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The Canadian Engineer

Vol. X.—No. 3. TORONTO AND MONTREAL, MARCH, 1903. PRICE 10 CENTS $1.00 PER YEAR.

The Canadian Engineer.

ISSUED MONTHLY IN THE INTERESTS OF THE
CIVIL, MECHANICAL, ELECTRICAL, LOCOMOTIVE, STATIONARY, MARINE, MINING AND SANITARY ENGINEER, THE SURVEYOR, THE MANUFACTURER, THE CONTRACTOR AND THE MERCHANT IN THE METAL TRADES.

SUBSCRIPTION—Canada and the United States, $1.00 per year; Great Britain and foreign, 6s. Advertising rates on application.

OFFICES—Cor. Church and Court Sts. Toronto; and Fraser Building, Montreal.

Toronto Telephone, Main 4310. Montreal Telephone, Main 2589.

BIGGAR-SAMUEL, LIMITED, Publishers,

TRAVELING REPRESENTATIVE: A. W. SMITH.

All business correspondence should be addressed to our Montreal office. Editorial matter, cuts, electros and drawings should be addressed to the Toronto Office, and should be sent whenever possible, by mail, not by express. The publishers do not undertake to pay duty on cuts from abroad. Changes of advertisements should be in our hands not later than the 15th of the preceding month or if proof is desired, 4 days ear ier.

CONTENTS OF THIS NUMBER :

The articles now running in the Canadian Engineer on the Electrical Power Developments of Canada, will be reprinted in book form, with diagrams and folding plates. Price $5.00 per copy Advance orders received.

Subscribers who intend binding the last volume of The Canadian Engineer, and who require a copy of the index, will please advise us at once.

THE KOOTENAY-ROSSLAND POWER TRANSMISSION.*

BY GEO. P. LOW.

The Rossland Sub-Station.

The transmission lines enter the sub-station at Rossland through portholes lined with eight-inch terra cotta piping similar to those provided at the power house. As one enters the door of the sub-station, the standard General Electric lightning arresters used are placed on a marble board in a corner at the left, as shown in the floor plan. The choke coils used are an innovation in that each consists of a core twelve inches or so in length turned in the centre of a stick of kiln dried and well filled timber about five inches square, by from six to eight feet long. About this core insulated wire is wound until the space is filled so that the choke coil thus formed resembles an exaggerated form of spark coil with its terminals carried out to the respective ends of the timber on which it is wound, these timber ends being strapped to the top of high tension insulators through which the choke coil is cut into the line. Such choke coils are placed in every line, not only at the sub-station but at every power service. The sub-station contains twelve 250-kilowatt step-down transformers. The line wires are carried to the high tension switchboard at the rear of the station on high tension insulators supported by framings that hang from the roof girders, and the usual facilities are provided to afford safety and celerity in the handling of both the high and low tension sides of the transformers. These latter are of the same type and size as those installed at the power house, with the exception that the primaries take either 9,600 or 16,600 volts, according to whether connected in delta or Y, while the secondaries deliver 2,200 volts in three-phase current, which is the potential used on all the lighting and power distributing circuits in and about Rossland.

Here may be explained the very meritorious method which the electrical engineer of the West Kootenay company has devised for applying the air blast to the transformers at the power house and at the Rossland sub-station. As in the power house, the blast is supplied by three 60-inch blowers each driven by belting from a two horse-power 100-volt induction motor. Instead of carrying this air blast to the transformers through small air ducts, as is usually done, the engineer has provided subways large enough for a man to enter and move about in. Each week the transformers are cut out of service one by one and the air ducts in them are examined and cleaned by a man who enters the subway in order that he may have access to the lower end of the air ducts in the transformer. His work in cleaning the transformers is facilitated by the use of compressed air, which is obtained in both the power house and the sub-station from a single drill compressor driven by an induction motor. It is safe to say that so long as this method of transformer examination and cleaning is faithfully carried out the Kootenay transmission will never lose a transformer from the choking of its air ducts. Slides for regulating the amount of air to be delivered to each transformer are provided and of course the subway is always air tight and the man who cleans the transformers is under the increased atmospheric pressure of the air blast while at his work.

All the electric lighting in Rossland, in both arc and incandescent services, is rendered from alternating circuits, and indeed the only use to which direct currents are put in the Kootenay plant is for the excitation of generators and synchronous motors. The electric lighting load reaches a maximum of nearly 400

*Concluded from February issue.

horse-power. Enclosed alternating arc lamps are used exclusively and these are burned from the 110-volt commercial circuits. The ultimate distribution is on the Edison three-wire system through the use of type H transformers taking either 1,040 or 2,080 volts on the primary and delivering 230 volts across the outsides of three-wire service. The utmost care has been exercised in preserving the balance on the three-wire distribution circuits, as well as in balancing the primaries of the commercial transformers on the three-wire, three-phase, 2,200-volt circuits, and this balancing has been carried out so well that it has never been observed that the phases of the 2,200-volt circuits have been more than 10 amperes out of balance.

The principal interest in the Kootenay-Rossland transmission centres in its application of electric power for mining and milling purposes, the most notable installations being in the properties of the War Eagle Mining and Development Company, the British Columbia Bullion Extraction Company, the British-American Corporation, and the Gertrude, Big Three and Iron Mask mines. These six properties alone consume about seventeen hundred horse-power in the operation of hoists, compressors, crushers, conveyors, ventilating blowers and in electrolytic work. The bulk of this power is delivered by induction motors, for as a general rule, synchronous motors have been applied only to the driving of compressors. The controller of the War Eagle hoist is a standard General Electric induction motor. It has a three-phase equipment operated at 2,300 volts, has twenty-four poles and delivers three hundred horse-power at three hundred revolutions per minute. Its technical designation is, therefore, "I 24—300—300 form A." The rotor shaft is geared to a Ledgerwood type double drum hoist through double reduction gearing, having a ratio of reduction of 300 to 40.

The principle under which variable speed is attained in the operation of this induction motor is found in the fact that while in the synchronous motor, exact synchronism between the motor and generator must always be maintained, yet the induction motor is so constituted as to be nearly independent of any magnetic slippage that may exist between its stator and rotor. When under full speed the motor is practically in synchronism with the generator, but with the generator speed constant a variable speed in the motor is best attained by the introduction of methods that will provide variable slippage as desired, for the greater the slippage the slower will be the speed of the rotor. The equipment at the War Eagle hoist is so controlled that the speed of the motor may be varied from forty revolutions or less per minute to its full speed of three hundred revolutions.

One who is interested could spend hours in watching the operation of this hoist. It is easily handled by one man, who finds himself with much less to do than has the motorman on an electric railway. In fact, the operation of the War Eagle hoist finds greater resemblance to street railway practice than one would imagine. The controller is manipulated with the same ease and celerity that attends the handling of a street railway, and it is more simple than the modern street railway controller in one regard, and that is the fact that reversal is accomplished in the War Eagle controller by the moving of the controller handle in a reverse direction rather than in the throwing of a special lever. At times when men are on the cage the hoist is kicked along by the momentary application of power to the motor, which enables it to be run at much slower speed even than that possible with the controller on the first notch. At other times in hoisting ore, a dead load of five tons of which is almost always carried, the motor will be brought to speed in a very few seconds and this without any abnormal inrush of current, for, as stated, during the writer's observations of the operation of the equipment under all conditions of service the motor intake did not exceed 110 amperes per phase. The motor has an efficiency of 92 per cent. and a full load power factor of 88 per cent., while at the slowest speed the power factor may drop to possibly between sixty and seventy per cent. Current for the operation of the entire War Eagle equipment is sold by contract; i.e., on flat rates.

The next feature of interest in the electrical installation at the War Eagle mine is found in the 300-kilowatt synchronous motor operating the 40-drill compressor. Three-phase current at 2,300 volts is applied to this motor which runs at 200 revolutions per minute. It is of the revolving armature type, has thirty-six poles, and, consequently, bears the designation "A P 36—300—200." A General Electric multipolar exciter is driven from a large pulley on the free end of the motor shaft, and this exciter has an output of nine kilowatts at 125 volts when operated at 1,450 revolutions per minute. The compressor, which is of a double duplex type, is driven through independent ropes applied direct. The method originally installed for starting the synchronous motor consisted of a thirty horse-power induction motor belted to a counter shaft through a friction clutch, this shaft carrying a spur gear by means of which the armature was brought up to speed. This equipment did not prove satisfactory, and the motor was replaced by one having more than double its capacity. A number of small motors ranging up to 20 horse-power are used in and about the War Eagle mine for ventilating purposes, driving conveyors, etc., and all these motors are of the induction type except that on the compressor.

At the Iron Mast mine is a 75-kilowatt "S. K. C." synchronous motor, made by the Royal Electric Company of Montreal. It is a two-phase motor, with connections altered for three-phase service, and is started through an "S. K. C." induction motor and water rheostat. The water rheostat consists of three fan-shaped blades plunged edgewise into a three-compartment tank of water, thus enabling the water resistance cut into each leg of the three-phase circuit to be varied according to the depth of immersion. The 75-kilowatt motor is belted to a jack-shaft which drives two double-acting compressors having a combined capacity of ten drills. This is the only Stanley equipment on the West Kootenay circuit, and its service is most reliable.

