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Volume 21. Toronto, August 31, 1911 Contents of this issue on page 257

The Canadian Engineer

An Engineering Weekly.

THE ADAMELLO WATER POWER STATION

In 1907 a company was formed to develop the water power in the Province of Breseia from the Adamello mountain group. Messrs. Escher Wyss & Company, who were responsible for the construction of the pipe line and turbine installation on the site finally adopted, have recently issued a pamphlet, abstracted from a paper by Director K. Zodel, read before the Zurich Society of Engineers and Architects, describing the Adamello Power Station.

The development is in two parts The upper station, with a net head of 3,000 ft., is the one we have dealt with in the following abstract. The intake works is at Lago d'-Arno. There is a shaft sunk down to the pressure tunnel that runs to the penstock chamber, this tunnel being about 4,900 ft. long and roughly 70 inches in diameter. Here the tunnel connects with a surge shaft designed to regulate pressure surges in the tunnel. This surge shaft is nearly 23 ft. in diameter and is carried 45 ft. above forebay level—total height of surge shaft being 230 ft. At 300 ft. beyond the surge shaft the water enters two steel penstocks through which it is carried to the power house, at Isola. These penstocks gradually change from 2 ft. 9 in. diameter at connection to tunnel, to 1 ft. 9 in. diameter at Power House. The thickness of the metal at power house, where the static pressure is 3,055 ft., is 1¼ in., a thickness just possible to weld satisfactorily with the water-gas process. In order to prevent freezing, since the plant is under load only eight hours of the day, the line of the pipes was located to secure a covering of earth of at least 6 ft.

The top section of the pipe line, down to the point where the static head reaches about 640 ft., consists of riveted pipes made in 20 ft. lengths in the shop. For the lower portion of the line, pipes of the same length, lap welded by water-gas, were used. These pipes were connected by an overlapped double riveted sleeve joint to a pressure head of 1,800 ft., and for the remainder of the line down to the power house were provided with flange joint. These latter have a welded-on flange end and with a recess containing a wedge-shafted groove to receive rubber packing. The two ends are pressed together by loose flange rings. All pipes were tested in the shops to one and a half times the working pressure and kept at this pressure for one hour, during which time the weld joint was thoroughly hammered; all pipes showing signs of sweating were rejected. The velocity in the pipes varies from 6½ ft. per sec. at the top, to 13 ft. per sec. at the power house.

Very special care had to be taken in the design and construction of the distributing pipes connecting to the power house. Both pipe lines are laid alongside each other as far as the middle of the power house wall, when they are joined together by a semi-circular bend, so that the lower turbines are fed from the second pipe round this bend. Sluice valves are arranged in such a way as to enable either pipe line to be closed at any time and the turbines to be run from the other; these valves are hydraulically operated. The flange bolts of the horizontal pipes near the power house have to withstand a considerable stress, since the hydraulic pressure acting on the cross section of the two pipes produces in each a thrust of 280 tons. A partial relief was provided for these joints, without interfering with their longitudinal motion during contraction and expansion, by a hydraulic piston acting on the semicircular bend from the last masonry foundation block at the end of the pipe line. The resulting relief amounts to about 61 tons. The semicircular bends and the special T-pieces which connect to the turbines are made of tough steel castings. Upon completion of the erection, each pipe line was filled with water and tested by pumps to one and a half times the working pressure. They were perfectly rigid and water-tight.

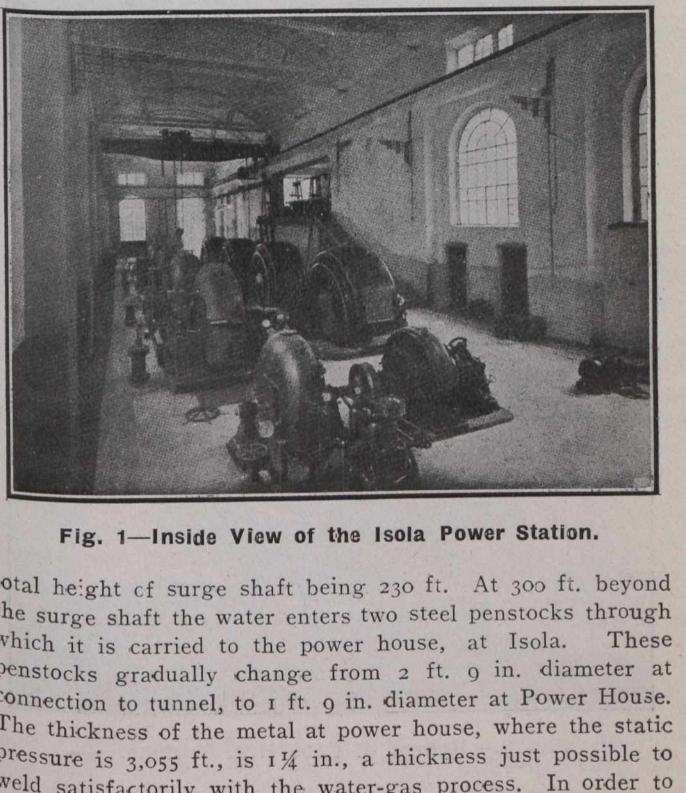


Fig. 1—Inside View of the Isola Power Station.

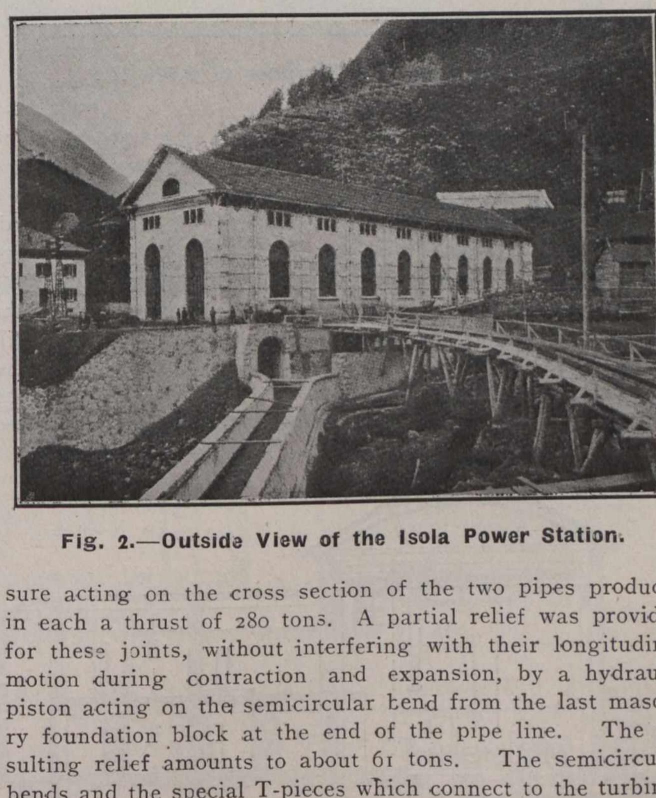


Fig. 2.—Outside View of the Isola Power Station.

The power house of the Isola central station has been built for receiving seven generating groups of 6,500 h.p. output each; its internal width measures 41 feet, with a length of 209 feet. The three-phase generators, built by Brown, Boveri & Company, of Baden, deliver current at 12,000 volts direct from the machines down to the transformer station at Cedegolo, which steps up for the long distance transmission to Milan. The switchboard arrangements at Isola are therefore, comparatively simple. Beside the main generator units, there is an exciter set of 500 h.p., and also an exciter rotary converter set of the same power, to act as a standby.

A single jet was chosen as the most suitable for the turbines, on account of the greater simplicity of the inlet pipes. Its diameter is about 3 inches, and it has a spouting velocity from the nozzle of 450 feet per second. It is evident that even the very best materials can only resist such a jet as this, if the latter impinges on the buckets without shock, and is deflected by them in a perfectly smooth and steady curve. Very special care was therefore

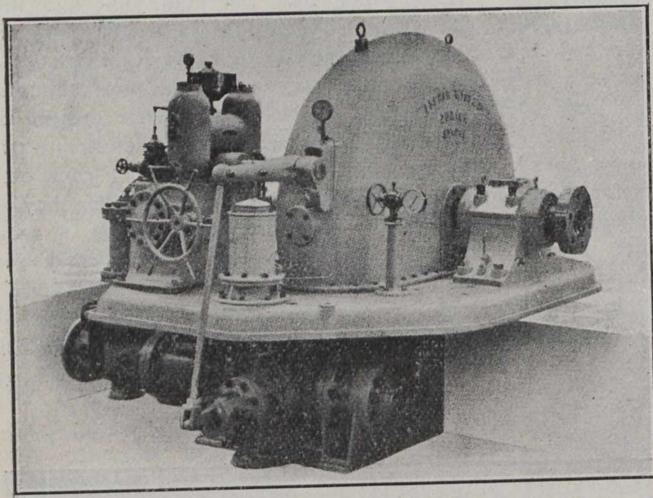


Fig. 3.—Generating Turbines of 6,500 H.P

necessary to safeguard the parts against rapid wear and to ensure a high efficiency. The question of regulation had also to receive close attention, so that no great rise of pressure should occur, on sudden variations of generator load, in a pipe line which was already highly stressed under normal conditions, and that there should at the same time be no waste of water to prejudice the yearly output of the station. It would have been an easy matter with this high fall to have built a wheel having a large number of revolutions and thus small dimensions and light weight. But the necessity in the case of providing for minimum wear and

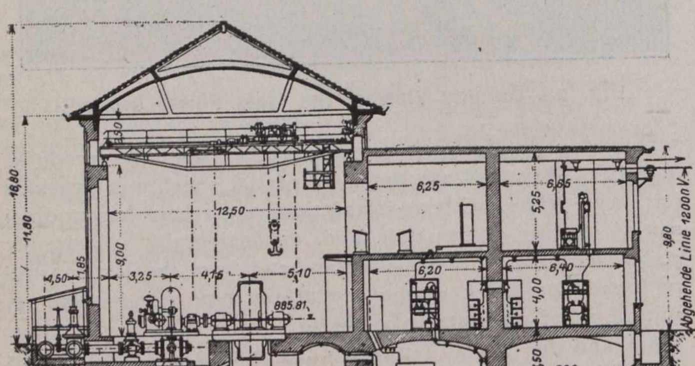


Fig. 4.—Section Through Isola Power House.

maximum efficiency required a wheel of large size; thus the comparatively slow speed of 420 revolutions per minute was selected. The runner has therefore an outside diameter of about 10 feet.

In order to obtain a large flywheel effect for the unit and therefore small moving velocities of the regulating mechanism, the turbine runner itself was built as a flywheel with a heavy rim. Although a rather longer time of closing is thus possible (5 to 6 seconds), yet this would be much too short to prevent serious rises of pressure in the pipe line, and another device has, therefore, to be provided, by which pipe line pressure oscillations could be avoided with certainty.

It was therefore determined to use a "deflecting nozzle" for the additional regulation required for the turbines of the Isola station, and this device will now be described. The supply of water flows from the distributing pipe to the turbine through a pipe of fourteen inches internal diameter, to which is connected a hydraulically operated sluice valve of specially heavy construction. The water then passes through a bend to a needle nozzle of circular cross section, from which it emerges as a cylindrical jet on the wheel.

A pear shaped needle which is movable along the axis of the nozzle regulates, in the usual manner, the area of the opening and the quantity of the water required for the load on the turbine. The whole inlet bend carrying the needle nozzle is movable about the axis of the inlet pipe, in which it is pivoted and jointed with double leather packing rings. By swinging this nozzle in the vertical plane, it is possible

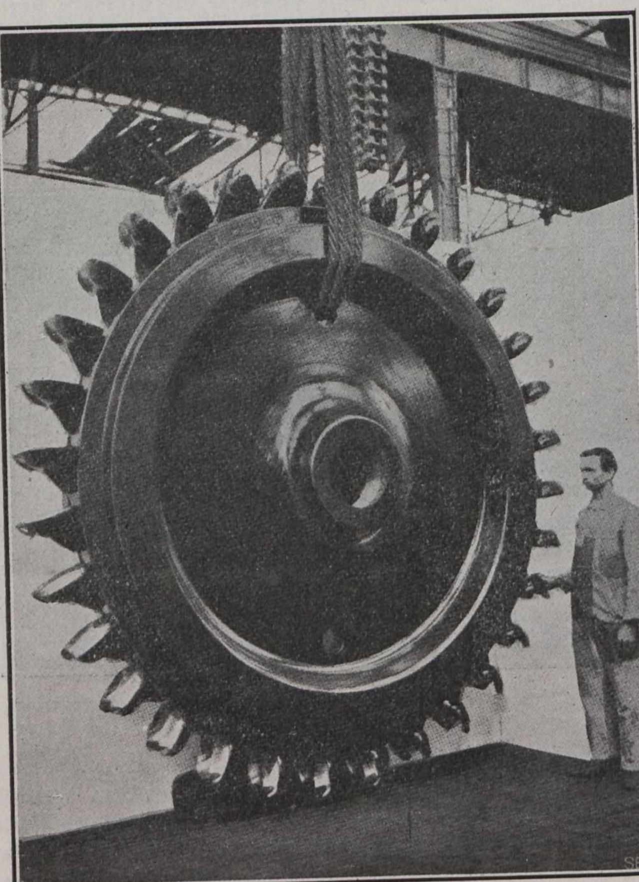


Fig. 5.— Runner of 6,500 H.P. Turbine.

to adjust the direction of the jet, so that it hits the buckets correctly at one end of its swing, but at the other misses the wheel entirely and shoots straight down into the tail race. The arrangement is known as a "deflecting nozzle", and it serves the same purpose as the pressure regulators with auxiliary outlets or with jet deflector, but has a considerable advantage over these in respect of durability of parts.

This patented deflecting nozzle, which is Zodel's design, is connected with the automatic governor in such a way that it swings out immediately any considerable reduction of turbine load occurs, without altering the setting of the needle and therefore without causing any shocks in the pipes.

The automatic regulating gear then begins to shove the needle slowly forward, and at the same time to swing back the nozzle. When the latter has again reached its first position, the movement of the governor is completed and a fresh condition of equilibrium is established. The closing time of the needle nozzle can be adjusted within wide limits to suit the conditions of any plant. A momentary loss of water, depending on the time of closing selected for the particular case, is of course unavoidable, just as in the case of the auxiliary outlet and the jet deflector. But the great advantage of the deflecting nozzle over the other pressure regulators just named lies in the fact that nozzle and regulator are combined in one, and that no wear or derangement of deflecting parts can occur, no matter how suddenly it is worked. By its use all continuous loss of water through leakage is avoided, and this is of very great importance on a high pressure plant of the present kind where storage is the main bed plate, which also carries the governor, the casing, and the dash pot regulator. The jet does not shoot directly into the tail-race when deflected off the wheel, but impinges on a small angle on an armored plate which turns it downwards. The lateral discharge from the buckets is also caught by the trough-shaped armor plates and turned harmlessly down into the tail-race.

The 500 h.p. exciter is constructed in a similar way.

The power station was started up on the 5th and 6th of November, 1910, when the preliminary tests were made on the turbines. The results were in every way satisfactory, especially as regards efficiency, output, and regulation.

The Isola power house lies close against the mountain slope, and on the right bank of the Poja d'Arno. The tail race passes under the turbines; its outlet passes at right angles, about in the middle of the power house, beneath the distributing pipes; it then turns to the right and widens to

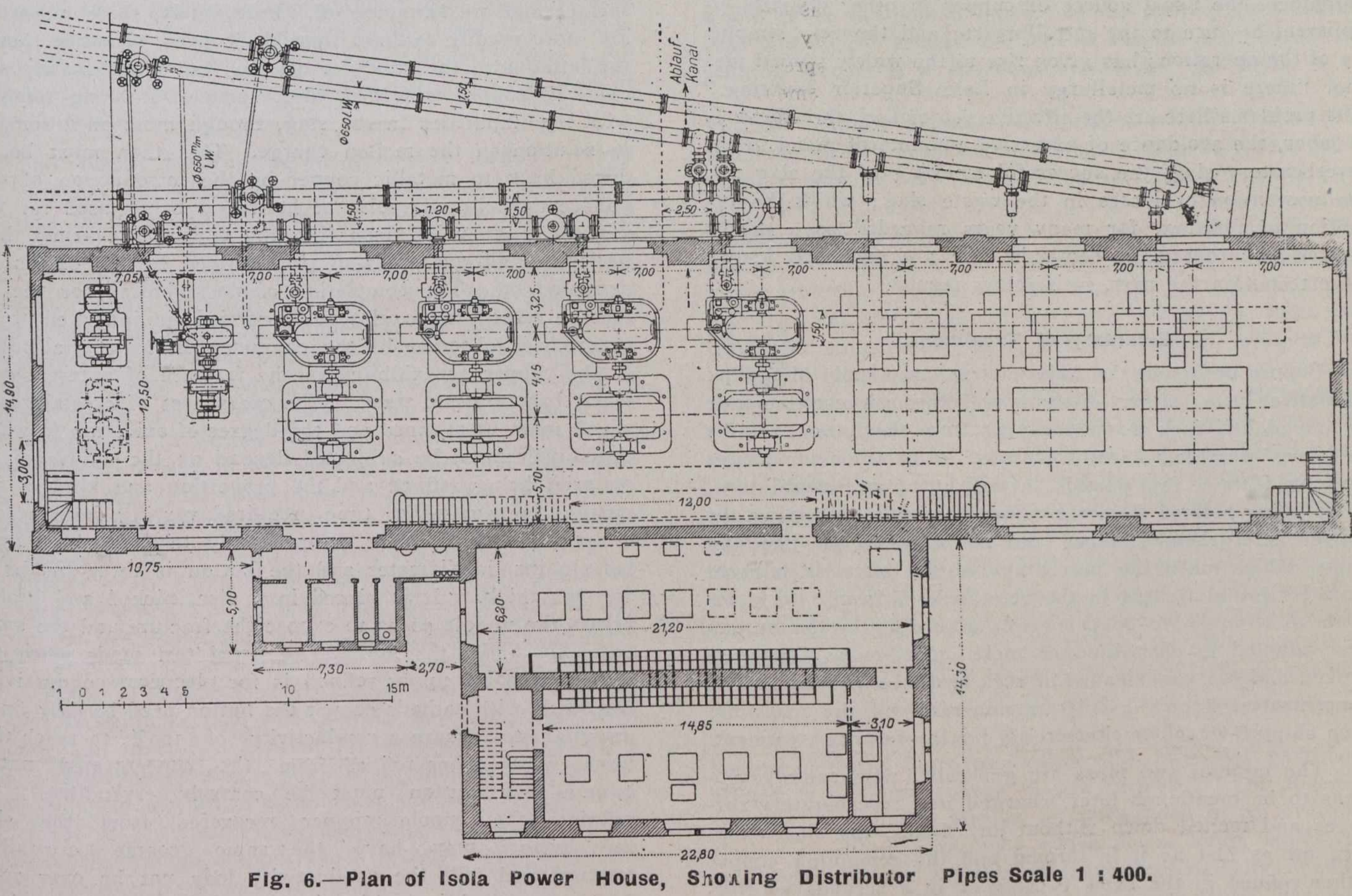


Fig. 6.—Plan of Isola Power House, Showing Distributor Pipes Scale 1 : 400.

an essential part. The main object of the device, to avoid pressure shocks on sudden switching off load, is fulfilled in an ideal manner, for the conditions of flow of the water through the nozzle are not altered by it being swung away from the wheel. The resulting slight change in direction of the reaction from the jet is taken up by the ample bearings with which the inlet bend is pivoted in the inlet pipe; the oil pressure regulator has only to overcome the friction of the movable part in the inlet pipe, mainly caused by the pressure of the leather packing rings and by the force of reaction of the water jet.

The material used for the nozzle is the finest steel, the needle and the nozzle lip are made of nickel steel; the buckets of the running wheel are of the finest flawless cast steel, machined on the inner faces as smooth as a mirror, and having the cutting edge on which the water impinges ground as sharp as a knife. The buckets are dovetailed into the wheel, and are each secured by two threaded bolts. The turbine shaft runs into two massive bearings bolted to

form a measuring channel and overflow weir. A junction is effected, immediately below this weir, with the conduit which carries the water from the Adame' and Salarno to the Cedegolo station.

SAFETY OF COAL MINING IN INDIA.

Strange as it may appear, recent statistics indicate that coal-mining fatalities in the mines of India are only at the rate of 0.93 per thousand. This compares with an average of 1.3 for the Uuited Kingdom, and of 2.97 for other European countries. In the coalfields of Bengal, where the majority of Indian mines are situated, there is a general freedom from gas, and the coal-bearing strata are so little disturbed by earth movements, that a natural roof can be relied on without any need of timbering. It is stated further that the miner himself, in India, is exceedingly careful and retains a sense of discipline that does not exist in the mines of Europe or America.

COPPER SMELTING PRACTICE IN LAKE SUPERIOR REGION.*

By Henry D. Conant, Superintendent Lake Superior Smelting Company.

