	640	11 022	7.714
Cement	3.100	4.108	9,627	14.473