In the Big Three mine is a 75-kilowatt General Electric synchronous motor, driving a seven-drill compressor, while at the Gertrude mine is a 50 horse-power General Electric induction motor operating a hoist. The British Columbia Bullion Extraction Company has one 50 horse-power induction motor driving a rock breaker, and one 75-kilowatt synchronous motor operating all machinery about the mine, including generators for electrolytic work.

These motors, as well as all others referred to hereafter, are of Canadian General Electric manufacture. In the properties of the British-American Corporation are four 150 horse-power induction motors, each operating a double drum hoist through equipments which are in every way similar to those at the War Eagle mine. All underground work in and about Rossland is operated at 220 volts. Aside from mining work, the principal power installation is that of the general machine shop of Cunliffe & Abblett, where a 50 horse-power induction motor is installed. There are many small motors ranging from one to five horse-power in size for the furnishing of light power in different industries in Rossland.

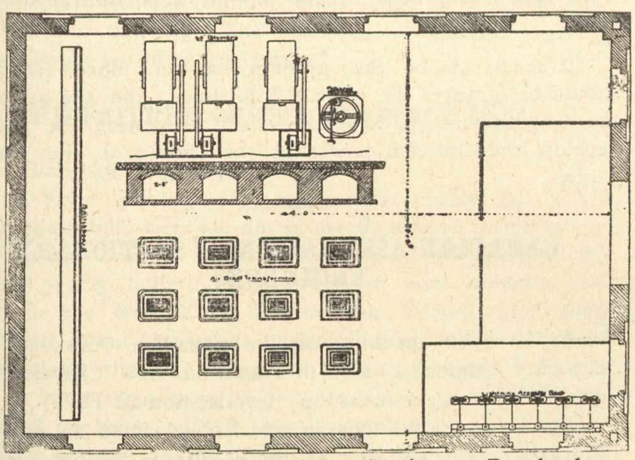


Figure 5—Floor Plan of Sub-Station at Rossland.

One of the most interesting points to be brought out by the Kootenay-Rossland transmission is the demonstration of the fact that the operation of synchronous and induction motors in large units for the driving of hoists and compressors will not necessarily create serious disturbance in the voltage of the distribution circuits, provided high voltage, ample fly-wheel effect and capacity prevails. During daylight the power and lighting circuits are operated in parallel although they are separated and operated independently from the power house by night. The War Eagle hoist, however, is operated on an independent circuit by day, but at night it is cut into the power circuit at the Rossland sub-station.

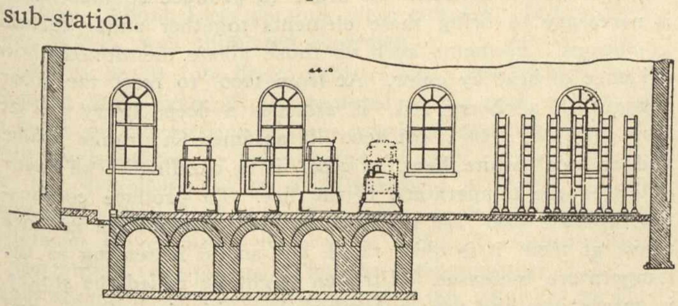


Figure 6—Side Elevation of Sub-Station at Rossland.

The conception and commencement of the work on the remarkably interesting transmission of the West Kootenay Power and Light Company, Limited, are largely due to the efforts of Sir Charles Ross, Bart., and Mr. Oliver Durant. The charter was obtained in the name of Mr. Patrick A. Largey, president of the Centre Star Mining and Smelting Company, Oliver Durant, manager, and C. R. Hosmer, manager of the Canadian Pacific Railway Company's telegraphs, and it was afterward transferred to the West Kootenay Power and Light Company. Preliminary surveys were made early in 1897, but it was in July of that year that the location of the plant was definitely settled and actual construction begun. The plans of the company contemplate the ultimate utilization of the entire three falls. The plant is under the personal management of L. A. Campbell, who fills the position of electrical engineer in addition to his duties as general manager. The line was erected under the supervision of B. O. Boswell, so well known in California, as superintendent of construction of the lines of the Folsom-Sacramento, Fresno, and other transmissions.

A LARGE IRRIGATION SCHEME.

The Canadian Pacific Railway has made a proposition to the Canadian Government, which, in the interest of the great North-West, it might be wise to accept. The company is still entitled to 3,300,000 acres of land under the original main line grant, which is yet unallotted. It offers to take 2,500,000 acres in the arid belt between Calgary and Medicine Hat if it is given the remaining 800,000 acres in the Manitoba and Northwestern reserve—that is, land set aside for the M. & N. W. railway. It will undertake to construct irrigation works for the purpose of reclaiming the 2,500,000 acres, at an estimated cost of from $3.50 to $4 an acre, or from $8,750,000 to $10,000,000 in all. The water will be taken from the Bow, Saskatchewan and other rivers in the locality. It asks which is only reasonable, that the land, which lies along the railway, should be given en bloc instead of in alternate blocks, as, besides the added cost, it would be manifestly unjust to allow the locaters of the alternate blocks to enjoy the benefit of the irrigation works without contributing to the cost. It is estimated that the land so reclaimed would provide homes for 10,000 farmers, or an agricultural population of 50,000, besides those of other callings who would be necessary for their maintenance. The land without irrigation is worthless for agricultural purposes, and if proper conditions are arranged it might be well to allow the railway company to undertake these irrigation works, even if there is a pretty good thing in it for them.

New York appears to have done a wise thing when it changed its system of payment for snow removal from so much a load to payment for the area cleared. After a recent snow storm, what would have cost $77,000 under the old plan, was accomplished for $49,000. In addition, it leaves the corporation men free to collect garbage and attend to their regular work.

—The telephone question has reached an acute stage in Ontario. The Markham and Pickering Co-operative Telephone Company, consisting of farmers who have installed an independent line, wished to place an instrument in Locust Hill station on the C.P.R., and presumably other stations, for their convenience in ascertaining when cars had arrived for shipping stock, etc., but were refused on the ground that under an agreement the Bell Telephone Co. had exclusive telephone rights in the C.P.R. stations. An information was therefore laid against S. F. Sise, president of the Bell

Telephone Co., under Section 520 of the Criminal Code, for unlawfully conspiring with the C.P.R. to unduly limit the facilities for transporting certain commodities. After a number of delays the case was heard before Magistrates Davidson and Parker, at Whitevale, Ont., J. E. Farewell Crown Attorney, of Whitby, acting for the prosecution. When the evidence was all in the magistrates announced that they would give their decision on March 5. Whatever it may be the mattter will not end there, but will without doubt be carried to a higher court. At Port Arthur and Fort William a somewhat similar situation has arisen, and an injunction was served on the Bell Co. to cease construction work. Members of the railway orders at Fort William held a meeting and decided to use none but municipal phones in their homes. The fight which has been entered upon is a determined one on both sides and will be fought to a finish.

It is said that lightning never strikes twice in the same place, and travellers say it is safer to travel by railways after an accident because of the extra vigilance which is exercised at such a time. This does not appear to be the case at present so far as Canadian railways are concerned. In our last issue we referred to the large number of accidents which had occurred in rapid succession. The list continues to grow, though happily the mishaps are of a less serious nature—more runoffs and fewer collisions. The most serious, which however, by one of those vagaries which attend such things, was unaccompanied by loss of life, took place at Whitby on Feb. 19th, when an express, two hours behind time and running at a high rate of speed, jumped the track, in consequence of a broken rail caused by the frost. Only the hind truck of the engine left the rails, but the six cars of the train, baggage, second class, first class and three Pullmans, rolled down an embankment some thirty feet high. Not a car remained on its trucks, all but the second class turned completely over, and it fell on its side, the baggage car was quite demolished, forty four persons were injured, yet not one was killed or is likely to die from injuries. This remarkable escape is doubtless due to the fact that the ground was hard frozen and the cars retained their upright position till the speed was considerably reduced, so that they were not violently thrown over. The baggageman was the most seriously hurt, the baggage having fallen on him. The damage to the Grand Trunk property was very large, the cars being badly broken up.

GOVERNMENT, MUNICIPAL OR PRIVATE CONTROL

The granting of a franchise to a third company to generate power at Niagara Falls has raised the whole question, as to who should control and distribute electrical energy. A conference was held at Berlin during the past month at which the matter was fully discussed, representatives being present from Toronto, Berlin, Galt, Guelph, London, Brantford, Stratford, Waterloo, Bridgeport, Embro, St. Catharines, Woodstock, Ingersoll, Hespeler, Preston, St. Thomas, Hamilton, Dundas and St. Mary's. The delegation included municipal officers, members of the Canadian Manufacturers' Association, engineers, business men, and others interested in cheap power. The effect of their deliberations was to adopt, with an addition, the report of a committee appointed at a meeting held at Berlin in October last, which, in brief, was as follows: (1) That it is practical to transmit electrical power from Niagara Falls to the cities and towns within reasonable distance. (2) That especially low prices can be had if electricity is taken in large quantities. (3) That while it would be much easier to have power delivered by the companies, it will be more advantageous for the Union of Municipalities to own their own transmission line. (4) That application be made to the Legislature for power for municipalities to co-operate to develop, transmit and distribute electrical energy with provision for a fair division of the cost. (5) That to ensure success and cheap rates, the number of municipalities must be large. The addition to the report was in favor of the Government building transmission lines, or, as an alternative, giving the Niagara Falls Park Commissioners power to do so.