Copper smelting in the Lake Superior district of Michigan comprises the melting of concentrates and mass containing native metallic copper, the refining of the copper, and the smelting of the slag formed during the melting operation to recover the high metal values carried by it. In the simplicity and directness of the methods and processes required the Lake practice differs very greatly from that of any other district and is altogether different from that involved in the treatment of the ores of copper. The absence of roasters, calciners, matte furnaces and converters, and the electrolytic refinery, essential to the smelting of copper sulphides—the usual source of copper in other districts—is apparent at once to the metallurgist; and the very simplicity of the operations has given rise to the widely spread idea that "there is no metallurgy in Lake Superior smelting." The problems here are the effective use of fuel, the efficiency of labor, the avoidance of excessive amounts of metal in the reverberatory slag, the successful smelting of the slag and the prevention of losses in the waste slag; while the operation of refining, for many years regarded as a deeply mysterious proceeding, demands care and technical knowledge to obtain the most satisfactory results.

Summary of Treatment.

Copper occurs in the Lake district practically altogether in native form, either disseminated through conglomerate or amygdaloid rock in sizes vaying from the finest particles to pieces weighing several pounds, or existing in masses running from a few pounds in weight up to several tons. After being hoisted from the mines the rock containing the copper is crushed, stamped and concentrated on jigs and slime tables until the percentage of the metal is brought from its initial figures in the vein rock of from 1 to 3 per cent. to from 60 to 80 per cent., according to the system best adapted to each kind of rock. The mass copper is broken and cut, and cleaned of rock as far as possible. The concentrates, known locally as mineral, and the mass are then shipped to the smelters ready for the furnace treatment.

The mineral and mass are generally, with some exceptions to be mentioned later, charged into reverberatory furnaces and melted down without any fluxes, the slag skimmed off as fast as it is formed and the remaining copper either refined in the same furnace or in a secondary reverberatory furnace into which it is tapped. The refined copper is then either ladled or dipped into moulds to form the several shapes into which it is marketed.

The slag is skimmed usually into conical pots, some metallic copper settling to the bottom in a button, cooled and broken into pieces and transferred to the storage floor or bins at the blast furnace. It is then smelted in a blast furnace with limestone, with the addition of ferruginous or siliceous fluxes as may be necessary, coke being used as fuel for melting and anthracite as a reducing agent. The resulting "cupola" copper is tapped into blocks which are melted in reverberatory furnaces and refined; while the waste slag, low in copper, flows continuously from the slag spouts into pots or into granulating devices for removal to the slag dump.

The Lake Superior smelting industry and its methods had its origin in practice derived from Wales, Welsh refiners having been employed in the works first established 50 years ago in Detroit, Mich., for the treatment of the Lake copper.

The old-time reverberatory furnace, with a capacity of 7 or 8 tons of copper—increased later to as much as 20 tons—had a hearth 11 ft. wide by 14 ft. long, with a fire box 4 ft. square. The sides and roof were laid up with clay fire brick and the hearth was put in with a highly refractory sand carefully baked in layers and seasoned with copper. Furnaces of this sort are still in use at three of the works. They are charged with mineral and mass in the afternoon, the fires are cleaned and built up, and the melting continued during the night, slag being skimmed off at intervals until the gauge has been removed, and early in the morning the charge is ready for the refining operations. The first step, known as rabbling, is to oxidize such comparatively small quantities of impurities as occur, which come to the surface and are skimmed off. Fortunately, these impurities are more readily oxidized than the copper, sensitive though the latter is to the attack of oxygen; but unfortunately suboxide of copper is formed also, some of it being removed with the impurities in the slag, though most of it remains in solution in the molten charge. This then must be reduced back to metallic copper by the introduction of carbonaceous material, poles of hardwood being used for this purpose and buried deep into the copper. During these periods small quantities of slag formed by the oxides are skimmed off. The completion of the rabbling, or the extent to which the oxidation is carried, is indicated to an experienced observer by the character of the crystallization of the copper as exhibited in the fracture of a test button taken from time to time. The coarseness of crystallization which must be attained and the degree of oxidation to which the copper must be subjected depend on the nature of the material being refined and the proportion and kind of impurities present—the time required varying from 2 to 6 hours. The test button is commonly taken with a small ladle 2 ins. in diameter and the button is three-fourths of an inch thick. It is placed in a vise, nicked and broken across the middle so as to expose the fracture and the small hole just under the top. The usual test made when the copper is poled up or refined is for electrical conductivity, and while with cathode copper the button need be only finely granular to assure a conductivity of 100%, to reach that figure with copper refined from the concentrated native mineral the button must be coarsely crystalline. In refining the cupola copper recovered from the slag the button may have the same coarse crystalline fracture and still the conductivity may not be over 70%. The amount of impurities is by no means uniform from one time to another even for the same kind of copper, and no general rule could be deduced to govern all cases because it would be necessary in order to apply the rule to determine precisely the kind and amount of impurities contained in each furnace charge—a proceeding which, for obvious reasons, is entirely out of the question. Rabbling was formerly accomplished by stirring the surface by pushing a rabble—a 4 by 6-in. piece of iron attached at right angle to an iron handle 8 ft. long—back and forth; this laborious operation has been entirely superseded by the use of compressed air either blown through 1-in. iron pipes inserted into the copper or made to impinge on the surface.

The refiner in charge of the furnace having satisfied himself by repeated tests that the copper is sufficiently purified submits a button to the foreman for his judgment; and if this is favorable, the poling is started and carried on until the surface of a test button sets level and without any depression when cold, this being the end of the refining process and the metal being then ready to be poured into

*School of Mines Quarterly.

moulds by one of the several methods employed at the different works.

The slag skimmed from the reverberatory furnaces during the melting and refining operations contains from 15 to 30% copper and may be either acid, that is running 40% SiO_2 and 20% Fe_2O_3; or basic, running 25 SiO_2 and 45% FeO. The acid slags come from the amydaloid mineral and the basic from the conglomerite. When these different kinds of mineral happen to belong to different mining companies the resulting slag is kept separate because of the irregularity in the copper contents in slag from mineral charges and from charges refined from cupola blocks and the impossibility of obtaining a representative sample for assay, thus necessitating the use of iron for fluxing the acid slag and silica for the basic slag in order to produce a freely running slag approximating 33% each of SiO_2 and FeO, and 20% CaO. The iron is found in the hematite mined within 100 miles or in pyrites residue shipped from sulphuric acid plants, while the silica is obtained in the form of sandstone quarried nearby. Limestone is either brought from Lake Erie by boat or by rail from quarries near the east end of Lake Superior.

The blast furnaces—or cupolas—were formerly round or elliptical in plan, but are now all rectangular varying from 40 to 48 ins. in width at the tuyeres and from 8 to 12 ft. in length, the crucible being built of fire brick lining within cast-iron plates and the shaft consisting of steel water jackets. The shafts are from 7 to 10 ft. high. No forehearths are used as, in the absence of matte which would keep hot, they would soon freeze up; so that the separation of the slag and copper is effected in the crucible—the deeper the crucible, the better the separation. In former years these furnaces were run with a blast pressure of as much as 16 ozs., but experience has shown that from 3 to 4 ozs. is as high a pressure as should be used, thus permitting the furnace to run slowly and allowing the greater reduction and better settling of the copper. By lowering the blast pressure and lessening the speed from ten tons an hour to 3, the percentage of copper in the waste slag has been reduced to one-fifth of what it was under the former conditions. The blast is supplied by a Roots or Baker blower. The reduced and metallic copper, containing small and varying percentages of iron, sulphur and arsenic, settles to the bottom of the crucible and is taped out at intervals whenever enough has accumulated to make a block weighing, at different works, from 300 to 100 lbs., while the slag, floating on the copper, flows continuously through a spout which inclines upward to form a trap to prevent egress of the blast.

Michigan Smelting Works.

The Michigan Smelting Works, situated on the south shore of Portage lake, some 3 miles west of Houghton, are the latest built, having been erected in 1904, and contain features new to the Lake practice although common in the west and east. The general scheme of the reverberatory plant is a combination of separate melting and refining furnaces—although the latter are also utilized to a certain extent for melting. The bulk of the mineral concentrates is melted in the melting furnaces proper, and the only time lost is the few minutes occupied in running the copper over to the adjoining refining furnace which sets at a lower level at one side with the bridge a little in advance of the front of the melting furnace. The mineral is received at the smelting works by rail in hopper bottom steel cars of 100,000 lbs. capacity, weighed on a track scale, and unloaded into circular steel bins situated high on the hillside, from which it is drawn into small steel hopper cars propelled by electric locomotives to the furnace hopppers. As soon as the copper is tapped out each morning the furnace is charged and the melting proceeds almost without interruption, thus securing the greatest possible efficiency from the furnace and avoiding the heat losses and strains and the loss of time—which would be from the 12 to 15 hours—incident to the refining operation. This arrangement also permits the adaptation of the furnace design to the purpose intended, a broad shallow hearth being used in the melting furnace, while a deep, narrow hearth is used for refining. In order to take advantage of the time not occupied in refining, the secondary furnace is charged at the close of the refining operation with such a quantity of the richer grades of mineral as can be melted and made ready by the time the primary furnace is ready to tap, this giving a well-balanced scheme. Bituminous coal is supplied to the furnaces from bins by electric tram cars and discharged into hoppers through coarse gratings which hold back large lumps that would choke the hopper gates. In the melting furnaces the coal is dropped through the roof of the fire box, but at the refining furnace it is shovelled in through end doors.

The refining furnaces are equipped with Walker casting machines, which are now very largely used in copper refineries, consisting essentially of a circular horizontal cast-iron frame with heavy movable brackets or arms projecting radially outward to serve as supporters for the molds. The machine is rotated about a central pivot by an electric motor controlled by an operator who sits in the centre. He also operates the hydraulic power for tilting the ladle into which the copper flows as it is tapped from the refining furnace, and from which it is poured by him into the molds as they are brought successively in front of it. As the machine rotates the copper chills or "sets" and becomes solid—the diameter of the mold ring and the speed of rotation are designed with this end in view. Setting or chilling is timed so as to take place just as the molds reach guides which engage with the lugs fastened to the molds and overturn them so that the copper ingot, bar or cake may drop into water for the final cooling upon a conveyor. The conveyor then removes it from the cooling tank and elevates it above the floor line and deposits it on a table for convenient transfer to steel platform cars of 30,000 lbs. capacity running on a 36-in.-gauge track and hauled by an electric locomotive to the scale and thence to the loading platform. More than 300,000 lbs. of copper have been refined in a single charge in one furnace. The space in front of the refining furnace is commanded by an overhead electric travelling crane with which poles, scrap, molds and other material are expeditiously and economically handled. Indeed, the use of electricity as a motive power has been very thoughtfully applied, and the absence of hand labor is very noticeable. The waste heat from the furnaces is passed through boilers in which sufficient steam is generated to furnish all the motive power, such as the electrical generator engines, pumps and air compressors.

The blast furnace is used for smelting mass copper as well as the reverberatory slag. This slag, skimmed into long narrow molds, is broken up in a rock crusher and elevated into bins from which it is carried to the furnace in side-dump steel cars pushed by an electric locomotive, together with the fluxes and fuel. The tram track runs longitudinally through the furnace at the charging floor level, and as the charging car passes over it the side gates are opened and the charge is distributed along the furnace. As the top of the furnace is normally cool, there is no danger of over-heating the rails or the cars; when the heat does rise, as in starting up and blowing down, the track is swung up to one side. The waste slag is granulated by dropping it into a stream of water flowing rapidly in front of the settler and is carried by the water through a launder to the slag dump in the lake.

Quincy Smelting Works.

Next in geographical order and in time of erection are the Quincy Smelting Works, built in 1898 on the north shore of Portage lake, opposite Houghton. There is one main refinery building containing four separate reverberatory furnaces, in each of which the mineral is melted and the resulting copper refined. The mineral comes from the stamp mill in 60,000-lb. capacity steel hopper cars having separate compartments for the different grades, and is unloaded into storage bins from an overhead trestle. Small steel charging cars pushed by hand are used to transport the mineral from the bins to the furnaces where the cars are lifted by electric jib cranes and emptied into the hoppers above the furnaces. The furnaces are charged each afternoon, the melting and skimming going on during the night and the copper is refined and dipped out the next morning. These furnaces have fixed boshes on which the molds are placed, and contain water into which the copper drops when the molds are overturned. The dipping is performed with ladles swung on trolleys travelling on I beams which run over the front door of the furnace and over the molds. The copper is fished by hand from the water when cool and piled on hand trucks for weighing and removal to the shipping dock.

The blast furnace is charged with 2-wheeled buggies from bins. The waste slag runs from the settler into a large slag car holding 3,000 lbs., mounted on four wheels. When this car is full it is run to an elevator and lifted about 30 ft. above the ground level to the slag tramway, along which it is propelled by a Baldwin-Westinghouse locomotive to the slag dump, which forms a broad solid deposit on low ground.

There is a briquetting plant for making briquettes of the very fine slimes that form part of the concentrates. These are mixed with fine lime and pressed into form in a White briquet machine; then the briquettes are piled on tram cars and placed in a steel cylinder in which they are hermetically sealed and subjected to intense heat in an atmosphere of superheated steam. This puts them in condition suitable for smelting in the blast furnace without excessive loss in flue dust.

Lake Superior Smelteries.

The Lake Superior Smelting Works at Dollar bay, some 3 miles east of Houghton, on the north side of Portage lake, were built in 1888. As originally planned there were two refinery buildings, each intended to contain four furnaces. After being remodeled twice the plant now comprises three large reverberatory furnaces and four small furnaces, the latter soon to be superseded by the fourth large furnace, now under construction. Each furnace is used for both melting and refining. The large furnaces, 17 ft. wide by 30 ft. long, are equipped with mechanical pouring devices and have a capacity of 200,000 lbs. of refined copper to the charge. The casting machine consists of a series of cast-iron plates connected on each side by an endless chain which passes over sprocket wheels at each end, carrying copper molds and bringing them successively in front of a hydraulically operated ladle kept constantly filled with copper flowing from the furnace. The ladle, in addition to the tilting motion, has a reciprocating motion alongside the table and is centred and carried along with the mold during the pouring by a lug which engages with one of the links of the chain and on being released at the end of the stroke is returned to the initial position by means of a hydraulic cylinder. This permits the continuous motion of the molds without having to stop them at the ladle. The ladle is controlled by one operator seated opposite the tap hole. As the molds pass down over the end wheels the solidified copper drops from them into the water of the cooling tank on to a moving conveyor which carries it along in the water until thoroughly cooled and then up to the loading table. From this it is lifted over to 4-wheeled trucks that carry between 5,000 and 6,000 lbs., which are pulled by a gasoline motor truck to the scales, two in number, and thence to the dock or platform, where it is piled in regular order ready for shipment. One of the scales has an ordinary beam which is read in the usual manner, while the other has a type-registering beam which makes a printed record when the load is balanced, thus affording an absolutely reliable check on the reading of the first scale.

The mineral is brought to the works in steel hopper cars of 100,000 lbs. capacity, which are run up a trestle over the bins, these, however, being little used, as the mineral is ordinarily dropped into hoppers leading to belt conveyors, which carry it direct to the furnace hoppers—the cars being weighed, both loaded and empty, on a railroad track scale provided with a type-registering beam.

An electric overhead monorail crane traversing the works and yard serves to handle cupola blocks, mass copper, supplies and other materials, delivers coal to the furnaces by means of a detachable shovel of the clam-shell type provided for that purpose, which can be removed when not in use, and hauls the slag pots containing the reverberatory slag to the blast-furnace charging floor.

Steam for running the power plant is obtained from vertical water-tube boilers which utilize the waste heat from the furnaces. Each furnace also has a stack through which the gases may be diverted in case repairs to the boilers are necessary. Recording pyrometers and draft gauges making 24-hour graphical records indicate the working of the furnaces and guide the furnace men in their work.

At the blast furnace the slag, fuel and fluxes are shoveled into small steel tram cars which are pushed by hand to the charging doors and up-ended by a steam-cylinder hoist so that the contents are slid into the furnace. The waste slag is granulated by falling into a stream of water and elevated by a link belt elevator into a storage tower from which it is hauled away by teams to the dumping ground. A recording blast gauge makes a continuous record of the blast pressure, which, together with the daily analyses of the waste slag, gives a check on the running of the furnace.

Calumet & Hecla Smelteries.

The Calumet & Hecla Smelting Works, built in 1885, are situated on the shore of Torch lake, 9 miles from Houghton, and contain 12 reverberatory furnaces. The mineral at these works is stored for a time in bins to allow the water to drain out, after which it is drawn to the furnaces in 2-wheeled buggies. These are lifted over the charging hoppers above the furnace by electric cranes. At the last blast furnace the slag, fluxes and fuel are lifted in the tram cars by an electric monorail crane and discharged into steel bins arranged around the sides of the building high enough above the charging floor to permit steel buggies to be loaded through shore chutes; the buggies are then wheeled to the furnace doors and the contents dumped into the furnace. The waste slag escapes through a trapped spot into slag pots mounted on wheels, from which it is dumped when chilled on the ground, broken and lifted by a derrick to railroad cars for transportation to the dumping ground.

Disposition of Smelt.

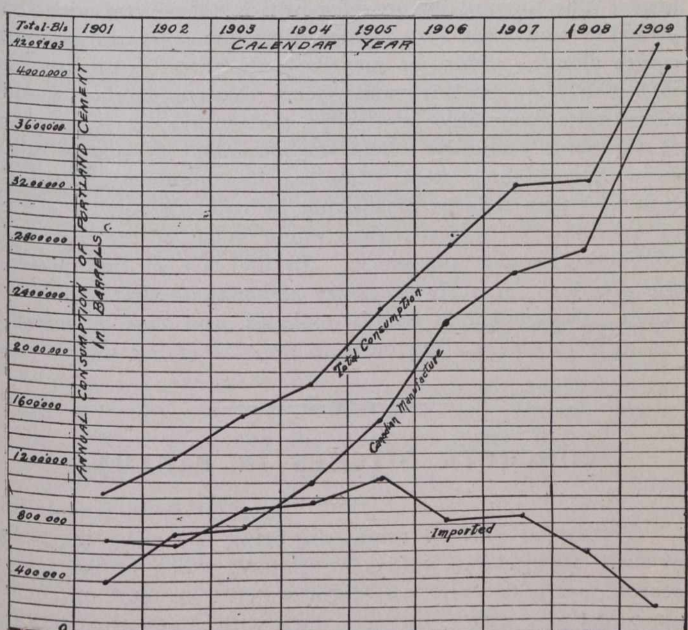
The refined copper product at the various smelteries is cast into a variety of shapes, such as ingots, weighing about 20 lbs. each, used for making brass, bronze, bearing metal, etc.; ingot bars consisting of two or three ingots joined together endways in one piece for convenience in shipping, thus avoiding the use of the casks required for small ingots; wire bars about 4 ins. square and 4½ ft. long, weighing 225 to 250 lbs. for rolling and drawing into wire for electrical purposes; cakes, both square and round, varying in weight from 120 to 6,000 lbs. and from 14 ins. by 17 ins., up to 56 ins. square, for rolling into sheets intended for making copper boilers, bath tubs, vacuum pans, digesters, etc., billets for manufacturing seamless drawn tubes; and when there is an appreciable amount of silver associated with copper, into anodes for subsequent electrolytic treatment to recover the silver.

Each plant possesses a well-equipped physical and chemical laboratory. This is maintained primarily to determine electric conductivity, and the percentage assay of copper. At the same time, too, considerable research work is carried on for the purpose of bringing to light unknown factors bearing on the refining and quality of the copper.

ANNUAL CONSUMPTION OF PORTLAND CEMENT.

The accompanying curves with the annual consumption of Portland Cement plotted against the calendar year shows very clearly the growth of the cement industry in Canada and also the history of imports of cement.

The top curve shows the total consumption of cement in Canada. The next curve shows the consumption of cement of Canadian manufacture and the bottom curve shows the consumption of imported cement. In 1901 of all the cement used in Canada 64 per cent. was imported, in 1909 only 3 per cent. was imported; 97 per cent. or over 4,000,000 barrels being of Canadian manufacture.



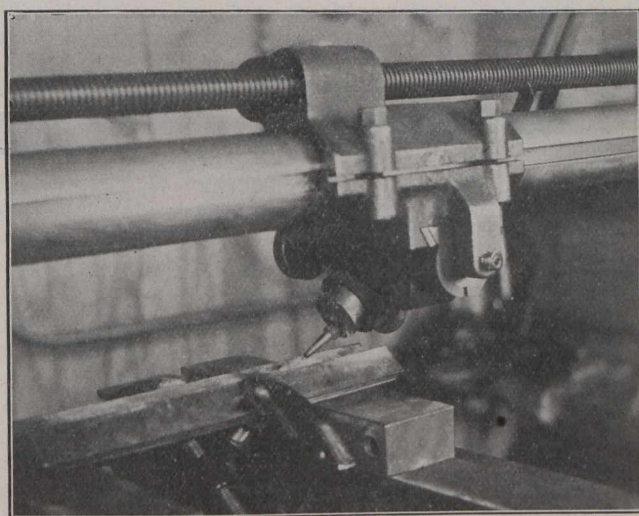
Annual Consumption of Cement in Canada of (Canadian and Imported) Years 1901-1909.

The above curves were plotted from data given in the Annual Report of the Mineral Production of Canada-Department of mines.

ACETYLENE WELDING AND CUTTING MACHINE.

Hand welding and hand cutting are now familiar operations to which the acetylene blow-pipe is highly adapted. Where straight-line operations have to be carried out, especially in connection with repetition work, a machine is often applicable and advisable. Where sheets are very thin, machine welding is very desirable, because of the certainty with which it can be regulated. The machine can be advantageously used in sheet metal work, where the thicknesses range up to, say, 3-16 or 7-32 inch. Straight cutting of both thin and thick work can be advantageously done with the machine because of the precision of the movement.

An acetylene welding and cutting machine has recently been built by the Davis-Bournonville Company, of 90 West street, New York City. The patent rights involved are held by this concern. There is a cylindrical upright perhaps six or seven feet in height. This carries a long hollow arm projecting for six or seven feet on one side. By means of a rack and pinion, this arm may be adjusted to any height desired. The arm carries a long screw, rotatably and horizontally mounted in suitable bearings. At the base of the upright, loose and tight pulleys are mounted on a short horizontal shaft and are driven from an ordinary counter-

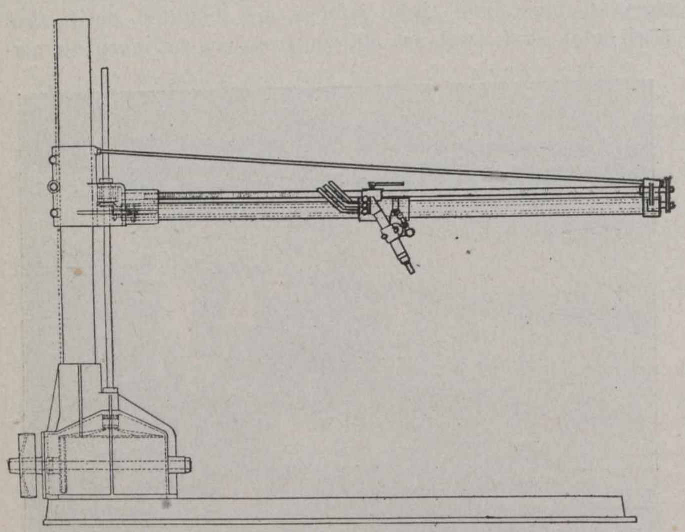


The Machine Rigged With Welding Torch.

shaft above. This latter shaft and a rotatable rod arranged in the hollow arm are put into driving connection by bevel gears. At the outer end of the arm, an arrangement of gears enables the inclosed rod to drive the screw. The turning of this screw operates a carriage back and forth horizontally along the arm. Upon the carriage, the torch and its controlling fixtures are mounted. The work is placed or secured on a suitable fixed table. Flexible tubes bring the oxygen and acetylene to the torch. The tip is practically the ordinary form. It is arranged at an angle, say 40 or 45 degrees, to the horizontal, this angle being to the rear of the welding movement. The torch then moves over the work much after the way a cowcatcher passes along over a railway track.

The method of welding is often quite simple. Thus, if the weld is to be a flat one and of inconsiderable length, the two pieces are simply clamped in the exact relative positions they are to occupy finally. Room must of course be left for the tip to pass. The operation of welding is then not unlike that which occurs with an ordinary shaper. The carriage with the torch moves evenly along at the proper rate of speed. The countershaft, running at say 140 revolutions per minute, operates the short horizontal shaft at about 70 revolutions. It is possible to adjust the friction pinion to vary the angular speed of the vertical shaft from about 70 to about 35 revolutions. Still further reductions of speed may be made by the gears at the end of the arm. Indeed, quite a range of speeds may be obtained by suitable combinations of the gears. The screw has about six threads to the inch, and gives the carriage a speed which may be varied from 3 to 24 inches per minute. The carriage has a back-and-forth range of five feet five inches, which means that a weld of approximately that length may be made. If an angular weld is to be formed, the only difference to be made is in the arrangement of the work. The angle opens downwards and the vertical plane through the line of the weld bisects the dihedral angle. To illustrate by practical example, we will suppose that it is desired to weld two strips edge to edge at an angle of 90 degrees. We place the strips on the sides of an angle bar, clamping them securely in position with clamping strips inserted between the outer faces of the work and the jaws of the clamps.

There is a possible economy which is possible with hand welding, and which will probably come into pretty general



One Method of Clamping Work for Angular Weld.

use where the machine is used. The object of using an oxy-acetylene torch is for the purpose of getting a very high temperature. Because of the enormous temperature of about 6000° F. which is claimed for the working point of the little inner flame, this torch is very successful in bringing steel and other metals locally to or near the melting point. Ordinary flames are incompetent to this. But the ordinary—and cheap—flame is incompetent to supply a large amount of the requisite heat. Where the form and character of the work do not prohibit, there seems no reason why pre-heating by cheap methods should not be employed. In other words, it is not necessary to do all the heating with gases like acetylene and oxygen. The saving is, however, not connected with the consumption of the gases alone: time may also be saved; and this means economy of the labor and the machine. For example, certain work requiring a long seam and involving sheets 0.10 to 0.12 inch thick can be welded on a European machine at the rate of about 12 inches per minute. Practical experiments where the work was pre-heated before passing under the torch showed, so it is said, that the work—and I understand it to be the same class of work—can be welded at a speed of 26 to 28 inches per minute. The economy in time is striking. The methods of pre-heating may be various. Thus, if it is a question of small repetition work, the pre-heating may in some cases be done subsequent to clamping but prior to putting the work on the table. Other cases will require pre-heating with the work in welding position. In general, the pre-heating arrangements will not be difficult to provide. Pre-heating is to be recommended strongly for two reasons—economy of oxygen consumption and reduction of effects of expansion and contraction.

The machine already described as a welding device can readily be used as a cutting apparatus. The high precision of the motion of the carriage recommends it for this purpose. In cutting, however, some variations are made. In the first place, the jet arrangements are different. But this is perhaps more a matter of simultaneous development, as the new arrangement of jets will no doubt be effective as a hand tool. On the machine, three jets are arranged in a rigidly vertical position, the gases being driven directly downwards. These are arranged in line with the direction of movement. Ahead is a heating jet of oxygen and acetylene; at the rear is another but smaller heating jet. Between the two, the cutting jet of oxygen is arranged. Three flexible tubes bring the gases. An oxygen and an acetylene tube together supply the gases for the two heating jets. Thus these jets are both supplied from the same sources. An independent oxygen supply is provided for the cutting jet, for the reason that ordinarily the pressure back of this jet is higher—and sometimes much higher—than is the case with the heating oxygen. By the foregoing arrangement of jets, a strong heat is provided just ahead of the cutting oxygen, and a moderate one just behind. The office of the jet ahead is pretty well known: it raises the steel to the temperature of combustion. The pure oxygen then enters the game, and the metal is "cut". It has been found, however, that by providing an auxiliary heater behind, the work of cutting is facilitated. Its operation is probably as follows: The forward jet provides heat for the metal which is probably somewhat lost by the time the pure oxygen jet comes along. This jet may be only three-eighths of an inch behind. Still it would seem that conduction would carry off considerable heat while the cutting jet is getting to the spot, especially where the movement is a slow one, as with very thick steel. The rear jet provided additional heat and thus reduces dissipation by conduction. Its scene of operation is in the region where much of the wasteful conduction would take place. In the case of thin plates, the rear jet is scarcely necessary and may be shut off. The whole arrangement is readily replaced, and thus is permitted an economical adjustment to the size of the work.

CONCRETE DITCHES IN PANAMA.

Permanent concrete drains are being laid along the beds of small ravines and gullies at Empire, which in the rainy season, serve to carry off storm water. A total of about 9,000 feet of concrete drainage ditch will be constructed, the work involving excavating and straightening the natural bed of the watercourses to established lines and grades, the building of suitable culverts where roads cross them, and placing concrete in the drains. This work is confined to the section in which the American quarters are situated, and is a sanitary measure, as it will obviate the necessity of removing obstructions which are constantly washing into the ditches, including dirt from cave-ins, and, in addition, will reduce the amount of grass cutting to be done. Similar ditches, says the Canal Record, have been constructed at Las Cascadas, and a system of permanent drains will probably be installed at Gatun during the next dry season.

FOREST RESERVES.

The changes made by the Dominion Act lately passed are here given:

Among the British Columbia reserves the Long Lake, Monte Hills, Martin Mountain, Niskonlith, Tranquille, Hat Creek and Larch Hills reserves are left unchanged. The Donald forest reserve is abolished, and the Yoho Park and Glacier National Park are brought under the Act.

In Manitoba the Riding Mountain, Turtle Mountain and Porcupine reserves are left unchanged. The Lake Manitoba West reserve is dropped. The Spruce Woods reserve is doubled, being increased in area from 110 square miles to 224.5 square miles. An addition of 153 square miles is made to the Duck Mountain reserve, making its total area 1,401 square miles. As this reserve has been extended into Saskatchewan, the same plan has been adopted in designating it as was taken with the Porcupine reserves; that is, the part of the reserve within the province of Manitoba is known as Duck Mountain reserve No. 1, while that in Saskatchewan is called Duck Mountain reserve No. 2.

In Saskatchewan Porcupine reserve No. 2 is unchanged. Moose Mountain forest reserve is diminished by seven square miles, while The Pines forest reserve has nine square miles added to its area. The Beaver Hills reserve is increased by twenty-seven square miles.

Three new reserves have been created, namely, Duck Mountain No. 2, Cypress Hills No. 2 and Nisbet forest reserves. Duck Mountain reserve No. 2 has an area of eighty-one square miles; it is contiguous with Duck Mountain reserve No. 1. The Cypress Hill reserve No. 2 is contiguous with Cypress Hills reserve No. 1 as established under this Act; it is seventy-two square miles in area. The Nisbet forest reserve is directly across the river from Prince Albert; its area is 15 square miles.

The Cooking Lake reserve in Alberta is reduced from 114 square miles to 111.5, and the Cypress Hills reserve enlarged from eighteen to eighty-one. The latter reserve is now known as Cypress Hill reserve No. 1 (for the same reason as in the case of the Porcupine and Duck Mountain reserves), and Cypress Hills reserve No. 2 is contiguous with it in Saskatchewan.

The largest reserve of all (first set aside by order in council in May, 1910, and referred to in the June, 1910, issue of the Journal) is the Rocky Mountain forest reserve. The area, as defined in the Act, is 18,213 square miles. This, of course, includes Rocky Mountain (Banff) Park, Jasper Forest Park and the Waterton Lakes Park.

Buffalo Park, near Wainwright, Alta., is also set aside, 159 square miles in area.

The aggregate area of the reserves and parks is now 25,186½ square miles, as compared with 16,312¼ square miles formerly. The increase in Manitoba is nine and a half square miles, the area now under reserve being 3,584¾ square miles, as compared with the previous area 3,575¼ square miles. With the present area of 937 square miles under reserve, the Saskatchewan reserves have increased by 197 square miles over the former area of 740 square miles. Alberta's reserves have well nigh doubled in area, being now 18,564½ square miles as compared with 9,702, an increase of 8,862½ square miles. In British Columbia alone has the area under reserve been lessened. In that province the former reserved area was 2,190 square miles; the area reserved is now 2,115¼ square miles, thus showing a decrease of some 75 square miles.

THE DISINFECTION OF WATER.*

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Although the term disinfection would ordinarily indicate the removal of some infectious type of organism, it is more generally used to indicate the removal of bacteria of all types, and may indeed be stretched to include the various algae which cause difficulties in reservoirs. The objection to the latter form of life is on the one hand that the amount may be actually so great as to clog the outflow pipes, and on the other that the death of the algae involves the passing into the water of various decaying materials which may give rise to unpleasant tastes, odors and colors.

Taking up first in brief the question of removal of the algae.

A number of chemicals have been tried, but there is here no place for discussion but any of the successful. The best so far discovered is copper sulphate, which may be used in proportions from 1/1,000,000 down. The original experiments showed that the method of application was simple, merely involving the towing of bags containing the material behind a boat until the proper proportion was estimated to be met. It could also be introduced in other ways and according to the first results was very valuable, on the one hand in the destruction of the algae, and on the other in that it did not injure the fish life in the small amounts used. It was hoped that it would also kill the bacteria, but this did not prove to be the case. As the method was tried out it was found that it did not quite come up to expectations, as in some cases the algae were of a resistent variety, in others they or some other form returned with renewed vigor after their apparent destruction. The method is by no means to be dismissed as it may be a material aid in reservoirs where water is stored for some time, especially in the summer. The other means for the prevention of the algae, such as the exclusion of light where possible, and the removal of as much organic matter as possible from the bottoms and sides of the reservoir must not however be neglected.

From the standpoint of prevention of disease the removal of the pathogenic organisms is more important. While by no means all of the typhoid in the United States, an amount which is disgraceful to the country, can be attributed to the use of polluted water supplies, there is no doubt that a great deal of it does come from this cause and that it is practical to prevent all such cases. Evidence in favor of epidemics being due to water is overwhelming and need not be brought forward here. Somewhat in the same way that whenever ship armor able to resist the last form of projectile has been developed a new armor piercing shell is invented, each method of making a water supply safe has been found to have its weak points, as indicated on the one hand by typhoid incidental after apparent purification, and on the other by laboratory findings of pollution by improved methods in waters supposed to be purified.

The usual American municipal supply is surface water of some sort, either from a pond, lake or stream, the number of large supplies from springs or wells being small. This involves the protection of the entire watershed, which under our present method is rarely accomplished. These waters are either supplied, in the majority of cases, untreated, or undergo some type of filtration. Since it has been satisfactorily demonstrated that the old theory of the self-purification

* Read before a conference of State and Local Boards of Health, held at Columbus, Ohio.

of water no longer holds in the original form, but that the important factor in the whole matter is that of time, more or less regardless of distance, attempts have been made to put this new information into practice by holding the water for as long as possible before distribution. Houston of London, England, has found a very marked disappearance of the sewage organisms in 48 hours, and recommends the process. The efficiency of the reduction depends notably on the quality of the water and he notes that for an absolute safety factor, a month would be necessary. This of course would necessitate a reservoir area of prohibitive size, where as much water is used as is the habit in our American towns. On the other hand where the supply comes from a great distance this factor will materially help in disposing of a good deal of pollution.

It appears then that unless the source of the water is very distant or is above suspicion, some form of treatment must be used. The most frequent of these is filtration, in some form or other, either the slow sand type or the rapid mechanical with use of chemical precipitants. While with waters fairly grossly polluted careful management will give a nearly bacteria free effluent, it is admitted that either type of filter needs constant and conscientious supervision, or else there will be leakage of sewage forms from time to time. The London data may be quoted as there are a number of plants there of various sizes, corresponding to supplies to individual municipalities and handling different types of water. In the year 1908-9, summary of the results in the daily tests showed that 5 to 50 per cent. of the filtered waters contained colon in 100 cc. or less, and that in the next year 3.8 to 31.3 per cent. showed the same results. Sometimes the appearance of the colon is very sudden and rapid changes in the weather conditions may bring about so gross a change in the bacterial content of the water that the filtered water will be polluted before any change can be made. The results at other places are similar. At Hamburg where the conditions of weather approach more nearly those of Northern Ohio than do those at London, the formation of ice on the filter beds or presence of floods in the river leads to the appearance of colon in the water. It is true that where colon is found only in so large amounts of water as 100 cc. there is very possibly no typhoid or dysentery, but in the absence of accurate knowledge as to the actual number of bacteria necessary to set up disease, we cannot take any chances. In summary then one may say that in the presence of a polluted water supply, filtration will remove the suspended matters, and will remove the greater part of the bacteria, but that sudden variations in weather conditions or in technic may allow pollutions to pass the filter, when the belief in its efficiency will cause continued free use of a dangerous water.

For safety then it would appear necessary to sterilize waters for domestic use even after filtration. In the present paper it is unnecessary to refer to the various household methods, though it is the duty of all health officers in case of uncontrollable pollution of the city supply to warn the inhabitants to boil the water.

There have been many plans for sterilizing the water for drinking purposes, and for all conditions, such as armies in the field, institutions, and municipalities. Only those which may be applied to central supplies with comparative simplicity will here be considered.

The main general methods at present in use by municipalities are three in number:—They will here be discussed in inverse order to their practicability.

Ultra-violet Rays.—It has been known for some time that the rays at the ultra-violet end of the spectrum have marked bactericidal powers, but it is only recently that the principle has been practically applied. The essentials for success are in the first place a white light, containing a large proportion of ultra-violet rays, next a water free from any opacity or turbidity, and in the third place an apparatus so arranged that the water will pass under the arc in a thin film and be thoroughly exposed. There has been recently established at Marseilles an apparatus of this sort, where the water passes into a constant level reservoir from which it issues over a central weir, passing at this point under the light from an arc formed between two carbons with cores containing alumina, giving a white light with many ultra-violet rays. The plant has been recently established and the results in the line of efficiency and economy will be watched for with interest. The objections at present to the method are that it has not yet been sufficiently tried out on a commercial scale, that it is not standardized, and that it requires expert care for its proper control. Moreover the absolute necessity for a transparent water makes a preliminary filtration necessary in most cases of polluted waters.

Ozone.—Here the destruction of the bacteria depends on the presence of nascent oxygen in the water. This is obtained by passing an arc through a current of dry air, which is then, with its new content of ozone, passed onto a rising column of water which is thereby sterilized. Some failures in the process which have occurred in municipal plants have been found to be due to the insufficient drying of the air, so that special measures must be taken to avoid this trouble. There is no question of the actual efficiency of the method, and plants have been adopted by St. Petersburg, in Paris and elsewhere for the treatment of the city water supplies in whole or in part. The advantages lie in that the main expense after the rather expensive first installation is the electric current, and that there are no waste products to be disposed of. Also from the point of view of the laity there is less objection to the introduction of oxygen than of any other chemical. On the other hand the primary expense is large, the constant services of an expert electrician are required, and the method is not as yet standardized. The best apparatus at present is probably that of the Siemens-Halske Company at Berlin, which firm has the contracts for Paris and St. Petersburg. The necessity of dry air makes further complications in the apparatus.

Chlorine.—It is probable that the essential principle involved is the same as in the ozone method, though more roundabout, the available chlorine so acting on the chemicals in the water as to free nascent oxygen which acts on the organic matter and the bacteria. For this reason the method by which the so-called available chlorine is obtained is more or less indifferent and a commercial rather than a laboratory proposition. The three usual methods used are chlorine gas in liquid form, chlorine as given off from the electrolysis of salt water, and chlorine in the form of the commercial bleaching powder. The first method is the most expensive, and is said by some to be less efficient than the others. Where supplies of bleaching powder are not available except under prohibitive freight conditions it may be profitable to establish local electrolytic plants, but under ordinary circumstances the use of bleaching powder has been found equally efficient with the other methods, and a good deal cheaper. The form in which it is usually sold contains about 35 per cent. of available chlorine, which goes readily into solution in water, and can be fed into the reservoir, the mains, or at any other place desirable, in measured quantities. The cheapness of the material, usually less than $25 a ton, the small amount necessary per million gallons, and the simplicity of the methods used, are all in favor of this plan. The disadvantage of the use of bleaching powder lies in the necessity of constant purchase of new supplies and in the large amount of residual sludge which must be disposed of after the chlorine is removed. When this method is used the usual practice is to have two or more tanks, one in which the bleaching powder is mixed with water to the consistency of a cream, either by hand or where necessary by mechanical means, allowed to settle, and the supernatant fluid drawn off into a second tank from which it is passed over a weir, through a grid, or by any scheme found mechanically acceptable, into the water to be disinfected.

Save under exceptional circumstances the proportion to the water to be treated is very small, one part to one million or less, according to the quality of the water and the degree of pollution. This proportion is of course in terms of available chlorine. The method is in use in a number of cities abroad and in the United States and when the chlorine is used in these amounts causes no complaints from the consumer. Certain very important facts must be kept in mind when using chlorine as a disinfectant. In the first place it is a strong corrosive and the materials in which it is kept must be constructed with this in view. The fumes from the raw material, or the concentrated solution, are very irritating and precautions must be taken on the part of the workmen. If the proportion used is too high, it will be smelt and tasted in the water and will cause complaints. When used in the dilutions noted above, there will be practically complete disappearance in an hour or less, so that if possible this time factor between introduction of the chlorine and the distribution to the first users on the line should be adhered to. In some cities, however, it is stated that the time factor is notably less and that there is no complaint.

In regard to all these methods as a whole there are certain broad lines of action. It must be remembered that the action of the disinfectant is on organic matter, which is broken up to a greater or less degree depending on its individual chemical composition. Bacteria are affected differently according to their varieties and the spore formers are less acted on than the non-spore formers. Fortunately the organisms of the ordinary water-borne diseases such as typhoid, dysentery and cholera hove no spores, and are readily killed. The index of the efficiency therefore can be the amount of destruction of the colon bacilli, as these are slightly more resistant than the typhoid and accordingly any measures that will take care of them will also take care of their more dangerous relatives.

In the next place none of these methods have any particular effect on the appearance of the water and will have no influence on the turbidity or the color. For the removal of these or for treatment of the hardness it will be necessary to use the standard methods. The use of chlorine has a tendency to increase the permanent hardness slightly, but in the small amounts used will not make a material difference.