A subsequent meeting at Galt endorsed the conclusions come to at the Berlin meeting, and a later meeting at Toronto, also held the same view, after which a delegation waited upon the Government. Hon. G. W. Ross, after listening to what they had to say, informed them that a bill would be introduced the coming session to appoint a commission, really the nominees of the municipalities, who will have power to develop, buy or transmit electric energy. The Government, the Premier said, would not be justified in using the provincial finances for the undertaking of a work that would be a benefit to only a portion of the province.

It seems to be the opinion that no more franchises should be granted to private companies, and the action of the Government will have the effect of vesting the right to develop and transmit power in the hands of the municipalities.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.

At an open meeting of the Canadian Association of Stationary Engineers, held in Hamilton, Geo. Chantler gave a very interesting address on "Combustion of Fuel."

The subject, said the speaker, had occupied his attention almost twenty years, and as the result of his investigation, he had made a departure from the principles as taught in schools of science to-day. He then defined the elements in combustion. The atmosphere is the great fuel supply of the world. One pound of carbon requires two and two-thirds pounds of oxygen to form combustion. The atmosphere is said to be a mixture of three elements. The speaker thought that air is a compound, just as water is a compound, as the proportions of the three elements are always the same, and are held in combination by fixed laws. In this compound there are two elements that perform important functions, the oxygen unites with the coal and produces heat, but the heat generated is in the ratio of the amount of oxygen consumed. Nitrogen, under certain conditions, is combustible. With hydrogen it will produce combustion, and the result will be water. The water will be slightly acid, showing that the nitrogen has entered into the compound, this shows that nitrogen is combustible. In order to produce combustion it is necessary to bring these elements together under certain conditions. Elements such as those above mentioned show evidence of heat by color. At from 1200° to 1400° the color changes to a cherry red. It assumes a deep cherry red at from 1600° to 1800°. At 1900° it assumes an orange shade, and at 2000° white heat, at 2500° it is dazzling. The color indicates the temperature of the fire. To produce combustion at least 1000° are required, at 1400° combustion is more rapid, at 1600° it is quite rapid, and so on increasing as the temperature increases. Nitrogen might be called the stoker, it enters into the fire in combination with the oxygen, and when these two elements come in contact with the heated carbon or hydrogen they are separated at the place where combustion takes place. Nitrogen is not only the stoker that carries the oxygen, but it is a great absorbent of heat, and conveys that heat to the surrounding bodies and carries it to the point at which it is to be utilized. The analysis of coal shows that it contains about 85% carbon and 50% hydrogen; of the carbon about 35% is free carbon. This free carbon and hydrogen when heated pass off through the chimney as smoke. If this can be burned, a great saving of fuel will be the result. Just along the front edge of the fire you have the flame of combustion, over your fire bed the flame of incandescent gas, and no combustion can take place at this point because there is no oxygen and also because carbon dioxide is present. Carbon dioxide will extinguish fire, and you cannot support combustion in the absence of oxygen. If this carbon dioxide can be eliminated, and a supply of oxygen supplied, then this smoke can be burned, and a great saving of fuel, as has been said before, will be the result. Then to burn coal to the best advantage, it is necessary to bring it in contact with two supplies of oxygen, and these must be distributed properly over the fire bed. The point is this, adjust your plans so that you bring heat and air together to consume the gas as it is liberated, and then bring another supply to burn your coke. The conclusion is, that to burn soft or hard coal, burn it from the top, with a top draft, and in this way you can retain it and transmit it to the point where it is to be utilized. At the conclusion of the address the thanks of the meeting were extended to Mr. Chantler.

A writer about town, in The Hamilton Times, remarks: "I don't know George Chantler, but I judge he is a man who does his own thinking. The Stationary Engineers show a good example to other tradesmen."

THE FAILURE OF THE CHAMBLY DAM.

Editor Canadian Engineer:

Sir,—Your photographs and article under the above caption again fully bear me out in my theory, as stated before the Canadian Society of Civil Engineers, published in the society's yearly bulletin, reproduced in your columns, re-echoed in the New York Engineering Record, and again reproduced in an important engineering periodical of London, England, that the weight of a dam, in case of its not being in other respects so tied to its site as to preclude any danger of its being pushed out of position by the pressure or weight of water against it, should be twice that equivalent, not only to the water impounded, but to the total depth of water, inclusive of height or depth of possible overflow. The Bouzey dam in France was carried away bodily, so was that at Austin in the United States, and I now have your photographs and statement to show that so was the dam at Chambly, and for the same reason—want of weight to counteract that against it. C. Baillairge.

MINING CONVENTION AT TORONTO.

A convention of mine owners, prospectors, and others interested in mining in Ontario, was held at Toronto, Feb. 17th and 18th. It met in response to a call by W. J. Elliott, acting on behalf of the Mining Exchange, in the hope expressed by some of his clients that proposals would be made to the Ontario Government which would result in legislation to benefit the mining industries of the province. About forty persons were present. James Conmee, M.P.P., was appointed chairman.

As a result of their deliberations, resolutions were adopted: (1) In favor of the removal of the coal duty. (2) In favor of the division of the province into mining divisions, with officers to take charge of each. (3) Declaring for the establishment of a Department of Mines with a responsible Minister at its head. (4) Urging the Dominion and Provincial Governments to provide sufficient transportation to the mining regions. (5) That the Commissioner of Crown Lands should be empowered to sell at a fair value to the discoverer of valuable minerals the pine timber on the location, provided it has not already been sold.

Some opposition was manifested, and during the convention, B. T. A. Bell, secretary of the Canadian Mining Institute, of Ottawa, Major Leckie, of Sudbury, and Eugene Coste, of Toronto, withdrew.

After the convention a committee waited upon the Government in Toronto and presented the resolutions. Hon. G. W. Ross promised to give them careful consideration in those respects in which the matters referred to came within provincial jurisdiction.

Col. Henry G. Prout.

Col. Henry G. Prout, who was formerly editor-in-chief of the Railroad Gazette, one of the leading technical journals in the United States, has been appointed First Vice-President and General Manager of the Union Switch and Signal Co., one of the numerous industries in which the Westinghouse Co. is interested. Col. Prout was through the civil war, graduated in civil engineering at the University of Michigan, worked on various railway surveys and construction, was Major of Engineers in the service of the Khedive of Egypt, was signal engineer in the company out of which the Union Switch & Signal Co., grew, and is a good writer, speaker and lecturer.

BOOKS RECEIVED.

The Universal Electrical Directory (J. A. Berly's), for 1903, containing a complete record of all industries connected with electricity and magnetism and the names and addresses of manufacturers all over the world, 22nd year of publication. London, H. Alabaster, Gatehouse & Co., 4 Ludgate Hill. Price 10s., Colonies 12s. This most useful reference book has now reached large proportions. It is a very necessary adjunct to every office having to do with electrical matters.

Continuous Power the Natural result of Converting Heat into work in an Insulated Expansion Engine at Temperature below the normal of the Atmosphere. By J. F. Place, New York, Standard Power Co., 257 Broadway.

General Review of Mining in British Columbia. The Undeveloped Areas of the Great Interior of British Columbia. These are two bulletins of the British Columbia Bureau of Provincial Information and contain much that is interesting to know about that province.

American Railway Engineering and Maintenance-of-Way Association, Bulletin No. 31, containing committee reports on Yards and Terminals and on Wooden Bridges and Trestles. These bulletins will be of much interest to railway men. L. C. Fritch, of 1,562 Monadnock Block, Chicago, is secretary of the Association.

STEAMBOAT ENGINEERS FOR THIS YEAR.

The following engineers have been appointed to the vessels named for the season of 1903:

Deseronto Navigation Company.—Steamer Resolute; John Harrison; assistant, Michael Toppings. Reliance, John Toppings; assistant, John Jamieson. Ella Ross, M. J. McFall. Deseronto, Stanley LeRue. Rescue, Owen Flood; assistant, George Toppings. Armenia, Peter Davis. Nile, Thos. Timlin. Ranger, William Stanhope.

Thousand Island Steamboat Co.—New York, Jas. Noble, second engineer. St. Lawrence, John Dickson; Barney Farrell, assistant. New Island Wanderer, Nicholas Larson, chief. Ramona, O. S. Woodhull, chief. America, James Gillie, chief; Wm. Hartley, assistant. Pierrepont, William Kelly, chief.

Canadian Lake & Ocean Navigation Co., Turret Line.—Turrett Cape, W. H. Dunham, chief; W. Robinson, assistant. Turret Court, Chas. McSorley, chief; A. Kennedy, assistant.

Turret Chief, Thos. Crossley, chief; W. McCallum, assistant. Turret Crown, Wm. Byers, chief; A. Lockerby, assistant.

Canadian Pacific Lake Line.—Manitoba, W. Lewis, chief; J. Walters, assistant. Alberta, A. Cameron, chief; C. Butterworth, assistant. Athabasca, W. Lockerbie, chief; J. W. Davey, assistant.

Northern Navigation Co.—City of Collingwood, B. Robinson, chief. Germanic, Joe Aston, chief. City of Midland, W. Whipps, chief. Atlantic, D. McLeod, chief. Britannic, S. Burgess, chief. City of Toronto, D. Harman, chief. Majestic, J. W. Aston, chief.

Lake Erie and Detroit River Line.—Car ferry Shenango No. 1, running on Lake Erie, Thomas A. Morrill, chief; James Cameron, assistant. Operating between Sarnia and Port Huron, car ferry International, George Brown, chief; John Downey, assistant.

Personal.

R. J. Gatling, inventor of the well-known Gatling gun, is dead.

A. B. Jardine, founder of the Tool Works, at Hespeler, in 1870, is dead.

Capt. Wm. Nichols, manager of the G.N.W. Telegraph Co., at Ottawa, is dead.

Thomas Ryan, engineer of the Government buildings, Montreal, died February 2nd. He was for many years engineer in charge of the Ottawa River Navigation Company's fleet.

George Tait, for many years city salesman for the Gutta Percha Rubber Manufacturing Co., of Toronto, has been appointed manager of the fire department supplies of this company for Ontario.

F. Hopkinson Smith, whose novel, "The Fortunes of Oliver Horn," has captivated the reading world, is a civil engineer. He paints and writes books for recreation. His writings are largely biographical.

David Bowker, the oldest engineer on the Eastern division of the Canadian Pacific Railway, has given up railroading and gone to a farm. He worked for the South Eastern Railway when it was opened into Newport.

Capt. John P. Angrove, one of the best known shipmasters in Nova Scotia, died February 12th. He took the ferry steamer Scotia from Halifax to Mulgrave and was employed by the Kingston Wrecking Co. to command the tug Petrel, which floated the steamer Scottish King on the Newfoundland coast.

Thomas Bell, one of the oldest railway engineers in Canada, died at Stratford, February 23rd, aged 82. Beginning his career on the Glasgow division of the Caledonian Railway in 1844, he came to Canada eleven years later, and had charge of one of the two engines running out of Toronto on the main line of the Grand Trunk. In 1859 he took the first engine to Sarnia. In 1893 he retired.

A C.P.R. engineer, named Vance, was frozen to death in a blizzard, near Battleford, February 15th. He was in charge of a party, who were making a survey of the proposed road from Saskatoon to Battleford. He was thirty-five years of age, and lived at Edmonton, but he was formerly a resident of Nelson, B.C. Last year he was engaged in straightening the C.P.R. between Sharbot Lake and Tweed.

—A. Macfarlane & Co., metal brokers and manufacturers' agents, Coristine building, Montreal, is the title of a new firm, composed of Archie Macfarlane, lately with Caverhill, Learmont & Co., and James Arnold, lately with Dorken Bros. & Co., Montreal. This new firm is open to represent manufacturers of small tools and hardware specialties. They have already secured the sole agency for Canada of such well known concerns as the Prentiss Vise Co., C. E. Jennings & Co., Cleveland Block Co., and eight or ten others.

—The railway running from Caracas in Venezuela, built by English enterprise, is a marvellous feat of engineering skill. The first and larger part of the route is a constant climb up the steepest of grades, around the sharpest of curves, and through seemingly interminable tunnels. At almost any moment you can look out of the front car windows and see the back of the train, considerably below. For an instant you may think it another train, and when you realize that it is not, but a part of your own, you shudder to think what would happen if anything should give way. But there is little danger, as security has been provided in several ways. Up around and among the peaks you climb through coffee planted on the rugged mountain sides, and, having reached the highest part of the road, above which the mountains still tower, you descend a thousand feet and find yourself in a beautiful green valley, though still many thousand feet above sea level. Altogether you have travelled 24 miles to reach a destination which the birds make in 6, and which the redoubtable Drake accomplished in 9 when he sacked Caracas, and carried off a million dollars' worth of treasure.

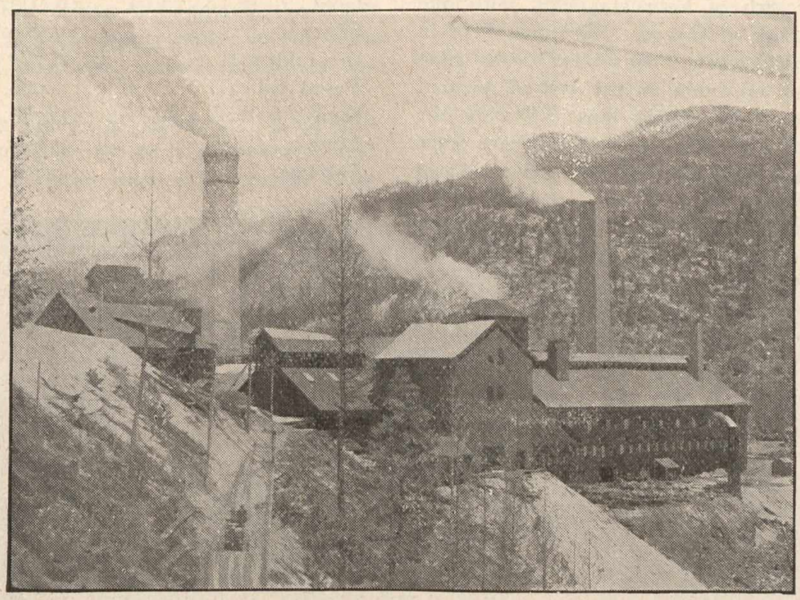
MINING IN SOUTHERN BRITISH COLUMBIA LAST YEAR.

A recent number of the Engineering and Mining Journal contains a review, by S. S. Fowler, of mining in Southern British Columbia in 1902, that being the part of the province from which the greater part of the mineral product is derived, the output from the northern part being chiefly alluvial gold. In reviewing the industry the output is considered according to its nature, (a) silver-lead ores, (b) gold-copper ores, (c) gold milling ores, (d) coal and coke. Treating of these in order the writer says:

The silver-lead industry seems as though smitten by a plague. This is the result of very low prices and a distant market for its lead. Although we have the advantage of ample local smelting facilities, the fact that the Canadian market for lead is very limited, and that the American is not open to us, forces the bulk of our lead product to far-off and low-priced markets at great cost. Consequently, only those mines whose ore is rich in silver can continue to operate. In East Kootenay, the St. Eugene, capable of an output of 3,000 tons of 65 per cent. lead concentrate monthly, has been idle throughout the year. The North Star has produced sparingly, and practically only enough to meet the expenses of development. The Paradise, the only mine in the province having considerable amounts of carbonate of lead, is also low-grade in silver, and has shipped very little during the year. Here, again, development only is being done in hope of better times. In the Slocan district of West Kootenay, famous for the high ratio of its silver to lead, the number of operating properties has continued about as in previous years, and the output of ore and concentrates will be about 26,000 tons, approximately the same as for 1901. It must be stated, however that this figure is maintained by the considerable output of dry silver ores, and the actual tonnage of lead will probably be shown to be much less than of the previous year, while both lead and silver will not bear comparison with the output of the banner years of 1897 and 1898. The chief producers of the year, as to tonnage, have been Whitewater, Rambler-Cariboo, Payne, Enterprise, Arlington and Bosun, and these, with some 25 or 30 others, which have produced during 1902, are employing at the close of the year probably not over 400 men. Such are the straits in which all manner of adverse external conditions have placed a large number of excellent properties. The only other silver-lead district is that of Lardeau, which has not yet reached a stage of large production, owing, until recently, to its inaccessibility. Like the Slocan, its lead ores are high-grade in silver, and it suffers from the same adverse circumstances. The chief mines are the Nettie L., Silver Cup and Triune. A determined effort is now being made by the lead producers to secure such changes in the Canadian customs tariff as will conserve the entire Canadian market for Canadian lead. Under the present tariff, and because of the absence of corroding works, it is possible for the refiner to dispose in Canada of only such lead as is used in the metallic form. This amounts to only 3,000 or 4,000 tons per annum. All lead mined in British Columbia is bought by the smelter according to the English price, and after deducting the costs of freight on the bullion and marketing charges, the miner now receives a miserable pittance—about $1.35 per 100 pounds—for his product.

The gold-copper districts continue to be Rossland and the Boundary region. Rossland in 1902 turned out approximately 350,000 tons (an increase of about 50,000 over 1901), all of which is smelted either at Trail, B.C., or Northport, Washington. The camp has been free from any labor disturbances, which so much interfered with its output in 1901; and in spite of some distrust as to the result of manipulation in the shares of some of its mines in London, it appears to have entered on a period of permanent, if moderate, prosperity and progress. Aside from the large amounts of high-grade material which go direct to the smelters, Rossland's mines hold much larger quantities of low-grade ores, which are doubtless amenable to a preliminary concentration, and much thought is now being directed to the dressing of these ores, with success in sight. The great bulk of the tonnage of the year has come from the Le Roi No. 1, Le Roi No. 2, Centre Star and War Eagle. No. 2 declared a dividend in May last, but No. 1, although it has published large operating profits for several months past, appears to have devoted its earnings to cancellation of debts. The Boundary district continues to uncover astonishing bodies of very low-grade smelting ores. The ores are, and will be for a long time to come, won by quarrying, and, being self-fluxing, are cheaply smelted (in the ratio of about 25 tons of ore into 1 of matte), at three plants, all within a few miles of the mines. The tonnage smelted in each furnace daily runs from 350 to 425, and the resulting matte is converted (to blister copper) at one of the smelting plants. Thus, with the assistance of the most economical exploitation, these extremely low-grade ores are turned to profitable account. Although no new producers have been added to the list, the old ones have materially increased their output, and it is probable that there will have been nearly 500,000 tons smelted during 1902. Along with the other smelters of the province, those of the Boundary suffered from shortage of coke supplies, and one of them was handicapped severely by a lack of water-power. These retarding factors kept the tonnage much lower than it might have been, but during the coming year the tonnage will probably be largely increased, and the costs decreased, by the use of the power of the Kettle River, generated at Cascade, where the Cascade Water Power and Light Company, Limited, has recently completed the installation of an extensive electric equipment, with transmission lines to Phoenix, the centre of the chief mines. The important mines of the year are the Snowshoe, the B. C., Knob Hill and Old Ironsides, all near Phoenix; and the Mother Lode and Sunset, west of Greenwood. Beside these the Emma for several months past has been putting out daily over 100 tons of iron flux, which is used by the smelters at Trail and Nelson.