Lastly, these disinfections are not intended to supply the place of a pure supply. While in suitable proportions they will remove the dangerous organisms even from the sewage, there will be certain changes which will cause a taste in the water and the sewage chemicals will still be present. The disinfection is not a panacea which will admit of drinking sewage with impunity.

In summation then, we have certain agencies which may be applied to water supplies which are not above suspicion and which will make them safe as far as the organisms of infectious disease are concerned. They are of great value in that respect and may be used either in raw waters which are not to be further treated or in filtrates where the efficiency of the filter varies from one cause or another, or where the expense of construction may be lowered by the combination of a comparatively low power filter and a disinfection process. Of the methods at present available the bleaching powder is perhaps the simplest and the cheapest, and is in use in more places. If the dilution is high, and the time factor before delivery is cared for there will be no complaints.

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WATER RESOURCES OF MINNESOTA.

The coöperative agreement between the United States Geological Survey and the Minnesota State Drainage Commission for the purpose of investigating the water resources of Minnesota has recently been renewed, and in consequence of an appropriation of $30,000 made by the legislature for two years' work, the investigations are being extended into portions of the state not previously touched.

The general plateau level of the northeastern portion of Minnesota, the section which lies north of Lake Superior and is contained chiefly in Lake and Cook counties, is more than 600 feet above Lake Superior. Numerous streams drain this region into the lake, and although they are small the fact that they descend 600 feet within a few miles of the lake makes them important as sources of water-power. Many of the streams pass through canons having vertical walls which would make excellent dam sites. The investigation has been started by making a survey of Pigeon (which forms the extreme eastern boundary between Minnesota and Ontario), Brule and Deviltrack rivers. Other streams to be surveyed are Cascade, Poplar, Temperance, Cross, Manitou, Baptism, Beaver and Gooseberry rivers. Besides the streams in the northeastern portion of the state, Vermilion, Big Fork and Little Fork rivers are being surveyed.

Measurements of the flow of the rivers are also being made, to determine more fully their value for water power.

THE USE OF COKE OVENS GAS AS AN OPEN HEARTH FUEL.

By Arthur P. Scott. (1.)

Characteristic of more or less recent metallurgical literature has been an increasing interest in the disposition of By-product Coke Ovens Gas, more especially with reference to its possibilities as a fuel in the Open Hearth Furnace, and in this connection four articles, which seem to be of especial importance, will be briefly abstracted by way of introduction to a short discussion of the subject. The first of these, "On the Present Day Status of Basic Open Hearth Practice," which is to be found in Numbers 1 and 2 of Stahl und Eisen for 1910, was read by Dr. Otto Petersen before the Verein Deutscher Eisenhüttenleute on December 5th, 1909, in Düsseldorf. In describing the Hubertushütte Open Hearth Plant in Kattowitz, O.S., Dr. Petersen says in effect: "The Steel Works consists of two twenty ton and one twenty-five ton Basic Open Hearth Furnaces, the capacity of whose regenerators amounts to about 1.4 cubic meters per ton in the gas chambers, and 1.6 cubic meters in the air chambers. The Gas Producer Plant consists partly of old Siemens Producers and partly of modern water-sealed Producers. This Open Hearth Plant has been using Coke Ovens Gas as a fuel since June, 1907. The quantity of Ovens Gas used was small at first, but was gradually increased until, taking the coal consumption at Hubertushütte for 1906 as normal under Producer Practice at 31.8%, in September, 1909, with an ingot production of 6,200 tons, the coal consumption amounted to only 14.9%, so that 53.15% of the total coal requirements was replaced by Ovens Gas. The above fuel consumption includes besides the Open Hearth Furnaces, provision for such allied requirements as test and hardening forges, ladle warming and a six ton Acid Open Hearth in the Steel Foundry with its Annealing and Core Ovens.

Ovens Gas is in regular use at Hubertushütte and the full complement of producers is only requisitioned to make good an occasional shortage. The life of the Open Hearth ends and roof has been reduced by about 8-10%, (being now 550-600 heats), while the life of the checkers has been increased 40-60%, (now 1,050 heats), for which reason, along with the saving in coal, unloading wages, producer labor and maintenance, this feature in Open Hearth Practice appears to be of considerable economic importance.

In the discussion following Dr. Petensen's address Herr Ing. E. von Maitiz, of Barmen, said in part: "I some years ago had to run three of the Open Hearth Furnaces on Coke Ovens Gas exclusively at the works of the Dominion Iron and Steel Co., at Sydney, C.B., Canada. It was not possible to preheat the Ovens Gas in the regenerators without considerable loss of CO and a corresponding increase of CO_2. We were compelled, therefore, to use the gas without regeneration and we followed the method employed in the Pittsburg district for Natural Gas, that is, the gas was led into the furnace through 6-in. pipes inserted close to the hearth on both sides of the ports. The heat obtained from this gas was so small that we were compelled to supplement it with tar from the Coke Oven Plant. As a result of the use of tar the life of the roof was reduced to ninety heats. We were obliged, after three years of fruitless effort, to give up the use of Coke Ovens Gas with tar. For this reason it would interest me very much if Director Amende, of Hubertushütte, gave a few details concerning his methods, whereby not only is the time of heat cut down, but also the life of the roof, considering the fuel employed is so unusually high."

Director Amende in replying gave no information as to the method of introduction of the gas, merely adding the following facts: That the Coke Oven Plant at Hubertushütte consists of ninety Otto Hoffman Ovens, 10 meters long, 1.5 meters high and .55 meters wide. This plant handles three hundred and twenty tons of coal in twenty-four hours and the Ovens Gas has the following consumption:—

CO_2	6.5
C_2H_4	2.0
O.	1.2
CH_4	16.4
H	38.7
N	24.8
CO	10.4

The coal employed is of poor quality and 50-60% or even 70% of the gas is used for heating the Ovens themselves. In general the excess gas amounts to 45%, in all about 50,000 to 70,000 cubic meters in twenty-four hours. There has been no deleterious effect upon the Open Hearth product, which consists of shapes and bars, also sheets and band iron of the finest grade. In every respect the use of Coke Ovens Gas has proven satisfactory and he would gladly use more of it if he had it to use.

The second article in question is a paper (2) read before the Fifth International Congress for Mining, Metallurgy, Applied Mechanics and Practical Geology, at Düsseldorf in June, 1910, by Chief Engineer Terpitz, who describes the use of Ovens Gas as an Open Hearth fuel at Hubertushütte, but adds nothing to the data given by Dr. Petersen and Director Amende. He calls attention, however, to the large additional surpluses of tunnel head gas that have become available by reason of the development of the Gas Engine, and emphasizes the increasing importance of studying the peculiar adaptabilities of Blast Furnace Gas and Coke Ovens Gas, respectively, that each may be employed to the best economic advantage.

He describes certain attempts to utilize Blast Furnace Gas as an Open Hearth fuel and though results to date have not been definitely encouraging, he believes that in a few years Blast Furnace Gas will be successfully used in that capacity, although it will probably have to be regenerated by passing it through hot coke or coal. He adds, however, that in view of the ease with which low grade dust coal may be used under boilers and of the fact that Blast Furnace Gas is distinctly more suitable for gas engine consumption than is Ovens Gas, the logical outlet for the latter is through the Open Hearth Furnace, for use in which, as has been fully demonstrated at Hubertushütte, it is pre-eminently well adapted.

The third article, which is a communication made to the alumni of the Liége Engineering School on May 1st, 1910, by Charles Wigny, Chief Engineer of the Cockerill Company, and is published in the Revue Universelle des Mines for August, 1910, describes the use of Ovens Gas in a four ton Open Hearth Furnace in the Cockerill Foundry. This article has already been reviewed from the German in the Iron Age of February 2nd, 1911, Page 318, but has lost so much in the double translation that it will be well worth the reader's while to refer to the original. A few of the main facts are here recapitulated. The furnace in question manufactures soft steel for the foundry, making with producer gas three and one half heats in twenty-four hours from a charge of 30% pig iron, 35% steel scrap and 35% steel turnings, with a yield of 95%. It is of special design, the hearth, gas producers and regenerative chambers for the air constituting one solid block of masonry. The gas

(1) Metallurgist, Allegheny Steel Co., Brackenridge, Pa.

(2) Reviewed in the Iron Age, July 14th, 1910, Page 103.

is not preheated, but arrives from the producer with practically all of its sensible heat and without losing any tar or carbon. The fuel consumption under producer practice is 40%, which, in view of the small capacity of the furnace, seems excellent. Analyses and of calorific values clearly show that while the products of combustion of Ovens Gas are less voluminous than those of Producer Gas, they are nevertheless considerably more bulky than either an equivalent of Producer Gas or the air required to burn it. Wigny's furnace does not preheat the gas, therefore, the air downtakes must be ample to accommodate freely all the products of combustion and insure proper draught. The Hubertushütte furnace, on the other hand, being of the usual Producer Gas type, must needs keep both air and gas downtakes in commission, in order to ensure good working draught. This has been effected in one of the two practical ways, viz., by keeping gas and air distinct and throwing the rich gas into a carrying medium of lean gas. The other way is to merge gas and air ports and utilize the whole regenerative system for air, introducing the rich gas cold at the neck of the furnace, as is done in the Pittsburg district with natural gas and which is in principle the method followed in the four ton furnace at Seraing.

There is no reasonable doubt that scrubbed by-product Coke Ovens Gas of average quality can be substituted for natural gas and successfully burned unmixed with any other gas in the present Homestead type of open hearth furnace without detriment either to furnace or to production, though there would be anticipated, other things being equal, a certain increase in the sulphur content of the product, dependent upon the character of the coking coal used; nor can we doubt that with the same general type of furnace, successfully burning fuel oil, a tar tank could be coupled to the oil pumps, due regard being had to the fluidity of the tar without prejudice either to the furnace or to production. Admitting this to be so, let us see to what extent in a self-contained steel plant the by-product coke oven installation may be depended upon for open hearth fuel.

Let our blast furnace plant, with a fuel ratio of 2,000 pounds, deliver 1,000 tons of molten basic iron per day to our mixers; let us use exclusively our own scrap which we shall suppose amounts to 20%; let our open hearth yield (ore not reckoned) be 98%, and let our fuel consumption be 8,000 (3) cubic feet of natural gas per ton of steel; let our natural gas have the following composition and calorific value:

Carbon dioxide	6.0
Oxygen	0.2
Ethylene	2.2
Carbon Monoxide	.3
Hydrogen	3.0
Methane	91.8
Nitrogen	2.5
Net calorific Value (calculated)	8298 calories per cubic meter.
Volumes of air required to burn one volume of gas	9.13

Let our Coke Ovens Gas have the following composition and calorific value: (4)

Carbon dioxide	3.2
Oxygen	0.4
Ethylene	2.8
Carbon Monoxide	6.3
Hydrogen	41.6
Methane	29.6
Nitrogen	16.1
Net calorific Value (calculated)	4240 calories per cubic meter.
Volumes of air required to burn one volume of gas	4.34

We can, therefore, figure roughly on an Ovens Gas consumption of 16,000 cubic feet per ton of steel. (5).

The following is fairly typical of the charge and yield of a well-known type of by-product oven with a good average gas coal:

Charge:—

5.65 gross tons of coal

Yield:—

Coke	4.43 net tons.
Tar	57 U.S. gallons.
Surplus gas	22600 (6)

On this basis we figure from our one thousand net tons daily of coke a surplus of 5,100,000 cubic feet, or enough—none being diverted to other uses—to take care of 320 tons of steel daily, that is about 25% of our ingot production, which we may calculate as 1,219 tons. With a higher fuel ratio at the blast furnaces, we should, of course, have a correspondingly larger surplus of gas.

In addition to this gas surplus we have also $\frac{1,000 \times 57}{4.43} =$ 12,867 gallons of tar as a by-product from our daily quantum of coke. Figures on the calorific value of coal tar are by no means plentiful, but from an abstract of an address by President Godinet of the Societe Technique du Gaz en France, and which appears in the Journal of Gas Lighting, Water Supply, etc., July 13, 1909, Page 99, we select a heating value of 8,000 calories, that being the lowest of the several values there given. The highest value quoted by M. Godinet is 11,000 calories and some authors give 10,500 as a representative value. Using 8,000 calories and a specific gravity of 1.18, we calculate calories per gallons of tar as 5,736, virtually the same value as 35,961 per gallon of fuel oil of the usual 10,555 calories and specific gravity .900. Assuming like thermal efficiency in the furnace for both tar and oil, we find ourselves enabled with 12,867 gallons daily of tar to provide for the production of a further 250 tons of steel, on the basis of 50 U.S. gallons of fuel oil per ton of basic open hearth steel—a reasonably liberal allowance.

We have thus substituted gas and tar for 47% of our fuel consumption. In other words, figuring the coal con-

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(3) This is a most liberal allowance. Under standard conditions this figure should be well under 7,000 cubic feet per ton for basic furnaces.

(4) The figures here given represent a typical analysis of the Sydney gas, and are taken from trustworthy notes in the writer's possession. This gas has at times been poorer, but was practically always at least of the excellence recorded for the Hubertushütte gas.

(5) This estimate is somewhat higher than the consumption given above for Wigny's four ton furnace. He reports the equivalent of 15,355 cubic feet for a gas with a net calorific power of only 3,640 calories, which, in view of the coal consumption of 40% reported by him for the same furnace under producer practice, shows our forecast to be conservative in the extreme. Our estimate also takes no account of suspended tar and benzol, which quite appreciably enhance the actual heating value of Ovens Gas.

(6) The figures given by Director Amende, of Hubertushütte, are equivalent to approximately 37,400 cubic feet of surplus gas for the same oven charge. His figures seem to indicate a thirty-six hour coke.

sumption under producer practice as seven hundred pounds per ton, we effect a daily saving of about 180 tons of coal, which represents an absolute return of 14% of the coal required to produce our daily coke supply, besides a certain small reduction in producer maintenance and wages; also, the life of the furnace should not be appreciably affected. When a melter states that fuel A is harder on the furnace than fuel B, he is simply unconsciously stating that he and his bricklayer have been accustomed to fuel B and favor furnace lines that suffer under fuel A. A melter accustomed to fuel A will aver contrariwise, and so on. If the Hubertushüttee regenerators are situated immediately beneath the furnace and lack slag pockets; if the producer coal is relatively high in ash and the producers are fairly close to the furnace—all of which things are probable—the increase of checker life with Ovens Gas, recorded by Director Amende, is readily understood. Under normal conditions, however, the character, both physical and chemical, of the stock employed, has more to do with furnace life than has the fuel.

There are two objections that may be urged against the use of by-product gas:

First. A shop that depends upon tonnage for its livelihood must standardize in every possible way and in the long run, other things being equal, an open hearth mill burning the same fuel all along the line, has the advantage of the mill which burns three fuels.

Second. Not least among the advantages of a producer fired furnace is its absolute independence of every other part of the world, as far as fuel is concerned, except the coal yard. The Ovens Gas—or tar-fired—furnace introduces an additional peradventure. If the normal fuel for the mill be natural gas or oil, this objection is negligible, since in the light of the above ventured opinions, natural gas, fuel oil, ovens gas and coal tar can be burned interchangeably in the open port type of furnace. If the normal fuel, however, be producer gas, two types of furnace are necessary, and in case of absolute failure of ovens gas supply, the open port type will require at the very least one weeks' time to change it over to the producer gas pattern. On the other hand, of course, such failure of ovens gas can be met by the use of stored tar for a time, or by fuel oil. A comparison of the reigning prices for tar and fuel oil, respectively, will be found to be very instructive in this connection, more especially in view of the probability that the former price will not rise and that the latter will not drop, at least in the near future.

Let it be said, in conclusion, that by-product recovery, as applied to the manufacture of blast furnace coke is logical and attractive; but it should be realized at the outset that the by-product coke oven must be strictly immune from "tonnage fever," which is another way of stating that its operating costs, other things being equal, cannot be materially depressed below a certain normal for any one set of conditions. Its high first cost must, therefore, be compensated for solely by increased percentage of coke yield, and by scrupulous economy of the by-products. Of the latter, ammonia is usually well taken care of, but not so for the most part the gas and tar, the all too frequent tendency being to seize every possible pretext for burning or otherwise disposing of them with some faint show of economy rather than to systematically husband them. Ladle warming, for instance, is a convenient scape goat. (7). These things should not be. It is only one degree less reprehensible to install a recovery system and fritter away a substantial portion of the by-product, than to build the older type of oven and frankly waste the whole of it. How, then, may by-product tar and gas be disposed of? Heat, light and power production and the chemical industries furnish only a partial answer. Do not the signs seem to point significantly in the direction of the open hearth furnace

A complaint was made by the Sydney melters that the Ovens Gas "flew high to the roof"—which was true; but this manifestation was wrongly blamed upon the relatively high hydrogen content of Ovens Gas. As will be shown later herein, the Sydney gas is of excellent quality. As a matter of fact, whenever we find the flame in an open hearth furnace curling about the roof brick instead of sweeping rapidly over the bath, we may conclude with certainty, not that aught is amiss with the fuel, but that there is a pinch in the draft somewhere. Natural gas in a poorly drawing furnace will hug the roof just as closely as the Ovens Gas ever did at Sydney. The same principle holds a fortiori when the congestion is aggravated by the introduction of a bountiful supply of steam-blown tar. The premature destruction of the roof recorded by Herr v. Maltitz is simply an indication that a good fuel was misapplied The writer firmly believes that under the same conditions fuel oil would have made an equally poor showing. Finally the employment of Coke Ovens Gas as a fuel at Sydney was only one of several very formidable metallurgical problems that confronted the management there at the outset and it was considered inexpedient at that juncture unnecessarily to complicate the situation by experimenting further with Ovens Gas, but the ingenuity of Herr Ing. v. Maltitz and of his associates had by no means been taxed to the utmost in this regard when the use of Coke Ovens Gas was abandoned. It is safe to say that if the management of the Dominion Iron & Steel Co. had considered itself warranted by general economic considerations in resuming the attempt to utilize Ovens Gas in this manner, it would have done so without hesitation, because there is not, to the writer's knowledge, on this side of the Atlantic a single steel works where the utilization of the by-product is more carefully and effectually studied than is done at Sydney. For instance, the high phosphorus content of Dominion iron, which at first seemed a serious menace to production, has been turned to very material account, the procedure being to blow the molten pig in a basic vessel to low phosphorus and then to transfer to a basic open hearth furnace, where, by mixing four of five pots of basic blown metal with perhaps one pot of molten pig, a fifty ton heat is finished in a very short space of time after the last pot has been blown, the "reboil" with molten pig counteracting entirely any super-oxidation that may result from the after blow. In this manner during a recent month Dominion made nearly 12,000 tons of ingots from one fifty ton furnace, which must be conceded to be a remarkable performance. Under such circumstances, of course, fuel cost almost vanishes. The economy of the process has more recently been added to by marketing the basic slag as a fertilizer. The only other plant where this basic duplex process has been operated, so far as the writer is aware, is that of the Phœnix Company, at Horde, Westphalia.

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(7) Ladle warming, it may be added, is one of the most gratuitously wasteful and poorly performed operations in steel works practice to-day. The quantity of fuel of one kind or another that is employed in very many works to produce a miserable apology for a hot ladle is nothing short of scandalous. One of the few creditable practices in this direction was observed by the writer in a certain European works where the ladle, of approximately fifteen tons capacity, was simply inverted over a small steam-blown fire of refuse coke, acquiring thereby a good and even heat with negligible fuel cost. Larger ladles perhaps scarcely lend themselves to this method.

The Canadian Engineer

ESTABLISHED 1893.

Issued Weekly in the Interests of the

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

Managing Director.—James J. Salmond.
Managing Editor.—T. H. Hogg, B.A.Sc.
Advertising Manager.—A. E. Jennings.

Present Terms of Subscription, payable in advance:

Canada and Great Britain:		United States and other Countries:	
One Year	$3.00	**One Year**	$3.50
Three Months	1.00	**Six Months**	2.00
Six Months	1.75	**Three Months**	1.25

Copies Antedating This Issue by More Than One Month, 25 Cents Each.
Copies Antedating This Issue by More Than Six Months, 50 Cents Each.
ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone, Main 7404 and 7405, branch exchange connecting all departments.

Montreal Office: B33, Board of Trade Building. T. C. Allum, Editorial Representative, Phone M. 1001.

Winnipeg Office: Room 404, Builders' Exchange Building. Phone M. 7550. G. W. Goodall, Business and Editorial Representative.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central.

Germany and Austria Hungary: Friedrich Lehfeldt, 2 Lindenstrassa, Berlin. S.W., 68. Telephone IV., 3198; Telegrams, Advertise, Berlin.

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor.

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS.

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

Printed at the Office of The Monetary Times Printing Company, Limited, Toronto, Canada.

Vol. 21. TORONTO, CANADA, Aug. 31, 1911. No. 9.

CONTENTS OF THIS ISSUE.

THE EDUCATION AND TRAINING OF THE ENGINEER.

Much has been written, and will continue to be written, on this all-important subject. There has been a good deal of discussion recently on the subject, and, while no definite conclusion has been arrived at, still many interesting facts have been brought out. As the "Electrical Review," which has been following closely the "Conference on the Education and Training of Engineers," recently held in England, notes, "The subject is without finality, just as there is no finality in engineering development."

There is no course of study laid down by any of our engineering colleges which will meet the case of every man successfully, for each individual's mental make-up, his powers of comprehension, his physique and his ambition will mould to a certain extent the result. What will act as an incentive to one man will be a detriment to another. For this reason it would appear as though it were better to only furnish the ground work in the education of the engineer in the faculties of engineering, and allow him to obtain his training either before he enters college, during his vacation, or after he graduates. His course in the schools should give him a mastery of the principles of physics, on which all successful engineering depends, and a firm mathematical basis for future theoretic work. It should teach him to reason for himself, and to be able to apply the essentials of physics and mathematics.

His training and experience are matters which are adjusted almost altogether by influence outside of himself. Opportunity and environment throw him into a certain line from which he will find it hard to deviate. This experience should begin at as early an age as possible. It is a mistake in most cases for a man to take up post-graduate work, unless, of course, he intends to enter academic work. Huxley says: "Those who have to live by labor must be shaped to labor early: the colt that is left to grass too long makes but a sorry draught horse." The lack of commercial element in the college training, while a good thing from some points of view, is apt to leave a man in an unfit condition to go forth in the struggle for existence going on in the business world.

The consensus of opinion of the convention noted above appears to be that the student of engineering should have at least a year of outside training or experience before entering a college of engineering.

SURGES IN PIPE LINES CONVEYING WATER.

In the early days of hydraulic power development, and until very recently, the types of development have been of the short penstock and open canal, or open forebay type. These types were developed first on account of the cheapness of first cost and the efficient regulation obtained thereby. Now, however, the available sites for installations of this kind are taken up, and we are coming to the use of plants with long feeder pipe lines and penstocks. With the advent of these long lines comes the attendant regulation troubles and excessive pressure rises, due to the inertia of the water column.

Many suggestions have been made by hydraulic engineers with a view to ameliorating these conditions, and many devices are now in use. Governor-operated by-passes and deflecting nozzles are the usual methods where the conserving of water is of small moment. Where water is valuable, however, as in the case of expensive storage conditions, other methods are used.

The best method, where natural conditions will allow, is to provide a large reservoir adjacent to the power-house into which the pipe line feeds, and from which the penstocks draw their supply. If this is impossible, the usual method of treatment is to provide a surge tank of cylindrical shape.

In the June issue of the "Journal of the American Society of Mechanical Engineers" appears a long and very technical article on the control of surges in water columns, which deals with this problem. The writer, Prof. W. F. Durand, develops a new method of handling these surges, which, he claims, is much simpler and more convenient than the method heretofore in use.

Prof. Durand imposes a certain programme of acceleration for the water column, and then finds a tank suitable for the realization of these conditions. By this method he claims to obviate a great deal of tedious arithmetic work.

An analysis of his results, however, seems to indicate that there is little, if anything, gained by the change. His programme of acceleration results in a tank of conical shape, exceedingly difficult to construct, whose volume is greater than a cylindrical tank, which will give equivalent final results.

It might be added, too, that the programme of water change for loads rejected on the plant is in any typical design just as important as the conditions of increment in load. To determine the detailed results in the case of rejected load it is necessary to use arithmetic integration and trial and error adjustment. To adjust for part load increment and total load rejection, which is the usual designing condition, the work entailed would appear to be prohibitive for his style of tank.

The method advocated by Mr. R. D. Johnson, which appeared in the June issue, 1908, of the Journal of the American Society of Mechanical Engineers, is, up to the present, the best method of treating this problem, that is, to introduce some resistance between pipe line and tank, which puts an additional accelerating head on the water column, and which, in case of shut-down or load rejection, applies quickly a large retarding head. This method entails some amount of arithmetic work, but the size of tank and its main features, such as height, etc., can be fixed by means of formulæ which he has developed in his paper.

The whole subject of regulation of long water columns is still in an unsatisfactory condition. It is to be hoped that it will soon be put on a better basis, so that the hydraulic engineers may design for regulation equally as well as for the other elements in the plant. The subject is of growing importance to engineers interested in hydraulic power development on account of the increasing use of hydro-electric power, and the consequent requirement of constant speed.

DAILY NEWSPAPERS.

One of the leading daily newspapers in Toronto was describing the cause of the street car tie-up, which had occurred the day before. The reporter remarks that he interviewed an expert, and, in all seriousness, gives the following account of the interruption of service on the transmission line supplying the street railway system. Among other remarks he says: "If there is an electric storm in the neighborhood of the wires, the current on the wire is protected by rotary converters, which transform the alternating current to a direct one. Sometimes the transformers are thrown out of service and have to be started up again, causing a delay on the systems fed by the power. When this happens the current is stepped down and out."

For unconscious humor this surpasses anything we have seen in print for a long time. The thought of the current on the line being protected from electrical storm by rotary converters, the transformers stopping and having to be started up again, and last, but not least, the explanation that when the power goes off the transformers step it down and out. These are among the most pleasing explanations of natural phenomena it has been our pleasure to read.

However, one's confidence in the paper is rather shaken after such an instance, and the moral is: Be careful what you believe when you read the daily newspapers.

EDITORIAL COMMENT.

The visitor this year at the Canadian National Exhibition notes a great improvement over previous years in the roads. Quite an amount of asphalt macadam has been laid, which improves immensely conditions on the grounds. The thick, heavy clouds of dust which before greeted the passerby on every side are now a thing of the past. The improvement, however, which will give probably the greatest pleasure is the new Hydro-Electric lighting. There are attractive white-painted poles bearing cluster lights on all the roadways and avenues, and these will provide ample illumination.

* * * *

A letter was received in this office recently from the Department of Public Works, British Columbia, stating that the Department does not advertise outside the province for tenders on work. The work in question was a very large piece of construction. It certainly is a rather short-sighted policy which saves a few dollars in advertising and results in paying out a greatly increased amount in excessive prices. On work calling for large outlays of public money there should be the widest competition possible in order to secure the best prices.

* * * *

In the short article in the columns of The Canadian Engineer last week on the "Foundation of a 55-Storey Building" mention was not made of the fact that the Foundation Company, of New York, were doing the work. We regret the oversight, for the work and the contractors are certainly deserving of note.

* * * *

The cement tile manufacturers have brought their product to a high state of efficiency through the aid of university laboratories and their own endeavors. So much so is this true that certain manufacturers of clay sewer pipe have suggested the use of partially glazed pipe in order to compete in price with cement tile. Here appears to be an opportunity for the laboratories of the engineering schools to investigate the comparative merits of cement pipe and unglazed pipe with a view to determining their respective places in the scale of economy.

THE COST OF STEAM POWER IN CANADA FROM ACTUAL PERFORMANCES.*

By J. O. B. Latour.†

Through the aggressiveness of gas engine manufacturers and hydro-electric power companies the cost of power for manufacturing becomes one of the most interesting subjects for the power users as well as the steam engineer and engine manufacturers.

Hydro-electric power has been developed to a stage of reliability that it must be considered a permanent prime mover. The good results are obtained by making all the apparatus necessary for such power with the utmost care of economical and reliable operation.

Gas engines operating on producer gas are highly economical on fuel and have been developed to such a stage of reliability that they also must be admitted as permanent prime movers wherever the conditions are favorable.

The large supply of good natural gas which favors several counties in this province also plays an important part in the production of power. It is sometimes applied direct to gas engines and oftener simply replaces the coal as fuel for generating steam.

The thoroughness of information as to the cost of operation by hydro-electric motors as well as gas engines has aroused the power user to enquire into his power costs, which up to this time has been looked upon as a necessary evil at so much a year without hopes of improvement. The more the subject was discussed the more interesting it became. The engine manufacturer was also stirred into real activity to improve the cost of operation. At one time their energies were spent in reducing cost of manufacturing and selling steam machinery. Now that the power user is being educated by competitors in prime movers, the steam engine manufacturers are adding experts in economical operation to their staff resulting in a much improved condition of operation.

I will confine myself to the cost of steam power only, all other types of prime movers have an abundance of exponents.

My long connection in the steam engineering field of this part of the province especially, has enabled me to quote records from actual daily performance in varied kinds of manufacturing. From this data I will base operation costs. The capital charges are based on the average cost price of the equipment enumerated as quoted by engine and boiler manufacturers doing business in this locality. Building costs are average prices from plants already erected. All examples are from plants operating ten hours per day, 300 days per year. The life of a steam engine is taken at twenty-five years, which makes a depreciation charge of 4 per cent., boilers can be depended on for twenty years, which makes a depreciation charge of 5 per cent. Buildings are charged 3 per cent. depreciation, taxes 1.5 per cent. on three-fourths of total cost, insurance 0.5 per cent. on total cost, interest 5 per cent. on total cost.

100 H.P. Plant Noncondensing With Exhaust Heating.

100 h.p. high speed automatic engine, noncondensing, size 12 x 12 inches by 300 r.p.m., having 1 72 in. by 16 ft. horizontal tubular boiler built to carry 135 pounds according to the requirements of different classifications, organizations, smoke connection from uptake to chimney, 1 open feed water heater, 2 5½ x 9½ x 6 in. boiler feed pumps, steam and water piping, including erection.	$2,780.00
Foundations, boiler setting, brick chimney, brick boiler and engine house	2,550.00
Total cost	$5,330.00
Interest on the whole cost at 5 per cent.	266.50
Depreciation on buildings at 3 per cent.	36.00
" engine at 4 per cent.	48.00
" boilers, etc., at 5 per cent.	79.00
Taxes	59.96
Insurance	26.65
Total yearly fixed charges	$ 516.11
Engineer and fireman, 1 man at $15 per week.	780.00
685 tons of coal at $3.25 per 2,000 pounds	2,226.00
Oil, waste, packing compound, etc., average of 7 years	187.50
Repairs average 11 years	67.30
Total operation 1 year	$3,260.80
Gross operation 1 year	3,776.99
Exhaust steam for heating 342,586 cubic feet of factory was used when necessary. Cold nights and mornings live steam was used, also a small quantity for manufacturing purposes, the coal charged includes this. All this work has been estimated by comparison with factories using steam for heat, but not for power, which averages 1.2 pounds per cubic foot or 342,586 x 1.2 x 0.25 ÷ 2,000 equals	668.04
Cost, 1 80 h.p. boiler for heating, including setting, stack, building feed pump, etc., all ready for work at $25 per h.p.	2,000.00
Interest on same at 5 per cent.	100.00
Depreciation at 4 per cent.	80.00
Taxes, 1½ per cent. on three-fourths of cost	22.50
Insurance	10.00
Total fixed charges	$ 212.50
Fireman 30 weeks at $9 per week	270.00
Repairs and miscellaneous	75.00
Coal as above	668.04
Yearly operating charges	$1,013.04

These quantities must be credited to the gross power costs as they would be required with any other type of prime mover, resulting as follows:—

Net cost of power plant, $5,330—$2,000=	$3,330.00
Interest, depreciation, taxes, insurance as yearly fixed charges, $516.11—$212.50=	303.61
Operation, $3,260—$1,013.04, equals	2,247.76
Making a total yearly net cost for power	$2,551.37

The load of this engine for ten hours averaged 80 i.h.p. with a maximum of 9.7 i.h.p. and a minimum of 59 i.h.p. and is continually repeated daily.

The boiler showed an equivalent evaporation from and at 212°F. per lb. of combustible pounds	$ 11.08
Crediting with heating the cost of power per i.h.p. is:—	
Operation cost per i.h.p. 1 year is	$ 28.10
Fixed cost per i.h.p. 1 year is	3.79
Total cost per i.h.p. 1 year is	$ 31.89
Total cost per i.h.p. heating not credited	47.21

*Paper read at the C.A.S.E. Convention.

† Inspecting Canadian Engineer with the Canadian Casualty and Boiler Insurance Company, Toronto.

250 H.P. Plant Noncondensing With Exhaust Heating.

The next case is a 250 i.h.p. Corliss engine, 18 x 42 in. x 90 r.p.m.

2 72 x 18 in. horizontal tubular boilers built to carry 135 pounds according to the requirements of the different classification, organizations, smoke connection to chimney.

1 Open heater.	
2 7 x 4 x 8 in. boiler feed pumps steam, exhaust and water pipe inside of engine and boiler room, including erection	$6,521.00
Foundation, boiler setting, brick chimney, brick boiler and engine house	$5,750.00
Total cost	$12,296.00
Interest on the whole cost at 5 per cent.	$ 614.80
Depreciation on buildings at 3 per cent.	90.00
" engine at 4 per cent.	124.00
" boilers at 5 per cent.	309.80
Taxes	138.33
Insurance	61.48
Total yearly fixed charges	$1,338.41
Engineer at $15 per week	780.00
One fireman at $10 per week	520 00
1,408 tons of coal at $3.25 per 2,000 pounds	4,576.00
Oil, waste, packing, compound, etc.	425.00
Repairs at 2 per cent.	245.92
Total operation 1 year	$6,546.92
Gross operation 1 year	7,885.33

Exhaust steam for heating 1,020,500 cubic feet was used when necessary. Cold nights and mornings live steam was used, also a small quantity for manufacturing purposes. The coal charge includes this, the credit for exhaust steam will be 1,020,500x1.2x3.25÷2,000 = $1,989.97.

Cost 2. 100 h.p. boilers for heating, including setting, stack building, feed pumps, etc., all ready for work at $25 per h.p.	$2,500.00
Interest on same at 5 per cent.	125.00
Depreciation at 4 per cent.	100.00
Taxes, 1½ per cent. on three-fourths of cost	28.12
Insurance	37.50
Total fixed charges	$ 290.62
1 live steam water purifier, including erection	$8,960.00
Repairs and miscellaneous	150.00
Coal as above	1,989.97
Yearly operating charge	$2,499.97

Crediting power with those quantities as previously:

Net cost of power plant, $12,296—$2,500 =	$9,796.00
Interest, depreciation, taxes, insurance, as yearly fixed charge, $1,338.41—$290.62 =	1,047.79
Operation, $6,546.92—$2,499.97 =	4,046.95
Total cost per i.h.p. 1 year	$5,094.74

The load on this engine for ten hours, averaged 204, minimum 141, maximum 219 and practically repeated daily, taking it at 200 i.h.p. the cost of power crediting with heating is:—

Operation cost per i.h.p. 1 year	$ 20.22
Fixed cost per i.h.p. 1 year	5.24
Total cost per i.h.p. 1 year	$ 25.47
Total cost per i.h.p., heating not credited	39 43

280 H.P. Plant Compound Condensing.

1 Corliss long range cut off tandem compound condensing Girder frame 16 in. plus 30 in. x 36 x 80 r.p.m.

1 steam driven jet condenser, 10 x 14 x 18 in.

1 duplex steam pump, 6 x 3½ x 6 in.

1 duplex plunger power pump.

1 injector.

1 open heater.

2 72 in. by 16 ft. horizontal tubular boilers with Jones underfeed stokers.

1 live steam water purifier, including erection	$8,960.00
Foundation, boiler setting, brick chimney, brick boiler and engine house	6,450.00
Total cost	$15,410.00
Interest on the whole at 5 per cent.	770.50
Depreciation on buildings at 3 per cent.	112.00
" engine at 4 per cent.	139.50
" boilers at 5 per cent.	388.00
Taxes	170.36
Insurance	77.05
Total yearly fixed charges	$1,660.41
Chief engineer at $17.50 per week, 50 per cent. to be charged to mill as master mechanic	455.00
1 shift engineer at $13 per week	686.00
Common labor	100.00
889 tons of coal at $3.20 per 2,000 pounds	2,844.80
Oil waste, packing compound, etc.	323.50
Repairs, 9 years average	257.60
Total operating 1 year	$4,666.90
Gross operating 1 year	$6,326.31

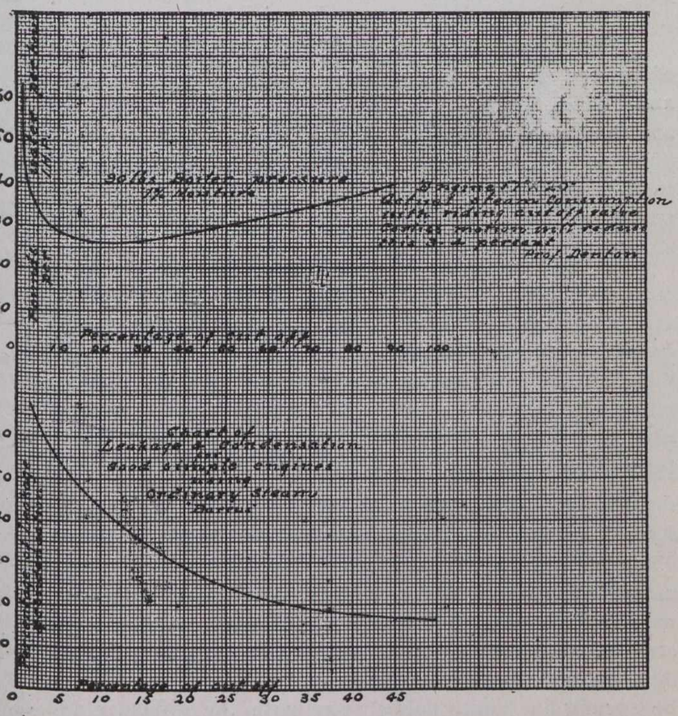
The load curve of this engine is 85 per cent., minimum 77 per cent., maximum 90 per cent. The average i.h.p. is 238 determined by several tests. The water evaporated per pound of coal is 8.97 pounds. The temperature of the feed water is 194°F., steam pressure 115 pounds. The steam actually accounted for by the indicator diagram is 85 per cent., showing the steam valves and pistons to be tight. All piping containing steam or hot water are perfectly tight and all well covered. I have known this plant for several years and never saw any difference in this respect. There is some live steam heating done when necessary. All returns are trapped to the open heater. The coal charged is included in this.

Cost operation per i.h.p. per year	$ 19.56
Cost, all charges, per i.h.p. per year	26.58

It may be well here to draw your attention to the fact that the above samples are in the minority and are the best examples I could select from those I have made up their costs. However, there is no reason why all should not be able to do the same.

As an example of probably an average condition, here is a plant with horizontal tubular boilers in good condition: 4 one-valve releasing gear engine and one automatic high speed engine, open heater supplying feed water at 198°F., all pipes covered, etc. The i.h.p. cost per year is $84.79. This plant is clean and discipline good. Another one with a 4-valve releasing gear engine, two horizontal tubular boilers, open heater, the cost of power is $132.60. This plant, probably as bad as can be found, has every appearance of negligence the instant one enters the place.

Naturally the question arises what is necessary for economic results. A short answer would be "use all the steam you require and save the rest." Beginning with the boiler it must be set according to approved methods, the brick walls (if any) must be tight, the grates in good order and suitable for the fuel burned. Coal should burn not slower than ten pounds per square foot of grate, if it does not burn that much reduce the size. Chimney must give ample draft. All pipes, valves, stop cocks and the various joints must be absolutely tight. Traps must discharge where the heat and pressure in the water must not be dropped or lost. In many cases this will require the assistance of return traps to the boiler direct. All these traps must be kept tight and their mechanical movements kept free. The steam and exhaust valves and piston of the main engines must be tight. Now for the real steam consumers, the independent steam driven auxiliaries which consume from 90 to 150 pounds steam per i.h.p. per hour when in fair running condition. I am sorry to say that in most plants they are placed in the most unreasonable place that can be found. There is absolutely no need for this condition in any plant. No more of these independent steam auxiliaries should be permitted in a plant than the quantity sufficient to exhaust



steam to an open heater to maintain the feed near but not at the boiling point. If vapor escapes from an open heater it is a direct loss of heat. When a boiler is closed down after the day's run everything should be tight enough that the water remains practically at the same height when it is cold. All supplies should be put neatly into locked cupboards and rooms. Complete records of coal and all supplies should be kept. Occasionally the power delivered should be ascertained by indicating also proper correction of the steam valves made if necessary, and see what it costs, at least quarterly. The engineer should be supplied with this information and given to understand that he is expected to be interested in the results. The ever commanding feeling to excel in most men will develop to a surprising degree with its profitable results to all parties concerned. Do not forget that intelligent operating engineers and firemen are absolutely necessary for economy and reliability.

Engines and boilers are rated at the point that they can develop their power the most economically. By examining the accompanying chart the difference in economy, by underloading especially, can be seen at a glance. The capacity for overload on engines can be taken at 25 per cent. for say a couple of hours daily if required, and 50 per cent. for momentary loads.

COST DATA FOR CONCRETE.

The accompanying data for figuring cost of concrete is abstracted from an article in the Concrete Age:—

Estimates on cost are at best very incomplete, as they embrace two general lines of calculations, each of which is variable, due to time, place, and conditions. The two lines embrace material cost, and labor cost. Material cost involves first cost of material, with the added cost of transportation, both variable and differing slightly with each locality. Labor cost involves cost of labor, efficiency of labor, and the conditions involving labor, such as nature and convenience of work. Then to meet this variable condition carefully prepared average costs are given. Lumber for centering costs per 1,000 feet, $25. Skilled mechanics for erecting, $10 per 1,000 feet. Wrecking with care to save lumber $3 per 1,000 feet. The cost of centering is usually computed per cubic yard of concrete used, and the cost of lumber will depend on the number of times the lumber can be used. While some parts are frequently used four times, it is safe only to count two uses which in this case reduces first cost of lumber $25 to $12.50.