The gold-milling ores of the province are, apparently, not very abundant. They are found chiefly in the Nelson district, and the Ymir mine continues to be the chief producer, having crushed about 50,000 tons of profitable ore during the year. At the Ymir mill about 60 per cent. of the gold is amalgamated, although 7 per cent. of concentrate is produced, carrying 20 per cent. of lead, besides much zinc and iron sulphides. The Arlington, of Erie; the Wilcox, of Ymir, and the Poorman, near Nelson, help to make a respectable total for the year. Another important mine of this class is the Cariboo, at Camp McKinney, Yale District, which has been a steady and profitable property for eight years or more. The free-milling ores at Fairview, Yale District, have not as yet proved of any importance, although it seems probable that one or two properties may yet turn out to be valuable. A portion of the Lardeau District, a few miles from the head of Arrow Lake, West Kootenay, has been the scene of a good deal of activity in the development of free-milling quartz, of which there appears to be extensive bodies. Thus far, however, little has been accomplished in actual output. The Similkameen River portion of Yale District is still without railway communication, and its several excellent copper-gold properties are therefore unable to produce.



Trail Smelter, British Columbia.

On Vancouver Island several discoveries of copper pyrite of low-grade in gold, but comparatively high in copper, have been made, and they are developing favorably. On the east side of the island the Lenora and Tyee are important mines, and are now possessed of smelting facilities. The coming year will probably see a large production of copper from this district.

The coal measures of British Columbia are a source of much wealth to the province. The mines of Vancouver Island continue, as they have for many years, to produce largely, mainly for export. The other producing mines are those of the Crow's Nest Pass Coal Company, in the south-eastern corner of the province. One of the company's mines suffered from a disastrous explosion in the early part of the year, and this was immediately followed by a prolonged strike of the employees. Agreement was finally reached in August, and, except during some minor labor disturbances, the several openings have since been outputting largely. The cessation of output seriously affected the operations of five smelters, and, through them, the whole community. Crow's Nest coke is exported in large quantity to Montana, and this demand, together with that of the local smelters, as well as the demand for coal for steam and other general fuel purposes, is causing a rapidly increasing yield from the mines.

Three dominant notes are then pointed out in the mining situation: First, that prospectors are feeling severely the effects of the check in the flow of mining capital to the province, as indicated by the fact that few, if any, properties of importance have been added to the list of mines during the year. Second, that the mining community has made a decided advance in the economies of production. Thirdly, that the provincial Government has done nothing to improve the conditions under which mining is conducted, but during the last session of the legislature further responsibilities were placed on those who operate mines, with a resultant tendency to keep back capital, and an increased risk to that already invested.

BRITISH COLUMBIA COPPER CO'S SMELTER, GREENWOOD, B. C.

By Paul Johnson.

The British Columbia Copper Company's smelting plant, of which a description was given in the Engineering and Mining Journal, of New York, for February 16th, 1901, commenced operations on the 18th of February, 1901, with one blast furnace, 42 by 150 inches at tuyeres. This was kept in blast till the 22nd of August, when it was shut down nine days for repairs, and started up again on the 31st of August, and since then has been continuously in blast. During the time from February 18th to December 31st, 1901, there were smelted in this one furnace 117,077 tons of ore, and produced 3,714 tons of matte, assaying from 45 per cent. to 60 per cent. in copper, from 2 to 6 ounces in gold, and from 10 to 30 ounces in silver. During 1902 there were smelted 148,000 tons of ore. Besides Mother Lode and Boundary ores there have been smelted some gold quartz ores of 80 per cent. to 90 per cent. silica, utilizing the basic character of the Mother Lode ore. The largest tonnage through one furnace was put through during the month of December, when 13,098 tons of ore were smelted, thus averaging for the entire month, for every twenty-four hours, 422½ tons of ore. The largest tonnage smelted in one single day was on January 10th, 1902, when the furnace put through 459 tons of ore, To handle this amount of material, and to break up and pile the matte produced there are in the blast furnace department proper, in twenty-four hours, used twenty-nine men, viz., six charge wheelers, four coke wheelers, nine feeders (on eight hours shift), two charge weighers, two furnace men, two matte tappers, two roustabouts, two foremen; thus during December were handled 14½ tons of ore per man and shift. Counting the total force of the smelter, the sample mill requires ten men for unloading and crushing ore, sampling and distributing same into ore mixtures, and loading and shipping matte. Engineers, foremen, one blacksmith, with a helper, and one carpenter, add eight more men to the force, making the total number of men employed, including foremen, forty-seven, which at 422.5 tons of ore put through daily, makes nine tons of ore handled and smelted for every man employed, which I believe is a record.

As for the character of the Mother Lode ore, I will mention that I classify it into limy, irony and sulphur ores, and would like for the smelting to have reserves of these different kinds to help out at times, when in the daily tonnage from the mine I get too much of one or the other of these different kinds. I will here give the assay and analysis of three large lots of these different ores:

a. Sample of Irony ore from 1,000 ton lot.
b. Sample of Limy ore from 1600 ton lot.
c. Sample of Sulphur ore from 120 ton lot.

	a. Irony Ore.	b. Limy Ore.	c. Sulphur Ore.
Copper	2.8%	2.2%	2.7%
Gold	0.11 oz.	0.09 oz.	0.15 oz.
Silver	0.58 oz.	0.48 oz.	0.43 oz.
Insoluble	28.7%	35.2%	29.8%
Fused Silica	16.9%	29.2%	24.5%
Iron	32.7%	14.7%	17.5%
Lime	5.6%	19.8%	16.0%
Sulphur	3.7%	5.3%	13.7%

British Columbia Copper Co.'s Smelter, Greenwood.

The character of these ores is not only self-fluxing, but at times rather basic. I have therefore sometimes smelted to advantage as much as 5% to 6% of straight quartz ores with them.

Before starting up the furnace I had my doubts whether I could make higher grade matte than 30% to 35% copper, without resorting to roasting the ore, but I found out by actual practice, what I had hoped, that the irony ore variety, which is magnetic oxide of iron Fe_3O_4 in smelting and reducing its iron ore to Fe_2O_3 for the slag, thus gives off one atom of oxygen for every molecule of Fe_3O_4, and this oxygen acts as a powerful desulpherizer, that I have in fact burned off as much as 85% to 90% of the sulphur on the charge at times. I have aimed at making a 45% to 50% copper matte, but sometimes this has come out as high as over 60% copper, having had much of the irony ore on the charge. I will mention in connection with making this high grade copper matte, an interesting fact I have noticed, that whenever the matte begins to come up to 53% copper, and above, the gold will "lock up" in the furnace on metallic copper bottoms formed. One week, making 58% to 63% copper matte, I got gold locked up to the value of $6,000 in the furnace bottom, next week I got sulphur ores that I could get the matte down to 45% copper, and then I got all the gold out in five days. Silver does not behave in this way.

The Mother Lode ore is exceptionally free from arsenic and antimony, and this ore behaves quite different in the furnace compared with the Silver King ore, which I used to treat at the Hall Mines smelter at Nelson, B.C., and which ore then carried quite an amount of As. and Sb., giving a nice colored purple-red smoke emanating from the chimney. When I was running the Silver King ore, I used to get metallic copper and speiss separated out as soon as the matte came up to 47% copper; this metallic copper and speiss used to raise the furnace bottom and settler bottoms, and cause all kinds of trouble in filling up the tap holes, threatening to plug up the furnace in this way. In Nelson I had on this account to change the trapped spout to the ordinary way of stopping up the tap hole with clay, and when the furnace bottom was rising up inside the tap jacket I used to blow the furnace for five minutes, the heat coming through here smelting its way through the metallics. With this Mother Lode ore I have made as high as 67% copper matte in the blast furnace, and using trapped blast too, without filling the tap hole with metallic copper.

For its size, 42-in. by 150-in. at tuyeres, I think this furnace has the largest record so far as large tonnage, and at the same time cleanness of slags made is concerned. The coarseness of the ore has more to do with tonnage, and to some extent clean slags, than anything else under similar circumstances. I found this out when we startea to crush the ore to five inch size, having got a wrong crusher head before, crushing the ore to two and three inches. A couple of per cent. of silica, more or less, in the slag does not slacken these big furnaces up as quick as it does on small furnaces. Neither is high lime as bad. What I have found bad, and raising the copper in the slag, is if the iron in the slag comes up to 30% and 32%, and silica at the same time is low, say 28% to 30%, this makes a heavy slag and poor separation of the matte.

I will give here examples of some different kinds of slags made, with the corresponding tonnage and tenor of copper in the slag:

1901, Nov. 7th.—The slag went $SiO_2 = 42.7\%$, Fe 21.1%, $CaO = 20.0\%$ and Cu 0.33%; the matte went 44% Cu, and furnace smelted 393 tons of ore.

April 1st.—The slag went $SiO_2 = 33.8\%$, $Fe = 32.5\%$, $CaO = 25.7\%$ and $Cu = 0.25\%$; matte went 49% Cu, the tonnage 402 tons of ore. High lime has a tendency to make the slags clean in Cu.

July 7th.—The slag went $SiO_2 = 30.9\%$, $Fe = 32.5\%$, $CaO = 16.8\%$ and $Cu = 0.44\%$; the matte went 53% Cu, the tonnage 399 tons.

1902, Jan. 10th.—When the furnace put through 459 tons of ore, the slag went $SiO_2 = 37.8\%$, $Fe = 24.5\%$ and $CaO = 20.9\%$ and $Cu = 0.35\%$; the matte went 49% Cu.

June 25th.—Two furnaces put through 765 tons of ore. Slag went, silica, 43.3%; iron, 20.1%; lime, 18.5%; copper, 0.31%. Matte produced went 49% copper.

October 29.—No. 1 furnace put through 399 tons of ore. Slag went, silica, 46.5%; iron, 19%; lime, 19.5%; copper, 0.29%. Matte produced went 49% copper.

I have had the concentration varying from 15 to 70, but when the matte fall is below 2 per cent. the furnace does not work well, there is too little heat brought down in the crucible, this especially within a rather silicious slag, when the light goes out of the tuyeres, and the smelting zone raises.

We make slag samples for copper twice a day, but do not make it by the generally adopted calorimetric method, which as a rule gives too low results and fools the metallurgist, making him believe and tell others that he makes cleaner slags than he does. The slag samples are taken every hour, chilled in water, and day and night shift kept apart. Two grams are taken for the determination, dissolved in hydronitro-chloric acid evaporated with HSO_4, diluted and copper precipitated with hyposulphite of sodium solution, the Cu_2S dissolved in HNO_3, and titrated with KCy; this determination takes somewhat over two hours, making other work at the time, but it is correct and reliable, and it will check, which I have proved, to one hundredths of one per cent. = 0.01% of copper; and where you have very little copper on your charge, it is important to have accurate determinations of your slags, and to keep them low in copper, as 0.1 of one per cent. makes quite an item. These daily slags are then put together, and once weekly, the average of all the slags is made for gold, silver and also copper. The slags, as a rule, have been very clean, the copper varying between 0.30 and 0.037%; gold, 0.0025 and 0.0035 oz.; silver, 0.04 and 0.07 oz. Of course, you are allowed more copper in the slag, and considered doing good work making 50% Cu matte, than you have in making 30% Cu matte. An old rule was formerly that a man was considered doing good smelting, when he had only 0.1% copper in the slag for every 105 copper in the matte, thus making 30% Cu matte, allowing you 0.3% in the slag, etc.

The amount of coke used is from 11½% to 12% of the weight of the ore. The blast used is from a No. 7½ Connersville blower, making 155 revolutions per minute, and giving 80 cubic feet of air per revolution. The blast pressure averages 1¾-inch mercury, equal to 14 ounces. Feed height above tuyeres varies from 4 to 8 feet; when little sulphur or much coarse ore, feeding high; when much sulphur, or much fine ore, feeding low. The best feed height for good running I have found to be from 7 to 8 feet. As to the running of the furnace, charges of three tons are put in at the feed floor, by feeders and not by any mechanical device, which I have had occasion to find out is an institution that does not pay, but costs a whole lot of money in less tonnage and bad working of the furnace, and dirtier slags.

A charge comes down to the tuyeres in ¾ of an hour; slag and matte run together continuously through a trapped spout into a water-jacketed forehearth on wheels, inside dimensions being 8 ft. long by 5½ ft. wide by 3 ft. deep. The matte, having a specific gravity of 5 to 5.3, sinks to the bottom and the slag of a specific gravity of about 3.4 to 3.5 overflows at the furthest end into a large settling pot, and from this into the granulating flume. The matte is tapped at intervals into matte pots, and their contents poured into matte moulds 2 ft. wide by 5 ft. long by 4 in. deep, thus cooling off the matte quickly, and delivering it into the shape of cakes 1 to 1½ in. thick; these matte cakes when cooled are knocked on the top side with sledge hammers and broken up into 3 to 5 in. pieces, and shipped in this way in bulk in box cars, the lot averaging 30 tons. This does away with a crusher and sacking, and makes the matte pots last longer.

During the latter part of 1901 we started to double the capacity of the smelter, and to this end erected new sets of lower ore bins, twelve in number, with an increased storage capacity of 5,000 tons of ore, making a total storage capacity for the lower ore bins of 10,000 tons. Another 560 foot railway trestle has been built between the two previous ones in order to facilitate and make possible the handling of over a thousand tons daily of material for the smelter by the railway. The second furnace was put in and was started up during 1902, and a No. 7½ Connersville blower furn:sh-d the blast for the second furnace. With this second furnace the smelter has now a capacity of 800 tons of ore, and together with the coke and coal and matte shipped, the railway has to handle about a thousand tons of material daily. We figure on increasing the plant with two more furnaces, and will, when these are put up, also add converter works for making the matte into blister copper here on the spot, and thus save in not having to transport iron and sulph-r in the matte, and get a better price for the copper in the blister copper, which will be an important item in cutting down the cost of handling the ore.

THE CHANGE OF ALTERNATING TO DIRECT CURRENT.

By John Waddell, D.Sc., School of Mining, Kingston.

Alternating current generators recommend themselves for their simplicity, there being no need for a commutator, the necessary insulation between the segments being avoided, and sparking at the brushes being absent. Moreover the alternating current lends itself to transformation from high to low voltage, and so is favorable for transmission since it may be taken for long distances as a high voltage current on small wires, and be changed to low voltage at the place where it is required. On the other hand there is difficulty in using the alternating current for series arc lighting and for traction purposes, and it cannot be used for charging secondary batteries or doing any other electrolytic work. Hence the strenuous efforts to convert alternating currents into direct. This conversion can be effected by arrangements having somewhat the character of a motor, but the form called the synchronous rectifier, though simple and efficient, gives considerable sparking, while with rotary converters there is a low efficiency as regards energy, and the converters are heavy and expensive.

A converter or rectifier with no moving parts would be ideal, if one could be obtained that would act efficiently as transformers act in changing voltage..

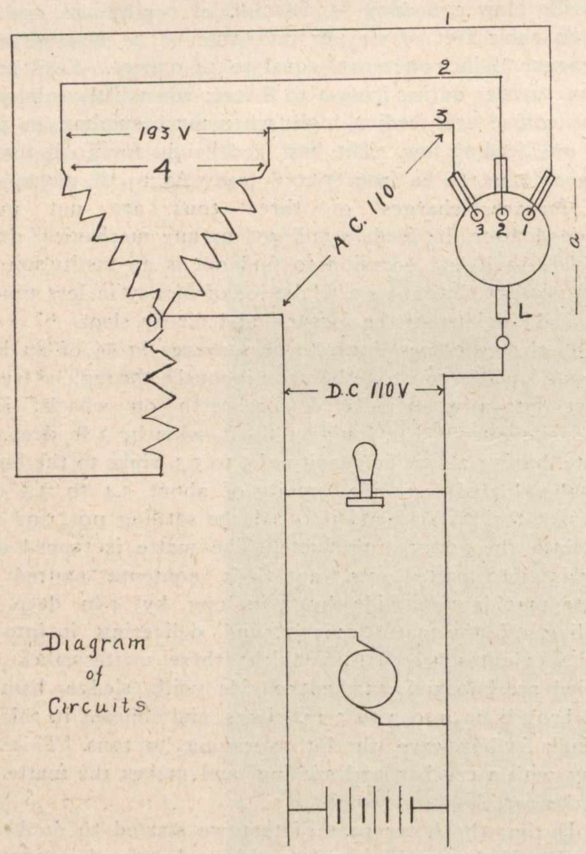


Diagram of Circuits

Two forms of static rectifiers claim special attention, one which has been known for some time; the other a very recent invention, the first is the electrolytic rectifier, the second is the static converter of Mr. Peter Cooper Hewitt. As long ago as 1855 it was noticed by Wheatstone that when aluminum formed one of the electrodes, some electrolytes were capable of carrying the current if the aluminum plate formed the cathode, while not allowing the current to pass if the aluminum formed the anode. This principle is made use of in the electrolytic rectifier. An electrolytic cell consisting of aluminum and lead electrodes, with solution of alum potassium, phosphate, copper sulphate, zinc sulphate, or one of many other salts as electrolyte, may be attached to the alternating generator, and the current flows readily in one direction, but not in the other. It seems that chlorides and similar salts are not available for the electrolyte, as they do not choke the current in either direction. It appears pretty evident that a coating of oxide on the aluminum plate prevents the passage of the current, but whether the effect is due to the ohmic resistance of the oxide coating or to polarization caused by a film of oxygen becoming entangled in the oxide layer is a disputed point. In the former case the current might be conducted by the aluminum when cathode, because hydrogen would reduce the oxide coating and lessen resistance. On the other hand if the resistance is due to the counter electro-motive force of polarization, it may be assumed that hydrogen is not entangled in the oxide film as oxygen is. This might give an explanation why chloride electrolytes are not effective, chlorine acting like hydrogen and not like oxygen.