In factory and all difficult monolithic buildings form construction is found to be about $5 to $7 per cubic yard, while for heavy construction, abutments, etc., the cost never exceec $. Steel rods for reinforcing in car lots cost about $35 per ton. Placing the same in average construction $8. This does not include cost of special system steel. The cost of steel for reinforcing is also estimated per cubic yard of concrete used, same as forms, and varies from 50 cents per cubic yard in simple reinforcing to $4 per cubic yard in difficult construction. Concrete costs per cubic yard hand mixed and placed in simple construction, C1. S3. A6., $4.50 per cubic yard. In factory and complicated monolithic work $9 per cubic yard of C1. S2. A4. By machine mix the cost of concrete can be reduced 25 cents per cubic yard. The cost of a cubic yard of concrete taken from an average of of 4,600 cubic yards, placed in six widely separated jobs in simple work with a composition C1. S3. A6. was as follows:

1¼ bbls. cement at $1.60 per bbl.	$2.00
0.3 cub. yds. sand at .90 per cub. yd.........	.30
1.1 cub. yds. crushed stone at .80 per cub. yd.	.88
Labor, one man, 8 hours, hand mix..........	1.40
Total cost per yard placed	$4.58

On a factory building reinforced throughout, footings, columns, pilasters, wall, beams, girders, floors, roof and stairs, complete including reinforcing and forms, the cost was found to be $19.50 per cubic yard of concrete used.

One cubic yard of concrete mixed in the proportion of:

C1. S3. A7. will require 1 bbl. cement.
C1. S3. A7. will require 1.3 bbl. cement.
C1. S2. A4. will require 1.8 bbl. cement.

One barrel of Portland cement, as mortar in the proportions given below, will cover an area as shown in table:

Composition	Sq. ft. Concrete	Thickness	Composition	Sq. ft. Concrete	Thickness
C1. S1.	72	1 in.	C1. S3.	132	1 in.
C1. S1.	96	¾ in.	C1. S3.	180	¾ in.
C1. S1.	144	½ in.	C1. S3.	264	½ in.
C1. S2.	104	1 in.	C1. S4.	200	1 in.
C1. S2.	139	¾ in.	C1. S4.	250	¾ in.
C1. S2.	208	½ in.	C1. S4.	400	½ in

Portland cement mortar cost per cubic yard.

Composition.

C1. S2:

0.9 cub. yd. sand at $1.60	$1.44
0.45 cub. yd. cement at $1.60 per bbl.	5.14
	$6.58

C1. S3:

0.95 cub. yds. sand at $1.60	$1.50
0.33 cub. yds. cement at $1.60 per bbl.	3.81
	$5.31

C1. S4:

1 cub. yd. sand at $1.60	$1.60
0.25 cub. yd. cement at $1.60 per bbl.	2.85
	$4.45

Portland cement concrete costs as follows per cubic yard allowing for a shrinkage of 10 per cent. for the tamping:—

C1. S2. A4:

1.8 bbls. cement at $1.60	$2.90
0.45 cub. yds. sand at $1.30	.58
0.9 cub. yds. aggregate at $1.25	1.12
	$4.60

C1. S3. A6:

1.3 bbls. cement at $1.60	$2.10
0.3 cub. yds. sand at $1.30	.40
1.1 cub. yds. aggregate at $1.25	1.37
	$3.87

C1. S4. A8:

1bbl. cement at $1.60	$1.60
0.25 cub. yds. sand at $1.30	.33
1.1 cub. yds. aggregate at $1.25	1.37
	$3.30

The costs of concrete and mortar do not include labor, only when so specified.

The removal of dirt from trenches ordinarily costs about 50 cents per cubic yard.

One man will shovel into wheel-barrow limestone or gravel 18 cubic yards per 10 hours, sand 20 cubic yards. This is from floor, from ground only 12 cubic yards.

A LARGE COMBINE.

It is reported from Stockholm that negotiations have been proceeding for some time between a group of British, German and Scandinavian financiers for the purpose of combining a number of Norwegian and Swedish power-plants in one company, which is to be called "The Hydraulic Power and Smelting Corporation, Limited." The capital will amount to $10,000,000. The German group is represented by the well-known banking firm of Bleichroder. The Combine intends to acquire a controlling interest in three undertakings belonging to Herredshovding Knut Tillberg, in Sweden, and also in those plants in Norway which have been promoted by Mr. Ragnoald Blackstad.

AT THE CANADIAN NATIONAL EXHIBITION.

There will be much to attract the attention of the contractor and engineering profession. This line is mainly confined of course to the Machinery Hall and the Industrial Building, but scattered throughout the other buildings, and indeed the grounds themselves, will be found articles which appeal to the contracting man, be he professional or otherwise.

The British Aluminum Co. are showing samples of seamless drawn tubing, wire billetts and aluminum cable for electrical purposes. Their booth is floored with aluminum matting of 17 gauge with raised diamonds of about one-sixteenth inch thickness. Another novelty they are showing consists of aluminum nails and rivets, brought out to replace copper for this purpose; these are selling at from 60c. to 70c. per pound. Some attractive looking boat fixtures made from the above mentioned metal, while around their booth, pictures have been arranged showing various aspects of their plant.

The Canada Metal Company have samples of lead pipe of various sizes and a good showing of various lead joints and angles for plumbers use. Fuse wire and wire samples are shown as are battery zincs, aluminum and copper ingots. Samples of their heavy pressure babbit metal are on hand to demonstrate the qualities of this product, and bars of spelter and pig lead are artistically arranged in their booth.

In the large tent erected in the vicinity of the main entrance to the Machinery Hall, Messrs. Wetlauffer Bros. are exhibiting samples of their line of concrete mixers and general concrete machinery and accessories. Their concrete mixers all carry the heart shaped drum, which ensures quick and thorough mixing. A brick machine designed to give a brick with two smooth faces is shown. This is a face down machine, with a capacity of twenty-four bricks.

The Johns and Mainville Co. are making a showing of fibre conduit, non-arcing fuses and subway boxes, etc. They are showing a method of lighting which they have named "Linolite," being adapted to show-case and side-window lighting. It consists in the main of a semi-circular strip of aluminum divided into twelve inch lengths. At each division spring clips are secured which allow the lamp to be sprung in place, doing away with the difficulty and discomforture of screwing them in place. These lamps are of special construction, being tubes of about three-fourths inch diameter, drawn down to the ends into which are formed brass studs concaved and designed to slip over the brass springs in the aluminum frame. The filament of the lamp is hung rather loosely from the brass studs, there being no pronounced or definite form, as is the case in the Edison lamps.

The Consumers Gas Co,. of Toronto, have a line of imported gas accessories which are meant to consume illuminating gas and perform many of the operations now carried on in shops with coke and other fuels. A furnace for hardening high speed steel is shown which receives the jet from the top. It would accommodate a piece of metal of about one and one-half inches in diameter, but could be adapted for larger sizes by cutting the fire-brick lining, with a small blower, giving about one pound pressure a temperature of 2,800° F, could be easily maintained. A melting pot for metals of a low fusing point has a pressed steel ladle which appears to be an improvement over the cast iron article, inasmuch as it is designed to conduct heat more readily, and has many other points of advantage, among which are toughness and lightness. A crucible heater for melting metals of a higher fusing point is lined with a mixture of cement and carborundum of approximately three inches thickness. The flames are directed into the central cavity in such a manner as to assume a swirling motion, thus avoiding a direct flame on the crucible and giving an equal heating surface. An enameling burner oven is shown, as is also a gas steam boiler. This, though probably adaptable to limited use, is somewhat of a novelty, and is an example of the many uses of gas managers and engineers are endeavoring to familiarize the public with.

In this boiler the steam pressure regulates the gas flame, so that with a constant water level little attention need be paid to the boiler. The blower recommended in many of these operations carries two rollers or vains, and is constructed in such a manner that these rollers fit into each other in a similar manner to large cogs. There is considerable leakage on the sides, but the blower gives about one pound pressure at five hundred revolutions per minute.

A gas engine of goodly proportions occupies considerable space of the booth. This has a few special features, among which might be included the enclosed magneto and the balances placed on the shaft opposite the crank-pin.

Messrs. Gould, Shapley and Muir are showing some of their gas engine specialties, among which are concrete mixers, traction engines and gas and gasoline engines of good sound construction. These engines carry a governor which can be adjusted while the fly-wheel is revolving. A large gas traction engine is on exhibit just to the side of the main entrance of the fair grounds, and should be examined as it appears to present many points which should be considered when an engine of this type is purchased.

The Campbell Gas Engine Co. are showing a 25 h.p. gas engine driven by gas obtained from a suction gas producer which presents many points of interest.

It is of an open hearth type, the steam gaining access to the flame through the bottom, which is an open fire place. The evaporator in this type is located at the bottom and the plant is designed to generate steam in excess of requirements which proves of great value in heavy loads. An oil engine of 15 h.p is exhibited, which is designed to operate on coal or semi-crude oils. It carries tube ignition and water injector, and is so constructed as to avoid thumping on heavy loads.

The General Machinery Co. are demonstrating the Luitwieler system of pumping. This pump is a departure from pre-existing types, the main features being its ability to operate without perceptible vibration, and its high efficiency. They are distributing literature on which is placed a cut showing an electric pump of this manufacture resting on a set of four tumblers supported by a saw-horse, the object being, of course, to forcibly demonstrate the features set forth above. The revolving portions of these pumps are beautifully balanced and reciprocating motion is transmitted to the pump plungers through means of yokes operating vertically in the engine frame. These yokes are driven by cams which operate against rollers mounted on the yokes to raise and lower them. These pumps deliver a constant flow of water at uniform pressure and without pulsation.

In the Industrial Building the Northern Electric Co. occupy a prominent corner, and have not failed to derive full benefits from their position. They have brought to the attention of rural and small municipalities their line of telephones and fire alarm apparatus. They are showing a sectional unit type switch board, designed to be added to from time to time as requirement calls for. A number of improved designs in magneto and inter-communicating telephones are shown. Possibly the foremost feature of their exhibit will be a complete fire alarm system, operating in the booth and demonstrating to town councillors and others interested the advantages of the system. A complete line of waterproof fixtures are shown, as is a flash-light police signal.

Messrs. Wm. and E. J. Greey are demonstrating a line of flour mill machinery and accessories, among which are a dough mixer and a dough devider, designed to deliver dough in quantites, equal proportions. This machine, of course, is adjustable. Methods of rolling oats for horse feed, feed grinders, sifters and mixers, trucks and general mill fittings are shown at their booth in Machinery Hall.

The Canadian Kodak Company have taken a prominent position in the manufacturers' quarters, and are demonstrating their full line of lenses, kodaks and accessories. They have decorated their booth with enlargements of various subjects.

In the opposite end of the building are the exhibits of the Dunlop Rubber Co. and the Gutta Percha and Rubber Co.

The former are showing belting, hose, matting, fire and heavy nozzles. A piece of thirty-six inch suction tubing forms a feature of their exhibit.

The Gutta Percha and Rubber Co. are demonstrating a produce which they have named "Multiped" hose. This is manufactured in continuous lengths of five hundred feet, and is made in one-half, three-fourths and one inch sizes. In addition to this they are showing the usual products of a plant of this nature. Automobile tires are being shown in the Transportation Building by this firm.

The Dominion Sewer Pipe Co. are demonstrating some of their products, among those being shown are chimney tops of various sizes and designs, drain tiles and pipes of all description, ornamental rustic work in clay, and wall coping. Their exhibit is to be seen near to the main entrance of Machinery Hall.

In the western portion of the machinery quarters will be found an exhibit which will interest millowners and machinists. This is the production of the Positive Clutch and Pulley Company. This firm are exhibiting samples of their pulleys, these are constructed with malleable iron centres and pressed steel spokes, designed in such a manner as to give the minimum amount of air disturbance. They are also demonstrating a new form of shafting hanger, which operates somewhat on the principle of the clutch holder used in threading and cutting pipe. The hanger carries two set screws, the lower one as well as the lower portion of the hanger being constructed in such a manner as to be swung out for belt adjustment or other purposes.

The positive clutch necessitates a personal examination to be fully appreciated, but the essential features are a set of spring claws operated by a lever which first bring a number of fibre bosses against the rim of a face plate, a further movement of the lever brings the face plate into touch with the steel rim locking the two securely.

Messrs. F. W. Bird & Son, of Hamilton, Ont., have erected a building near the eastern entrance of Machinery Hall to demonstrate their roofing specialties. The roof of this structure is composed of Neponsot-Proslate roofing, the floor is covered with felt, and around the walls arranged on shelves are samples of their product.

Petrie have installed a pretentious exhibit of Keighley gas and oil engines, one of these engines, probably the largest gas engine at the fair, is designed to give 65 horsepower, and for this yield is of very economic proportions. Some smaller engines of similar design are shown, and an upright engine which could be used to advantage in dynamo driving in confined quarters. In addition to this a display is made of small grinding stones and machine accessories.

A TREATISE ON RETAINING WALL DESIGN.

Specially Contributed for Student Readers.

By J. H. Everest, C.E.

(Continued from last week.)

It has been previously stated that many retaining walls are constructed which do not agree with practice in respect to earth pressure. Take Rankine's theory for instance. Rankine's theory assumes that the total horizontal pressure against the wall is equal to:—

$$T = \frac{1}{2} W H^2 \times \frac{1 - \sin\phi}{1 + \sin\phi};$$ and that this pressure acts at one-third the height of the wall. Now, it is questionable, as several authorities have stated and demonstrated, if this is actually the thrust suffered by the wall. Several experiments have been carried out to prove this. By kind permission of Professor Charnock, Principal of the Engineering Department of the Bradford Technical College, England, in Fig. 1 I reproduce graphic illustration of an experiment he carried out with a view to ascertaining more practical information. A certain variety of sand weighing 94 lbs. per cu. ft., and having a natural slope of 33 degrees, was taken and deposited against a vertical surface. Professor Charnock took the mean of a number of trials with a small experimental apparatus, and thereby found that the normal pressure against the vertical surface amounted to 2.7 lbs.

$$\text{Inclined R on diagram} = \frac{6.64 \times 9.00 \times 94}{1.728} = 3.25 \text{ lbs.}$$

and the horizontal pressure T equals R Cos 33 degrees of R $\cos\phi = 3.25 \times .838 = 2.72$ lbs.

Now compare this result with Rankine's formula for total horizontal pressure or thrust, which is:—

$$T = \frac{W H^2}{2} \times \frac{1 - \sin\phi}{1 + \sin\phi}$$

In this formula:—

T = Total horizontal pressure.

W = Weight of earth in lbs. per cu. ft.

H = Height of wall.

$$\therefore T = \frac{94 \times 7 \times 7}{2 \times 12 \times 12} \times \frac{1 - .544}{1 + .544} = 4.7 \text{ lbs.}$$

Consequently by this the thrust calculated according to Rankine's theory, is twice as much as that determined from experiment by Professor Charnock.

The student will now understand why retaining walls constructed according to Rankine's theory possess greater stability than actually necessary. As previously pointed out, Rankine's theory will, however, be adopted, because it is the safest and most reliable theory to adopt by students. It is to be hoped, however, that the important question of earth pressure has been sufficiently demonstrated to point out its importance. In such an elementary treatise as this, exhaustive investigation is out of the question, therefore it is understood that the student will further study the matter from more important sources. We will now consider Rankine's theory of earth pressure.

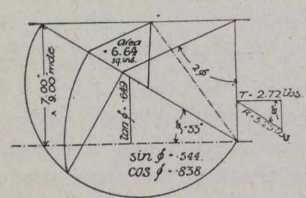


FIG. 1

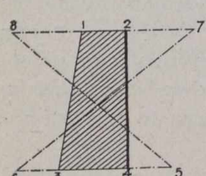


FIG. 3

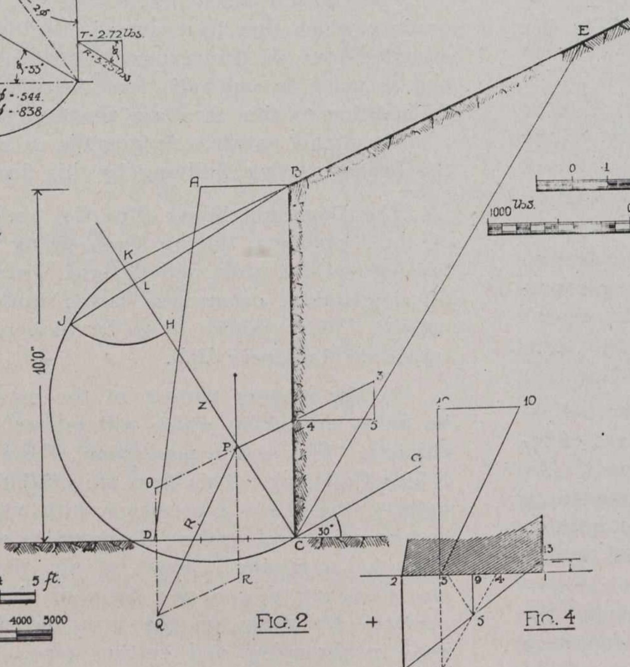


FIG. 2

FIG. 4

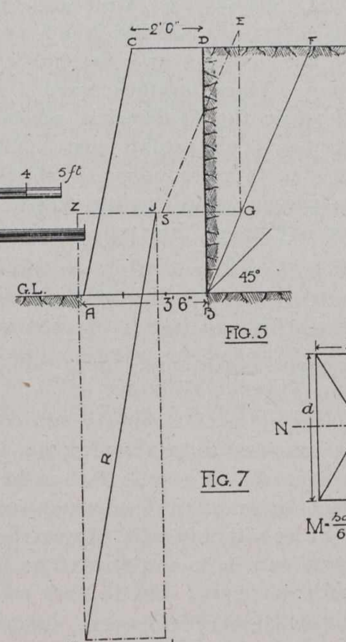


FIG. 5

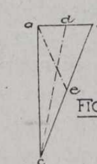


FIG. 6

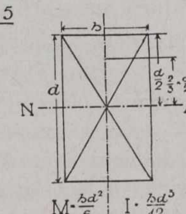


FIG. 7

Rankine's Theory of Earth Pressure.

After what has just been stated the student may be somewhat surprised to find that finally Rankine's theory is selected for the design of a retaining wall. Inasmuch, however, that this article is designed to meet the especial needs of student readers, economical considerations may be sacrificed for problems of stability. Therefore, providing that the student is a careful designer, the following conclusions may be considered by him an adequate solution to the problem. Besides, many eminent engineers still adhere to the old theory of Rankine on account of the large margin of safety which it affords.

Graphical Analysis of Stresses.

We will take the example shown in Fig. 2, which represents a brick wall constructed to support an artificial bank of earth. We resolve the stresses as follows:—

Weight of earth per cu. ft. .... 120 lbs.
Weight of brickwork per cu. ft. .... 112 lbs.
Natural slope .... 30 degrees.
Height of wall .... 10 ft. 0 in.
Top width .... 2 ft. 6 in.
Bottom width .... 4 ft. 0 in.

Draw accurately to scale on paper a wall having these dimensions. Referring to Fig. 2, bisect the angle BCG, and produce the line until it meets the slope of surcharge B E in E. The resultant line is called the plane of rupture, that is, it theoretically divides active from inactive material, and is the theoretical plane upon which the material would slide against the wall if rupture occurred. Therefore, what we have to consider now is the amount of earth the wall is to support, which is B C E. Make angle B C K equal to angle B C E, now produce E B to cut C K in K. Bisect C K in Z and with Z as centre and Z K as radius, describe the semi-circle shown. From B drop a perpendicular on to C K, cutting it in L. Then with K as centre and K J as radius describe the arc J H, the point J being determined by producing the line B L, until it cuts the semicircle. The horizontal thrust always acts at one-third the height of the wall, consequently draw the horizontal thrust line 5/4 in the position indicated and determine its value from the following formula:—

$$T = \frac{1}{2} W (C H)^2$$

$$= \frac{1}{2} \times \frac{120}{1} \times \frac{49}{8} \times \frac{49}{8} = 2{,}250 \text{ lbs., say } 2{,}300 \text{ lbs.}$$

Adopting a convenient scale of lbs., make 5/4 = the above value, and draw 4/3 parallel to slope of surcharge. Draw a perpendicular line from the point 5 until it meets this line in 3. Now find the centre of gravity of the wall as shown in Fig. 3, as follows: Make 1/8 and 2/7 equal to the base of the wall, similarly make 6/3 and 4/5 equal to the top width. Draw diagonals and the point of intersection will be the centre of gravity of the wall. Draw a perpendicular line from the centre of gravity and produce 3/4 to cut it in P. On 3/P produced from the point P cut off P O equal to 3/4. Now, with the same scale of pounds make P R equal the weight per lineal foot of the wall. Complete the parallelogram of forces O P Q R, and draw the resultant Q P. To ensure condition of no tension as previously explained the resultant should fall within the middle third. It does not happen in this case for tension obviously exists from the fact that the resultant is outside the middle third. Consequently it becomes necessary to calculate the maximum stress on the outer edge. Adopting the formula:—

$$\frac{W}{A} + \frac{M}{Z};$$ which has been previously explained and substituting the equivalent values, we obtain:

$W = 4750$
$A = 4$ sq. in.
$M = 4750 \times .84$
$Z = \frac{1}{6} bd^2$

Therefore:—

$$\frac{4750}{4} + \frac{4750 \times .84}{\frac{1}{6} bd^2}$$

$$= \frac{4750}{4} + \frac{3990}{\frac{1}{6} \times 1 \times 4^2}$$

$$= 1187.5 + \left.\frac{3990}{\frac{8}{3}}\right\} = \frac{3990}{1} \times \frac{3}{8} = \frac{5985}{4} = 1496.2$$

Consequently compression = 1187.5 + 1496.2 = 2683.7 lbs.
Tension = 1187.5 — 1496.2 = 308.7 lbs.

Suppose we check this result by the graphic method shown in Fig. 4.

Graphic Method for Obtaining Maximum Stress.

Using the same scales as adopted for figure, resolve the thrust into its components normal and parallel to 1/2. Divide the normal component 12/3 by width of wall 1/2, as follows $\frac{4750}{4} = 1190 = 9/5$. Join the core points 3 and 4 to the last ascertained point 5. Now project 4/5 until it meets the normal component produced in point 6. Project the point 6 to meet the perpendicular drawn from 2, thus obtaining point 7. The line 2/7 measured to scale gives the compression in lbs.—on the toe 2. Similarly the compression or tension could be determined on the other edge. In our case tension exists as previously explained and graphically shown in Fig. 4. Upon measuring the line and determining the equivalent values, it is found that they result as follows:—

Compression or 2/7 = 2,700 lbs.
Tension or 1/13 = 320 lbs.

Upon comparing these results with those determined analytically by the above formula, they will be found to compare very favorably, thus proving that the above calculations are correct.

There exists yet another rule by which we could determine the amount of compression, viz.:—

$$\frac{2}{3} \frac{W}{d};$$

In this formula W = total load or vertical component of resultant, and d the distance of resultant from the outer edge. In this formula no tension is allowed. Applying it to our case we obtain the following calculations:—

$$\frac{2}{3} \times \frac{4750}{1} \times \frac{10}{11} = 2{,}900 \text{ lbs. compression practically.}$$

Upon comparison with the above results, these will also be found to be favorably correct. There will be ample margin of safety in these results.

Walls Unsurcharged.

The rules governing the principle of finding the stability of walls, not surcharged are similar to those for surcharged walls, a slight modification being apparent in the stress diagram. For instance, in the example shown in Fig. 5 the wall is 7 feet high, and is constructed of brickwork in cement mortar, with a vertical back. The wall is to be constructed to retain a moderately dry bank of earth, the composition of which is clayey, having a natural slope or angle of repose of 45 degrees. After setting out the angle of repose and bisected the complement to find the line of rupture, find the centre of gravity of wall and wedged shaped portion of clay. To find centre of gravity of wedge (see Fig. 6) bisect a/b in d, and b/c in e, join the points so obtained and their point of intersection will be the required centre of gravity. Now find the weight in cubic feet per lineal foot of clay and wall respectively, and when this has been done erect from G a perpendicular equal to the weight of 1 foot section of clay. From E draw a line parallel to line of rupture to find the amount of the horizontal thrust, which in diagram is represented by G.S.

From J make J Z equal to S G, J L equal to the weight of wall and join K J, which will equal the resultant in magnitude and direction. In this case the resultant is found to fall well within the middle third, consequently it will not be necessary to make further calculations.

THE HYDRAULIC SERVICE OF QUEBEC.*

Mr. Arthur Amos, C.E., Engineer Quebec Hydraulic Service.

The Honorable, the Minister of Lands and Forests, in his address to this convention, mentioned the waterpower resources of the province, and explained briefly how they were given special attention by his Department. Allow me to develop and complete his reference, by a few remarks on the subject. Forest and stream are intimately associated, and mentioning one entails describing the other; for in a measure they depend on each other, and the protection given to the former will be reflected in the preservation of the latter.

The Department of Lands and Forests organized a Forestry Branch a few years ago. In conformity with a logical development, the Hydraulic Service was becoming a necessity. This has been recognized, the principle is now adopted, and henceforth, questions pertaining to rivers and lakes will receive attention from a distinct staff. I cannot yet entertain you with our achievements, since we are, as is said in mechanics, only a potential force. It will, no doubt, take sometime to organize such a bureau, for the country is vast, and although much data exists in the form of numerous reports, and narratives of interesting expeditions it will be quite a task to sum up all this information and make it immediately available.

Before proceeding any further, let us briefly explain our programme. In the first place, the most pressing demands will evidently require our attention; that is, gauging rivers, and measuring falls and their power, as such information is asked for, and as grants are applied for. But now, one often hears it stated that the public is in ignorance of our hydraulic resources and of their value. Our mission will therefore be to give particulars, to awaken ideas of development in connection with industries, for which waterpower is used, and help as much as possible the utilizing of this wasted energy. However, I hasten to say that in the last ten years many applications have been made to the Department, which tend to show the increasing interest taken in the matter. This has necessitated expeditions and reports from engineers, full of interesting information, and when duly classified will be still more so.

But it is not sufficient to know the power of falls or rapids at a certain time. Manufacturers have learned how important is a knowledge of the regimen of a river, including the maximum and minimum flow; for thereon depends the regular working of the plant. Therefore, it would be important to register and study the fluctuations on water gauges and thus find the mean flow. Here, I hasten to add that the systems of the great arteries such as the St. Lawrence, Ottawa and Richelieu are now well known. For years, records have daily been kept of the variations of the St. Lawrence, from the great lakes to Quebec; and such observations, followed by studies and logical conclusions, have enabled the federal government to begin a work of the highest importance, I mean the regulating of the flow of the Ottawa River. The best results are expected from this project which is already in a fair way of being carried out and in which the provincial government takes a special interest. On its success depends an entirely new policy from the standpoint of the great public works, and such works will serve as a pattern for many other rivers in Canada.

You are all probably aware of what I refer to, so, I will say only a few words about it. The sources of the Ottawa consist of immense lakes, the chief ones being Lake Timiskaming, Lake Quinze, Lake Kippewa, etc. These three lakes alone have a total superficlal area of about 325 square miles. During the spring thaw, many tributaries pour their waters into them, raising their level, and the Ottawa, which is the funnel of the whole system, becomes a torrent. Its flow then amounts to as much as 250,000 cubic feet per second, an enormous volume of water which is not only lost but causes incalculable damage along its course. In winter, on the contrary, when the sources dry up, the flow drops from 250,000 cubic feet (1,555,000 gallons) to sometimes as little as 15,000 cubic feet (93,000 gallons) per second. Then comes a period of depression; the owners of factories and works on its banks become anxious; they find themselves compelled to shut down their sluice-gates to husband the water, to reduce their output, and industry is arrested through lack of motive power. Consequently great dams have been, and are now being built at the foot of the lakes I have just mentioned. An attempt will be made to keep back the great excess of water in the spring, to store it up for the months of drought and it is hoped that the flow of the Ottawa will be regulated by being kept at a constant and uniform volume of 55,000 cubic feet per second. This will prevent the periodical inundation of Ottawa, Hull, the banks of the Gatineau river and the whole of the district, and give the large mills at the Chaudière the regular supply of water essential to their proper working. Moreover, we foresee that many water powers will be created or will at least acquire value, when such regular flow is assured. Thus the government of Quebec, alive to the importance of the result, has not hesitated to give a free grant of the lands required for the works, reserving only a share of the benefits from the water-powers so created.

Such are the results we can anticipate from these works and (because it would be foreign to the matter before us) I have not mentioned other advantages they will have in connection with the project of the Georgian Bay Canal. These great reservoirs will be feeders of that canal, and form part of its plan.

I have endeavored to show you the economic advantage obtained by regulating the course of a river after it has been gauged, and its flow at various periods of the year has been ascertained. I might also speak to you about the utility there would be to establish Bench Marks whose elevation above the sea would be known, and which would enable one to ascertain the level of the rivers at all periods, and especially during freshets and when the waters are at their lowest. The question is important in so far that the bed of a navigable stream belongs to the state up to high water mark, and it is very frequently difficult to determine it when the water is low.

When the owners of adjacent lands want to have the boundaries of their lots established, such stations would enable the surveyors to quickly determine the boundaries of each one's property. Several surveyors have already asked me for information on this point and this has led me to make this suggestion, as it would facilitate their work. I hasten, however, to add that the Hydrographic Branch of the Naval Department has established such Bench Marks on a portion of the St. Lawrence and that, on its part, the Georgian Bay Canal Commission has also established many along the Ottawa, as far as French river. All that remains to be done is to publish the information which has so far remained in the books, with the addition of a few notes.

Now, I would call your attention and that of our legislators to the problems to be solved in the near future. I mean the classification of rivers into navigable and non-navigable, floatable and non-floatable rivers, for this problem too often paralyzes proper administration, gives rise

*Paper delivered at Canadian Forestry Convention, June 20, 1911.

to antagonism and causes long delays. In fact, the navigableness of a river gives the state a clear title as regards the ownership of its bed and waters. In the contrary case, disputes may arise and they are generally burdensome upon both parties. I at once admit that the question bristles with difficulties, so much so, apparently, that the administrative departments do not seem to have always ventured to confront them, and the courts, as a rule, have been called upon to solve them. In any case, we wish to include classification in the programme of the Provincial Hydraulic Service and will endeavor to throw some light on the subject, for the courts—and I speak with all the respect that is due them—seem in many cases to have been inspired in their decisions more by the letter than by the spirit of the subject. Some rivers, for instance, which were at least partly navigable, have been declared non-navigable and vice versa, the declaration covering the whole of their course. It would perhaps have been better to be more circumspect and to declare them navigable or non-navigable only in certain well defined sections.

Moreover, it is not surprising that legislation in connection with water-courses in Canada, should not be very precise as yet, inasmuch as in Europe, in France especially, where the question has been debated since the Revolution and even before, clear formulas and formal texts have been reached only in the past few years. The act of 1898 seems to sum up all that can be said on the subject, and we have reason to hope that we shall be guided by it.

I was asked to speak on the waterpowers of the province of Quebec. Pardon me if I have somewhat evaded the subject. I thought it would be rather dry work to give you figures which are always hard to remember and which interest only a few. To the latter I would rather say that our waterpowers in the best known regions—on the St. Maurice, in the region of Lake St. John, on the Manikuagan river; and, in the west, on the Ottawa and Lièvre rivers, in the Timiskaming region, etc.,—are beyond number and that some of them are of gigantic capacity, such, for instance, as the three great falls on the Manikuagan river whose total force would exceed a million horsepower; the great Bear falls on the Ashuapmuchuan river near Lake St. John with a force of 99,000 horsepower, etc. Besides, we have already begun to classify all the known falls that can be utilized, and we shall soon be in a position to give the public more information and to better encourage industry to avail itself of our great heritage.

Should I speak to you about the pecuniary value of those falls or of their upset price? I would fear that I was going beyond my sphere. I will merely say that in all probability our waterpowers—at least the more extensive ones—will in future be leased under emphyteutic leases, the terms whereof will vary according to their importance and situation.

FRENCH OPINION REGARDING AUTOMOBILES MANUFACTURED IN THE UNITED STATES.

Automobiles manufactured in the United States are becoming quite popular in France, and the French engineers and manufacturers, who admittedly lead in the production of first grade cars, state that the regular stock cars built in the United States have too much power. They maintain that putting racing power in a family touring car is ridiculous, wasteful and inconvenient, and in consequence is not good engineering. They predict that in future years have more than 30 horse power and in the 7 passenger class never over 40.

BOOK REVIEWS.

History of Bridge Engineering. Henry Gratton Tyrell, C.E.; published by the author, Chicago; 447 pages, 6 x 9, fully illustrated.

As pointed out in the preface, proficiency in any art is not attained until its history is known. Many students and designers have found, after weary hours of thought, that the problem before them was considered and perhaps mastered by others years ago.

Mr. Tyrell has undertaken a stupendous task, as anyone who is at all familiar with the history of bridge building can readily attest. In view of this very fact, it is acknowledged by the writer that a great deal of information was necessarily crowded out of a volume of this size; but the final result is such that a very complete work has been gotten together. In the evolving of new work the designer does well to be familiar with outlines and details of other and perhaps older work. This book can very well help in giving such ideas to the designer.

Quite necessarily a good deal of space has been devoted to bridges built before the advent of metal as a structural material. Although professedly not of a technical nature, this book has distributed throughout its pages a large amount of dimensions that are valuable when taken in conjunction with the illustrations.

Altogether, the book is a credit to the author and will be a valuable addition to engineering literature.

Design and Construction of Mill Buildings. Henry Gratton Tyrell, C.E.; published by the Myron C. Clark Publishing Co., Chicago and New York; 490 pp.; 6x9, fully illustrated; price $4.00.

Mill building construction is becoming an extensive branch of engineering in itself, and this book is a decided addition to the available literature on the subject. This book is the outcome of a smaller one entitled "Mill Building Construction," published in 1900. These books are based on the author's personal experience, and most of their contents are from his notes and records.

The author has included a part on "The Theory of Economic Design," which gives a knowledge of the possibilities and requirements. This has caused some repetition later in the book.

He has devoted a great part of the book to descriptions of the details and materials of construction. The different loads which may come on a structure are well analyzed, and there is a good chapter on framing.

There is a total absence, however, of methods of theoretic analysis and graphic statics, which the author says have been sacrificed for more important material. His strictures on mathematicians and mathematical analyses, in which he quotes Trautwine's Engineer's Handbook, might well have been omitted for the book lacks in just that department.

However, the book on the whole is a valuable one to the designer and estimator, containing much of use to both, when used in connection with other treatises on mathematical methods and statics.

Canadian Forestry Convention. The report of the Canadian Forestry Convention at Quebec has just been issued, and makes a volume of 160 pages, of addresses, papers, and discussions by Canadian and United States authorities on forestry and lumbering. All parts of Canada are embraced in the report, and all phases of the subject, commercial, educational, administrative, and protective are dealt with. The resolutions passed and changes suggested in the laws are included. Persons interested may receive a copy free upon application to The Secretary, Canadian Forestry Association, Canadian Building, Ottawa, Canada.

Virtue's Encyclopaedia of Practical Engineering. Virtue & Co., of London, have published a work by Joseph G. Horner, A.M.I.M.E. It consists of 10 volumes devoted to a general description of all material and apparatus used in the different branches of the engineering profession, and the various trades.

The volumes are profusely illustrated with zinc cuts and half tones.

A mere mention of some subjects treated will enable the reader to form some opinion of the work; they include factory accounts, angle bending, beams, belt pulleys, boiler testing, compressed air, dredging, grinding, locomotives, patternmaking, sand, slide rests and valves, slide rule, turning.

The text is quite instructive, mathematics being included where necessary.

This work will doubtless prove a boon to the mechanic who seeks to broaden his capabilities and opportunities, more so in fact than to the professional engineer.

Speed and Consumption of Steam Ships. J. F. Ruthven; published by J. D. Potter, London, 78 pp., 6 x 9.

A book for navigators and sea-going engineers, so says the preface. The book is a compilation of rules and empirical equations—collected and edited for use in the Royal Navy and Mercantile Marine. Each formula has a practical example worked out. The book may be of some slight service to captains of ocean-going steamers, but it is of no use for engineers.

Annual Report of the Division of Mineral Resources and Statistics in the Mineral Production of Canada for Year 1909.

Report is made up by the Canada Department of Mines and contains revised statistical information descriptive of the mining and metallurgical production in Canada during 1909. Much of the material it contains has been published in separate pamphlets before, but this volume forms a valuable compilation.

PUBLICATIONS RECEIVED.

Annual Report Commissioners Queen Victoria Niagara Falls Park. The twenty-fifth annual report containing copies of contracts for Boulevard construction and copies of agreements with power companies, also report of superintendent on construction of Boulevard.

Journal of the American Peat Society. Published quarterly in Toledo, Ohio. Issue contains articles on Production and use of fuel in United States, Canada and Europe.

Twentieth Annual Report, Bureau of Mines. Vol. XX. Part 2. A report on the Porcupine gold area, by A. G. Burrows.

Comparative Prices, Canada and the United States. Report gotten out by the Department of Labor, giving comparative prices in Canada and United States from 1906 to 1911, of Agricultural, Fisheries, Lumber and Mines products.

Seventh Annual Report of the Commissioners of the Transcontinental Railway, for the fiscal year ending March 31, 1911.

The Resources of Tennessee. A monthly publication of the State Geological Survey, devoted to the description, conservation and development of the resources of Tennessee.

CATALOGUES RECEIVED.

Profiling Machines.—Garvin Machine Company, Spring and Varick Streets, New York, forward new catalogue "Da," superseding old catalogue edition "D." This catalogue illustrates and describes Profiling Machines, Duplex Milling Machines, etc., manufactured by them.

Steel Posts.—American Steel Post Company, Los Angeles, Cal., are sending out catalogues of "Carbo" Steel posts and poles-Describes posts, also method of construction of fences.

Heavy Lathes.—Niles-Bement Pond Company, New Bement Pond Company, New York, in a finely illustrated booklet describes different types of lathes manufactured by them.

Production of Mechanical Wood Pulp.—Jens Orten-Boving, London, are issuing a well arranged pamphlet entitled "Some Short Notes on the Production of Mechanical Wood Pulp," illustrating machines manufactured by them and used in wood pulp manufacture.

Coal Crusher.—The Jeffrey Manufacturing Company of Columbus, Ohio, are sending out Bulletin describing Single Roll Coal Crusher.

Alternating Cement Motors.—T. W. Broadbent, Ltd., Huddersfield, England, forward pamphlet describing motors for one, two and three phase circuits.

Electric Locomotives.—C. W. Hunt Company, New York, forward catalogue No. 11-5 describing their new Electric Locomotives running by storage battery or trolley.

WORKMEN'S COMPENSATION.

Adequate protection for employer and employee, increased safety of industrial operations, sure and certain relief for workers injured at extra hazardous occupations, and their families and dependents, elimination of litigation and consequent saving of retainer's fees and court expenses and regulation by State police powers of dangerous trades, are some of the advantages claimed for the Workmen's Compensation Act, which will become effective in Washington on October 1st, 1911.

The theory of the Act, which was adopted by the last legislature, is stated in these words:

"The welfare of the State depends on its industries and even more upon the welfare of its wage-earners."

The new law applies to all factories, mills and workshops where machinery is used and foundries, mines, smelters, powder works, breweries, elevators, docks, dredges, laundries, printing, engineering, logging, lumbering, shipbuilding, railroad and general building operations, street and interurban railroads, electrical, power and heating plants and steamboats.

One hundred and fifty thousand dollars has been appropriated by the State to bear the expense of administering the law, and Governor Marion B. Hay has appointed a commission to have full charge of the industrial insurance work, including the collection of premiums and the adjustment and settlement of claims. The commission, which is composed of George A. Lee, of Spokane, representing the legal profession, chairman; G. A. Pratt, of Tacoma, for the manufacturers and employers, and J. H. Wallace, of Seattle, for the workingmen, has power to create new classes and establish new rates.

The law provides that each of the industries shall contribute a certain percentage of its pay-roll to an accident fund, from which various sums are paid out for total or part disability or on death to the family and dependents of the injured workman, the expense of handling the fund being borne by the State. Injured workmen, their families or dependents, cannot recover by law except where the injury is caused by the intent of the employer, in which case the workman or his family may recover not only the sums due under this act, but may sue for any excess of damage over these amounts.

Where a workman is injured because the employer has neglected to observe the safeguards by law or by the regulations of the department, the employer must pay 50 per cent. more than the fixed amounts. Where the workman intentionally injures himself he receives no benefit.

The industries of the State are classified and certain premiums fixed for each class. The employers are required to pay three months' premiums into the State treasury on or before October 1, 1911. After December 31, monthly payments are required, provided, however, that if any industry has a sufficient amount on deposit with the State to take care of its accidents no further payments shall be required.

Each industry is responsible only for the accidents occurring in that class. It is intended that the accident fund shall be neither more or less than self-supporting. The rates are subject to re-adjustment, depending on the number of accidents and the need for compensation of injured workmen.

Employers are required to report accidents promptly, and their books, records and pay-rolls must be open for inspection by the commission. Refusal to permit inspection is made a misdemeanor and the employer also is penalized $100 for each offense, to be collected by action in court and paid into the accident fund.

Misrepresentation in his pay-roll makes the employer liable to ten times the difference between the correct and the wrong figures. If the employer refuses or fails to pay his monthly assessments, a workman injured in his service may sue in the courts with the employer's defence of "fellow-servant," "assumption of risk," and "contributory negligence" abolished.

No part of the premium can be deducted from the wages of the workman, the violation by the employer of this section of the law being made a gross misdemeanor, punishable by one year in the county jail or by a fine of $1,000, or both.

The schedule of payments for various injuries is as follows:

In the event of death, expenses of burial, $75; payment to widow or invalid widower, $20 a month while unmarried, $240 in a lump sum on re-marriage of the widow; for each surviving child under 16, $5 a month, monthly amount limited to $35; if no widow or widower survives, $10 a month to each child under 16 years. The same rule applies to children who become orphans by death of surviving parent, with monthly limit of $35. Dependents will be paid 50 per cent. of the average monthly support formerly received from the deceased workman, limited to $20 a month. Parents of deceased unmarried workmen receive $20 a month up to time deceased would have been 21 years of age.