It has been claimed that the efficiency of the electrolytic rectifier is 95 per cent. but it seems to have been assumed in this calculation that the only loss is that due to resistance of the electrolyte. This is not the only loss, however, for there is also decomposition of the electrolyte, giving a counter electro-motive force. Moreover, sparking takes place frequently, from points on the aluminum electrode, and is due to the choking not being absolute when the aluminum plate is the anode. In this way there is a leakage which is greater as the area of the aluminum electrode is greater. Hence for this reason the aluminum plate should be small, but on the other hand a small electrode increases the resistance of the electrolyte, and in that way decreases the efficiency. Besides, the purity of the aluminum is an important factor, the presence of other metals, either alloyed or in particles scattered through the aluminum, diminishing or even destroying its rectifying power. The electrolytic rectifier shows marked increase of leakage with increased voltage, and the leakage estimated with a direct current is no criterion of what the leakage will be with an alternating current. In some special experiments with a cell in which both electrodes were made of aluminum, the leakage was almost inappreciable at voltage of 160 with direct pressure. At 200 volts it was fully treble what it was at 160 volts, and at 215 volts treble what it was at 200 volts. With alternating pressure the leakage was as great at 60 volts as with direct pressure at 215 volts, at 120 volts it was double what it was at 60 volts, and at 144 volts was more than double what it was at 120 volts.

In addition to all the drawbacks already mentioned is the fact that the temperature of the electrolyte must be kept low, not exceeding 40°C., with the ordinary aqueous electrolytes. It seems that fused electrolytes may be used with greater efficiency. Experiments were made using fused sodium nitrate between aluminum and iron electrodes, and the leakage was less. But the use of fused electrolytes is evidently inconvenient, and the electrolytic rectifier cannot be considered a success..

The static converter of Mr. Hewitt is of entirely different structure. It is a vacuum tube, one of whose electrodes is mercury. It is adapted to a three-phase circuit, which is joined up to three electrodes of the ordinary kind. The mercury electrode is connected with one side of the working circuit which supplies current for electric light, motors or storage batteries, the other side of the working circuit being joined with the neutral point of the Y winding of the generator.

There is a resistance between the liquid mercury and its vapor, so great as not to be overcome by a low voltage, and if the working voltage is not very high a special discharge from a separate induction coil must be employed for starting. When the resistance is once broken down a low voltage is able to continue the breach, but there must be no complete stoppage of the current. The converter described is able to carry the current only when the mercury electrode is negative. A simple alternating current would, therefore, give rise to stoppages, and as this is not allowable, a polyphase current is necessary. In this way some one of the electrodes, 1, 2 and 3 in the figure, is always positive towards the mercury electrode L. The difference of potential between the electrodes 1, 2 and 3 is sometimes greater than between them and the mercury electrode, but as the resistance between them has not been broken down there is no current from one to another. A converter with a capacity for supplying two hundred lamps, weighs only about four pounds, whereas a rotary converter of the same capacity would weigh seven hundred pounds. The cost of the static converter is very small, not more than that of a 100-c.p. lamp. The converters have a drop in pressure of about 14 volts, being the same for all currents, which is a very important feature, because if the turning on of more lights in a circuit materially lessened the available voltage the lamps would greatly vary in brilliancy according as there was a light or heavy load. Though the drop in voltage is now considerable, experiments indicate that it will probably be reduced to less than half.

The range of voltage to which the static converter is applicable is much greater than is the case with the electrolytic rectifier. The converter described has been operated at a voltage as high as 1,800. With a drop in voltage of 14 the loss would be less than one per cent. At 600 volts, or approximately the pressure for street cars there would be an efficiency of about 97 per cent. Of course the drop in voltage causes heating in the converter, but radiation is sufficient in most cases to prevent the glass becoming too hot, and moreover there is nothing to prevent the converter being made of iron or steel, where the shell would act as negative electrode, the mercury being in contact with it, while the positive electrodes could be inserted through insulating material such as porcelain.

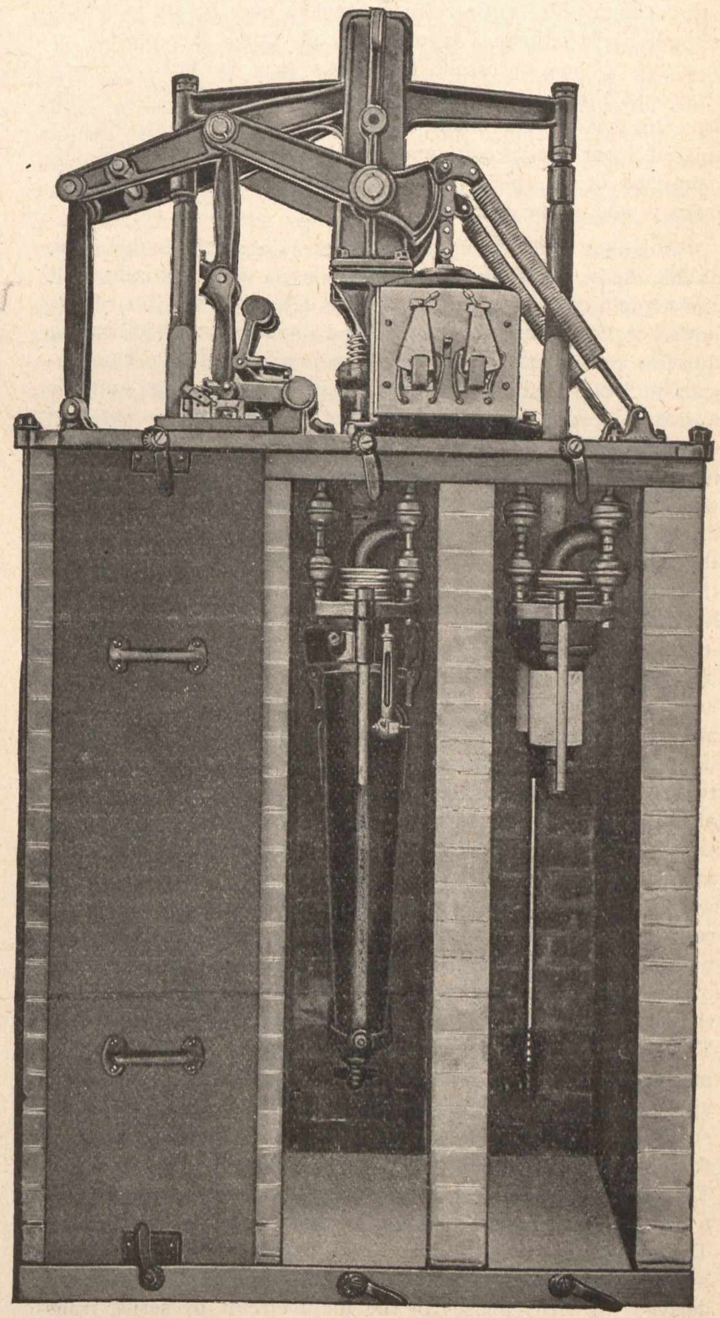
Experiments point to the probability that voltages as high as 3,000, and even 10,000 may be employed with the static converter, but the matter has not been very fully investigated.

Of course the current supplied by means of the converter is not continuous, though it is direct. It is pulsating, but a pulsating current is claimed to be advantageous for charging storage batteries, and is not unsuitable for other purposes in which a continuous current is employed. It would seem that there is a great future for the static converter if it turns out to be approximately as satisfactory as described.

ELECTRICALLY-OPERATED OIL CIRCUIT-BREAKER FOR HIGH TENSION CIRCUITS.

The rapid increase during recent years in the size of central stations and the currents and voltages handled therein has necessitated a great development in the methods and apparatus for controlling and switching electric currents. While a few years ago most alternating-current switchboards were equipped with hand-operated knife switches, it is now found advisable and often necessary to use some means of auxiliary control. This permits the actual current switching devices to be located with regard to the general design of the station and a satisfactory lay-out of circuits and apparatus, at the same time it centralizes the control within a small space where the operator may have under his hand, so to speak, the whole station, and before his eye, an indication of the condition of every circuit.