When totally disabled, loss of both arms or one leg and arm, sight, paralysis or other injury preventing the workman from doing any work, entitles him to $20 a month if unmarried; if supporting wife or invalid husband, $25 a month; if the husband is not an invalid, $15. For each child under 16 years, $5 a month additional up to a total of $35. In case of death of the totally disabled workman, the widow or widower receives $20 a month until death or re-marriage and $5 a month additional for each child until 16. Orphan children receive $10 a month.

When partly disabled by the loss of one foot, leg, hand or arm, eye or fingers, the workman will receive a certain cash lump sum up to $1,500. The loss of one arm at the elbow is made the maximum injury and the payment for other injuries is scaled down by the commission. If the injured workman resides or moves out of the State the commission may lump the monthly payments, not to exceed $4,000, based on the Amercian mortality table. Any decision of the commission is subject to appeal in the superior courts.

"It is thought the new system will create a better feeling between the employer and employee," said Howard L. Hindley, secretary of the commission, "and in the end establish the principle of State industrial insurance on a sound and practical economic basis."

RAILROAD AND COMPANY EARNINGS.

Railroad earnings for week ended 14th August:—

	1911.	1910.	Increase or decrease.
C. P. R.	$2,205,000	$1,999,000	+ $206,000
G. T. R.	1,048,062	877,152	+ 170,910
C. N. R.	319,700	233,600	+ 86,100
T. & N. O.......	37,358	31,131	+ 6,226
Halifax Electric .	5,713	5,419	+ 293

The Sao Paulo tramways statement of earnings and expenses for July is as follows:—

	1911.	1910.	Increase.
Tt. gr. earnings.....	$ 283,441	$ 243,615	$ 39,826
Operating expenses ..	530,142	487,810	42,332
Net earnings	173,056	153,158	19,898
Ag. gr. earnings from January 1	1,967,694	1,631,040	336,654
Ag. net earnings from January 1	1,233,522	1,038,429	195,093

The Montreal Street Railway's statement shows the July surplus as $9,541, or 7½ per cent. over last year, while for the ten months the surplus shows a gain of $104,946, or exactly 10 per cent. The ten months' figures are as follows:—

	1910.	1911.
Passenger earnings	$3,402,275	$3,785,503
Miscellaneous earnings	88,370	91,207
Total earnings	3,490,645	3,876,710
Operating expenses	2,021,516	2,246,207
Net earnings	1,469,129	1,630,503

The statement of combined earnings and expenses of the tramways, gas, electric lighting and power and telephone services operated by the Rio de Janeiro Company for the month of July, 1911:—

Total gross earnings	$ 980,339	$1,145,938	$ 165,599
Operating expenses	478,810	530,142	42,332
Net earnings	492,529	615,796	123,267
Ag. gr. earnings from January 1	6,023,076	7,253,711	1,230,635
Ag. net earnings from January 1	2,877,281	3,741,579	864,298

The net earnings of the Winnipeg Electric Company in June were $164,100, as compared with $125,292 for June 1910. The total net earnings for the first half year of the Winnipeg Electric amounted to $925,583, as compared with $764,875 in 1910 for the corresponding period. The increase during the six months is $160,708, equal to 21.01 per cent. of the total for the first six months of 1910. The net earnings of the Winnipeg Electric for the whole of 1910 amount to $1,629,508.

The Canadian General Electric Company has issued its report for the year ended December 31, 1910, which compares as follows:—

	1909.	1910.
Operating profit	$625,990	$911,208
Deductions:		
Interest	51,660	76,820
Depreciation	91,093	188,088
Total deduction	142,753	264,908
Balance for dividends	483,237	646,300
Preferred dividends	140,000	140,000
Common dividends	329,000	354,625
Surplus	14,237	151,675

The amount available for dividends on the common stock, $506,300, is equal to 9.39 per cent. earned on $5,392,737 common stock, compared with 7.30 per cent. earned on $4,700,000 common stock last year.

The report of the Canadian Northern Express Company, as filed with the Interstate Commerce Commission at Washington for June and twelve months ended June 30, compares as follows:—

	1910.	1911.	Changes.
Total rcts. from op.	$ 38,869	$ 46,867	+ $ 7,998
Express priv. deb.	15,076	18,246	+ 3,169
Total oper. rev.	23,792	28,621	+ 4,828
Net oper. rev.	11,451	14,130	+ 2,678
Oper. income	11,083	14,148	+ 2,292
July 1 to June 30:			
Tot. rects. from op.	386,825	466,087	+ 79,262
Express priv. deb.	147,410	178,974	+ 31,564
Total oper. rev.	239,415	287,113	+ 47,697
Net. oper. rev.	105,374	132,189	+ 26,814
Oper. income	103,573	130,648	+ 27,075

Mileage: Steam roads 1911, 3,369; 1910, 3,280; other lines 1911, 22; 1910, 22.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, C. H. Rust; Secretary, Professor C. H. McLeod.

QUEBEC BRANCH—
Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH—
96 King Street West, Toronto. Chairman, H. E. T. Haultain; Secretary, A. C. D. Blanchard,, City Hall, Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—
Secretary, E. Brydone Jack. Meets first and third Fridays of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—
Chairman, Geo. H. Webster; Secretary, H. K. Dutcher, 40-41 Flack Block, Vancouver. Meets in Engineering Department, University

OTTAWA BRANCH—
Chairman, A. A. Dion, Ottawa; Secretary, H. Victor Brayley, N. T. Ry., Cory Bldg.

MUNICIPAL ASSOCIATIONS.

ONTARIO MUNICIPAL ASSOCIATION.—President, Mr. George Geddes, Mayor, St. Thomas, Ont.; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALITIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Mayor Reilly, Moncton; Hon. Secretary-Treasurer, J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. E. McMahon, Warden, King's Co., Kentville, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Hopkins, Saskatoon; Secretary, Mr. J. Kelso Hunter, City Clerk, Regina, Sask.

CANADIAN TECHNICAL SOCIETIES.

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang; Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons. Regina; Secretary-Treasurer, M. B. Weeks, Regina

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS, CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Charles Kelly, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto.

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

CANADIAN FORESTRY ASSOCIATION.—President, Thomas Southworth, Toronto; Secretary, James Lawler, 11 Queen's Park, Toronto.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. Frank D. Adams, McGill University, Montreal; Secretary, H. Mortimer-Lamb, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., Castle Building, Ottawa, Ont.

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

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 157 Bay Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July, August.

DOMINION LAND SURVEYORS.—President, Thos. Fawcett, Niagara Falls; Secretary-Treasurer, A. W. Ashton, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, W. B. McPherson; Corresponding Secretary, A. McQueen.

ENGINEER'S CLUB OF TORONTO.—96 King Street West. President, Killaly Gamble; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian Members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain, and W. H. Miller, and Messrs. W. H. Trewartha-James and J. B. Tyrrell.

MANITOBA LAND SURVEYORS.—President, George McPhillips, Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C.B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, S. Fenn; Secretary, J. Lorne Allan, 15 Victoria Road, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, W. H. Pugsley, Richmond Hill, Ont.; Secretary, J. E. Farewell, Whitby,

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. Whitson; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5 Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Alfred T. de Lury, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, H. P. Ray; Secretary, J. P. McRae.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, Grant Hall; Secretary, W. H. Rosevear, 199 Chestnut Street, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page
Brantford, Ont., nurses' residence	Sept. 2.	Aug. 24.	241
Brantford, Ont., steel bridge	Aug. 30.	Aug. 24.	70
Montreal, P.Q., automobile fire apparatus	Aug. 31.	Aug. 17.	211
Ottawa, Ont., station, Truro, N.S.	Aug. 31.	Aug. 24.	68
Ottawa, Ont., branch line railway	Sept. 15.	Aug. 24.	70
Ottawa, Ont., breakwater and dredging, Port Stanley, Ont.	Sept. 13.	Aug. 24.	68
Ottawa, Ont., St. Peter's Canal	Sept. 12.	Aug. 24.	70
Ottawa, Ont., Guysborough County Harbor Line	Sept. 15.	Aug. 24.	72
Ottawa, Ont., breakwater, Felizen, N.S.	Sept. 6.	Aug. 24.	241
Ottawa, Ont., breakwater, Kelly's Cove, N.S.	Sept. 12.	Aug. 24.	241
Ottawa, Ont., breakwater, West Advocate, N.S.	Aug. 30.	Aug. 24.	241
Ottawa, Ont., breakwater, Thessalon, Ont.	Sept. 11.	Aug. 24.	241
Ottawa, Ont., landing pier, Wheatley, Ont.	Sept. 13.	Aug. 24.	241
Ottawa, Ont., breakwater, French River, N.S.	Sept. 6.	Aug. 24.	241
Ottawa, Ont., ties and switch ties	Aug. 31.	Aug. 17.	211
Toronto, Ont., library work, Ontario Government Buildings, Queen's Park	Sept. 5.	Aug. 24.	241
Toronto, Ont., main drainage work	Sept. 12.	Aug. 24.	64
Toronto, Ont., steel steam screw tug	Sept. 5.	Aug. 24.	68
Toronto, Ont., steel pipe	Sept. 5.	Aug. 24.	68
Toronto, Ont., rail accessories	Sept. 7.	Aug. 24.	68
Victoria, B.C., bridge work	Aug. 31.	Aug. 3.	152
Victoria, B.C., construction of bridge	Aug. 31.	Aug. 3.	152
Weyburn, Sask., public building	Sept. 5.	Aug. 24.	242
Winnipeg, Man., valves and hydrants	Sept. 8.	Aug. 24.	70
Winnipeg, Man., C.I. water pipe	Sept. 5.	Aug. 24.	72
Winnipeg, Man., fire apparatus	Sept. 24.	Aug. 24.	242

TENDERS.

Halifax, N.S.—Sealed tenders addressed to the undersigned, will be received up to 4 p.m., Wednesday, 30th August, 1911, for the erection of a concrete building in the town of Glace Bay, according to plans and specifications, which may be seen at the office of the Eastern Telephone Company, Sydney, and Glace Bay; the lowest or any tender not necessarily accepted. J. H. Winfield, general manager, Eastern Telephone Company, Limited, 90 Hollis Street, Halifax, N.S.

St. Rose, Que.—Tenders will be received until September 15th, 1911, for the construction of the St. Rose Aqueduct. J. E. David, secretary-treasurer of the corporation of the village of St. Rose. (Advertisement in this issue).

Hull, Que.—Tenders will be received until September 5th, 1911, for cast-iron pipe, valves and hydrants. J. P. Albert Laforest, City Engineer. (Advertisement in this issue).

Ottawa, Ont.—Tenders will be received until September 5th, 1911, endorsed, "Tender for Interior Fittings, Post Office, Lunenburg, N.S." Plans and specifications to be seen on application to Mr. N. Myra, caretaker, Public Building, Lunenburg, N.S., and at the office of R. C. Desrochers, secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received until September 4th, 1911, for the manufacture, and delivery f.o.b., cars, Moncton, N.B., on or before the 1st day of December, 1911, of 2,000 gross tons of 80-lb. steel rails, complying with the specifications of the Commissioners. Specifications may be had on application to Mr. Gordon Grant, the Chief Engineer of the Commissioners, at Ottawa. P. E. Ryan, secretary, the Commissioners of the Transcontinental Railway, Ottawa.

Ottawa, Ont.—The time for receiving tenders for the construction of a "Stone Passenger Station" at Truro, N.S., has been further extended from August 31st, 1911, to September 15th, 1911. L. K. Jones, secretary, Department of Railways and Canals, Ottawa. (Advertisement in this issue).

Ottawa, Ont.—Tenders for the construction of a concrete retaining wall at Long Branch Rifle Range, Toronto, Ont., will be received until September 4th, 1911. Plans and specifications can be seen and all information obtained at the offices of the General Officer Commanding 2nd Division, 215 Simcoe Street, Toronto, and the Director of Engineer Services, Department of Militia and Defence, Ottawa. Eugene Fiset, Col., Deputy-Minister, Department of Militia and Defence, Ottawa.

Ottawa, Ont.—Sealed tenders will be received until September 20th, 1911, for the construction of a breakwater extension to north pier and dredging at Kincardine, Bruce County, Ont., according to plans and specifications, etc., which may be obtained at the offices of J. G. Sing, Esq., District Engineer, Confederation Life Building, Toronto, Ont.; H. J. Lamb, District Engineer, London, Ont.; on application to the Postmaster at Kincardine, and at the office of R. C. Desrochers, secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Sealed tenders for the construction of a boat house and the renewal of wharfs at Kingston, Royal Military College, Frontenac County, Ont., will be received until September 25th, 1911. Plans,, specifications and form of contract can be seen, and forms of tender obtained at the offices of J. G. Sing, Esq., District Engineer, Confederation Life Building, Toronto, Ont.; on application to the Postmaster at Kingston, Ont., and at the office of R. C. Desrochers, secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received until September 6th, 1911, for the construction of a public building at Lloydminster, Sask. Plans, specifications, etc., may be had at the office of Mr. J. E. Cyr, Superintendent of Public Buildings for Manitoba, Post Office Building, Winnipeg, Man.; at the Post Office, Lloydminster, Sask., and at the office of R. C. Desrochers, secretary, Department of Public Works, Ottawa.

Toronto, Ont.—Tenders will be called for the construction of double track underground subways, on or about September 15th, 1911. G. R. Geary, Mayor, City Hall, Toronto. (Advertisement in The Canadian Engineer).

Guelph, Ont.—Tenders will be received for the construction of a new Y.M.C.A. building in Guelph, Ont., up to noon on September 5th, 1911. Plans and specifications can be seen at the office of Messrs. Mills & Hutton, architects, Hamilton, or Mr. W. A. Mahoney, architect, Guelph. H. G. Cockburn, chairman, Guelph, Ont.

Guelph, Ont.—Tenders will be received by A. H. Foster, manager the Guelph Radial Railway Company, up till September 11th, 1911, for the construction of a system of tile drains, consisting of approximately 29,000 feet of tile. (Advertisement in this issue.)

Scott, Sask.—Mr. G. M. Phillips, town secretary-treasurer, will receive until noon Monday, September 25th, 1911, tenders for power house furnishings and fittings, water works material, laying of mains, and the construction of a power house. (See advertisement in this issue).

Winnipeg, Man.—Tenders will be received until September 6th, 1911, for supply of material and erection in place of oil and water system in the city sub-station on King Street. Instruction to bidders, specifications, etc., may be obtained at the office of the Power Engineers, Carnegie Library Building. M. Peterson, secretary, Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders will be received until September 11th, 1911, for the manufacture and delivery, f.o.b., Winnipeg, of the following supplies, according to approved specifications, namely:—

Sec. A.—Mercury Arc Transformers and Rectifiers.

Sec. B.—Magnetic or Metallic Flame Arc Lamps.

Sec. C.—Electrodes.

Sec. D.—Inner and Outer Globes.

All information governing form of tender, etc., may be obtained at the office of the General Manager of the City Light and Power Department, 449 Main Street. M. Peterson, secretary, Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders will be received until September 8th, 1911, for supply of quantity of valves and hydrants for the Domestic Water Works System. Specifications and forms of tender may be obtained at the office of the City Engineer, 223 James Avenue. M. Peterson, secretary, Board of Control Office, Winnipeg.

Moore Park, Man.—Tenders will be received for the erection and completion of a ten-roomed brick veneer school building with full concrete basement, to be erected at Moore Park, Man., until September 1st, 1911. Plans and specifications may be had at the office of W. W. Blair, architect, Winnipeg; Mr. Maybeer, manager of the Bank of Commerce, Brandon, and from C. Dearing, secretary-treasurer, Moore Park, Man.

Calgary, Alta.—Tenders will be received for the erection of a church and Sunday School building for Knox Church, to be built on Sixth Avenue and Fourth Street West. Plans, specifications and all information may be had at the office of the architect, to whom all tenders will be sent on or before September 21st, 1911. F. J. Lawson, Architect, Norman Block, Calgary.

Victoria, B.C.—Tenders will be received until September 1st, 1911, for the erection and completion of a large one-room schoolhouse with sub-basement at Gleneden, B.C., in the Kamloops Electoral District. Plans, specifications, etc., may be seen at the offices of the Government Agent, Kamloops, B.C.; M. McKay, Esq., secretary of the School Board, Salmon Arm, B.C.; and at the office of J. E. Griffith, Public Works Engineer, Department of Public Works, Victoria.

Victoria, B.C.—Tenders will be received until the 5th day of September, 1911, for the erection and completion of a large one-room schoolhouse with sub-basement, at Hope, B.C., in the Yale Electoral District. Plans, specifications, etc., may be seen at the offices of the Government Agent, Ashcroft, B.C.; V. I. St. George, Esq., secretary of the School Board, Hope, B.C.; and at the office of J. E. Griffith, Public Works Engineer, Department of Public Works, Victoria.

AGENCIES WANTED.

An engineering firm in London, England, makers of concrete mixers, sheet steel piling, sewage washing machinery, and tar macadam mixers would like to hear from firms in Canada with a view to an agency being established. Address "Piling," Canadian Engineer.

A firm in England, makers of a much used and well-known time recorder is eager to hear from firms in Canada who are prepared to push their sale in this country. Those interested will secure further information by addressing "Recorder," Canadian Engineer.

CONTRACTS AWARDED.

Ottawa, Ont.—The Nova Scotia Construction Company has been given a contract by the Government for the building of a pier 800 feet long, containing sheds for the I.C.R., at Halifax. Hundreds of men will be employed, and the contract figure is $914,600. Work begins immediately.

Toronto, Ont.—The contract for the 500-foot extension to the intake pipe was awarded by the Board of Control to Messrs. Miller, Cumming & Robertson, at a cost to be twenty per cent. over and above the actual price of laying. Captain William Leslie also tendered for the same work at $37,500.

Port Arthur, Ont.—The contract for the Utilities Storehouse for the city was awarded to Messrs. Seaman & Penniman, at $4,850. The building is reinforced concrete and brick.

Dundas, Ont.—Public building.—Contractors, Nagle & Mills, Ingersoll, Ont., $31,200.

Toronto, Ont.—The Hydro-Electric have been awarded the contract for power and street lighting in North Toronto in competition with the Interurban and Toronto Electric.

Peter Nicholson was awarded the contract for the building of the disposal tanks at a total cost of $29,744.39, his tender being considerably lower than the other two.

Tilbury, Ont.—Public building.—Contractors, John Piggott & Sons, of Chatham, Ont., at $20,000.

Amherst, N.S.—Dredging at mouth of La Planche River.—Contractor, Edward R. Reid, of St. John, N.B.

Mr. W. W. Harvie, secretary and treasurer of the Dominion Creosoting Works, signed the contract with the Great Northern Railway for the piling for the Great Northern's new wharf on Burrard Inlet, in the vicinity of the sugar refinery. This contract is simply and solely for the providing and driving of the piles, and the amount involved is $45,000.

Russell, Ont.—The trustees of the police village of Russell have awarded to Helmer & Winstanley, of Morrisburg, Ont., the contract for the construction of 35,000 square feet of granolithic pavement; also the contract for macadamizing about half a mile of street from the O. and N.Y. Railway to the Castor River.

Virden, Man.—The Manitoba Hardware and Lumber Company have received the contract for the installation of a steam heating plant in the Virden Municipal Hall at a total cost of $3,489.15.

Calgary, Alta.—Customs fittings, alterations and additions to.—Contractors, the J. T. Schell Company, of Alexandria, Ont., at $1,091.

Saskatoon, Sask.—The contracts for storm sewers have been let as follows: A. R. Campbell, for laying 8, 10, 12 and 15-inch pipes, and for catch basins; Saskatoon Construction and Engineering Company, for laying 42-inch pipe and for manholes; Lock-Joint Pipe Company, for furnishing reinforced concrete pipes; John A. East Foundry Company, for cast-iron basin grilles.

Saskatoon, Sask.—The tender of Messrs. Drummond, McCall & Company has been accepted for supplying 24-inch gate valves for the intercepting sewer at $180 each, f.o.b. Saskatoon.

Saskatoon, Sask.—Mr. Thomas E. Farley's tender to construct the nurses' home on the basis of ten per cent. commission on a fixed estimated cost of $26,693, giving the work his personal supervision and supplying the plant required, and all materials to be purchased through the city commissioners, has been accepted.

Victoria, B.C.—A contract for clearing fifty miles of G.T.P. right-of-way beyond Aldermere, has been let by Foley, Welch & Stewart, to M. Sheady & Company, at $50,000.

Vancouver, B.C.—The Kettle Valley line has just awarded to Messrs. L. M. Rice & Company, of Vancouver and Seattle, a contract for the construction of a forty miles section from Penticton, at the south end of the Okanagan Lake, westward to Ausprey Lake summit.

Vancouver, B.C.—The Board of School Trustees have awarded the contract for the building of the Britannia High School to Mr. D. Matheson, his tender being the lowest, viz., $123,799. The only other tender submitted was that of the Norton-Griffiths Construction Company for $126,109.