One of the most remarkable pieces of apparatus which has contributed to make this great development possible is the high-tension, power operated, oil-break circuit-breaker, While the carbon shunt, open-air type of breaker, in which the arc is ruptured in the open air, has given excellent service in most classes of work, there are many places where, on account of space or other limitations, its use would not be feasible. It is to meet the need of a compact, safe and reliable device for rupturing high-tension circuits that the oil-break circuit-breaker has been developed. The accompaning illustration shows a three-pole, double-break automatic oil circuit-breaker, operated by electro-magnets. The circuit-breaker is erected in a masonry structure with each pole and oil tank in a separate, fire-proof compartment. There are two stationary contacts to the pole, one connected to the incoming lead and the other to the outgoing lead of the same phase, each contact being mounted in a large porcelain insulator. In the illustration, one of the porcelain insulators is visible in the right-hand compartment. The insulators are fastened to a cast iron frame which also supports the enclosing oil tank. The frame itself is supported from the soapstone slab at the top of the masonry walls by strain insulators. The movable contact for each pole consists of a U-shaped piece of copper fastened to the end of a stout wooden rod. In the closed position of the switch one of these U-shaped pieces electrically connects the two stationary contacts of each pole. The wooden rods are fastened at their upper ends to a common cross bar, which extends over the three masonry compartments, and is supported by a system of levers giving a straight-line up-and-down motion. The cross bar is raised by the enclosing magnets, assisted at the beginning of the motion by a pair of balancing springs. The springs and the case containing the magnet are at the upper right-hand corner in the illustration. A toggle joint, shown at the left



View of a Westinghouse, electrically operated, automatic, oil-break circuit-breaker, showing the left-hand compartment closed by an iron door, the oil tank suspended in the middle compartment, and the right-hand compartment without the oil-tank. The over-load relay is just above the second brick pier from the right, and the tripping device just above the third pier.

in the illustration, automatically locks this system of levers when the circuit-breaker is in the closed position. The toggle joint is released by a blow from the tripping magnet, whereupon the cross bar under the influence of gravity, and a powerful spring quickly drops, opening the contacts. The break takes place first at the main contacts and then afterward at a removable plug attached to the stationary contact which enters a hole on the movable contact. The plug thus receives all the effects of any arcing that there may be, and, since it is removable, is easily replaced. The current for the closing and tripping magnets is derived from the exciters, storage battery, or other source of low-voltage, direct-current supply. If necessary, the circuit-breaker can easily be operated by hand without disturbing the mechanism in any way. The oil tanks, one of which is to be seen in the middle compartment, are constructed of heavy sheet metal and the interior is lined with insulating cement, which is moulded to fit closely about the terminals, and moving contact piece, leaving just room enough for the free movement of the parts in oil. By this means the amount of oil is reduced to a minimum. When the circuit-breaker is open, the wooden rod interposes an effective barrier between the two terminals of each pole. Suitable levers are provided for handling the tanks, which may be lowered away from the contacts and removed without disturbing the rest of the circuit-breaker. The entire circuit-breaker may be set in place, and all parts adjusted before the oil tanks are placed in position. When necessary the tanks may be filled without removing them from their position. The oil level is easily seen by means of a small sight gauge. The tanks are insulated from the circuit, and all the live metal parts being immersed in oil, there is no possibility of receiving a shock from touching the breaker.

Mounted on each circuit breaker is a small double-pole, double-throw knife switch, which is used with the indicating and tripping circuits, and is operated by the motion of the levers of the circuit-breaker. The controlling and indicating devices consist of a controlling switch, an electro-mechanical, tell-tale indicator, and a lamp. These are suitably mounted at the operating platform. A polyphase over-load relay, connected to series transformers in the main circuits, is provided for automatic opening. The controlling switch, which is of the drum type, has three positions, namely, closed, off and open. It will remain of itself in the off or the open positions only. In other words, if it is thrown to the open position it will remain in that position when the hand is removed, but if it is thrown to the closed position it will turn of itself to the off position, as soon as the handle is free. In the off position it connects the control circuit so that if the oil circuit-breaker opens through the action of any of the automatic devices the lamp will be lighted on the operating stand to attract the operator's attention. If the oil circuit-breaker is opened by the operator throwing the controlling switch to the open position, the lamp does not light. The mechanism of the electro-mechanical tell-tale indicator consists of an electro-magnet which attracts a pivoted armature through an angle of about 90 degrees. Attached to the armature is a disc with a pointer which indicates to the eye the open or closed position of the oil circuit-breaker. In the accompanying illustration the closing magnet is partly hidden by the overload relay. This operates on the principle of the single-phase induction motor. Each of the sectors swings between the poles of an alternating-current electro-magnet. Part of each pole is surrounded by a short circuited strip of copper, which acts to retard the magnetic flux and thus produce a shifting field. This tends to move the counterweighted sectors which carry a contact closing the tripping circuit of the circuit-breaker. The two sectors are connected in parallel, and either alone will trip the breaker. The currents for their magnets are derived from the phases of the main circuit by series transformers.

The apparatus described above, known as the Type C Circuit-Breaker, is manufactured by the Westinghouse Electric & Mfg. Co., whose engineers have devoted much attention to the development of simple and efficient means of operating switchboards in large power plants.

W. H. Wiggs, who carries on business under the name of the Mechanics' Supply Co., at Quebec, dealing in machinists', plumbers', engineers', gas and steam fitters' and electricians' supplies, is preparing to build a four-story stone and brick warehouse to accommodate his increasing business. Staveley & Staveley are preparing the plans.

ERECTION OF THE NORTHWEST MIRAMICHI BRIDGE, NEWCASTLE, N.B.*

By H. D. Bush, Mem. Can. Soc. C.E.

The broad tidal river, the Miramichi, is formed about one mile above Newcastle, N.B., by the junction of two branches, called respectively the Northwest and Southwest Miramichi. The head of navigation for ocean-going craft is about two miles farther up each branch, where both are crossed by wooden highway bridges and, just above these, are the single track bridges of the Intercolonial Railway. The latter are structures of some interest historically, and were built from about 1870 to 1874, the engineer being (Sir) Sandford Fleming, the contractors for the substructure, Brown, Brooks & Ryan, and for the superstructure, Clarke, Reeves & Co. The piers are of native sandstone with granite faced cutwaters, and are being used without alteration to support new and heavy superstructures that over the Northwest river having been erected in 1902, and that over the Southwest River to be erected in 1903. The foundations were made by sinking open double walled caissons for the southwest bridge, the material being dredged out through wells until a suitable bearing on a thick stratum of gravel was reached, and the caisson then filled with concrete. At the northwest bridge, rectangular cribs were used with two rows of sheet piling driven inside, and the enclosed space dredged out, and filled with alternate layers of concrete and rubble stone. One pier settled 10 inches during construction, but under a test weight, greater than that it had to carry, and left on several months, it settled only two and one-half inches more. Investigation showed the settlement to have been wholly within the caisson, and not due to compression of the gravel foundation. The floor system of the old Phoenix spans was strengthened in 1888 by the addition to each floor beam of two 2¼ inch square truss rods, and by the replacing of the original floor beam hangers by new ones 2 inches in diameter. A heavy lower lateral system was at the same time added. The old spans so far taken down show a remarkable state of preservation. The insides of the columns, apparently coated by dipping in something like a pipe compound, are entirely free of scaly rust and show only slight discolorations from rust after thirty years of use. The pin nuts have unscrewed more easily than expeted, and the pins show practically no signs of wear. The old spans have each 14 panels of 14 feet 7 inches, making them 204 feet 2 inches long between end pin centres. The floor beams are 24 inches deep, with flange angles, 4 in. x 4 in. x ½ in. The two lines of stringers are 16 in. deep with 3 in. x 3 in. x ⅜ in. flange angles and rest on a small shelf angle, and are each connected to the floor beam webs with six ⅝ in. bolts. There are wooden cross bearing beams, under the ends of the old stringers, on all the piers and abutments, the pockets in the masonry being about 30 in. deep. The new spans are heavy riveted trusses, each with 7 panels of 29 ft. 4 in. The floor beams, 72½ in. deep, are entirely below the lower chords and riveted between the vertical web members of the trusses, which extend down through the chords. There are four line of stringers, 48½ in. deep, spaced 3 feet centre to centre. In the end stringers the bottom flange angles are brought up in a reverse curve to reduce the depth at their outer ends to 33¾ in. to fit the pockets in the masonry.

The new bridges are designed in accordance with the Intercolonial Railway specifications of 1901, the uniform live loads per lineal foot for the several parts being as follows:

Trusses	5,900 lbs.
Floor beams	6,750 lbs.
Main stringers	9,100 lbs.
Connections of main stringers and floor beams	10,600 lbs.

It was suggested in these specifications that the old spans be removed bodily by means of scows with trestle work thereon, and taking advantage of the rise and fall of the tide. The spans were to be rolled back on trestle work, built on the south shore, below the bridge, so as to be in a position

* Read Before the Canadian Society of Civil Engineers.

for sliding down to the deck of a barge for transportation to Prince Edward Island, where they are to be used. The method of erection of the new trusses and removal of the old ones as outlined in these specifications was adopted by the Dominion Bridge Company, the contractors for the new bridges. The original idea of transporting each old span, entire, on a special scow, to Charlottetown, has been abandoned, and they have been taken apart at the shore ends of the landing trestles. The centre lines of these trestles are 204 2 in. apart, and, in the Northwest River there was barely room for them between the railway and highway bridges; in fact, the up stream trestle could not be constructed until the span adjacent had been replaced. Four scows were built for this work, each 84 ft. x 26 ft. and 8 ft. deep. There are five longitudinal Howe trusses in each scow, spaced 5 ft. 3 in. centre to centre. Two scows were used for each truss, both old and new. As the old trusses required a support at each panel point, a Howe truss bridge was built crossing over the two scows, and projectng three panel lengths at each end, the scows being spaced four panel lengths apart. The chords of these trusses were 12 in. x 24 in., made up of 3 in. x 12 in. planed planks, bolted together to make a net section equal to about 10 in. x 18 in. for a calculated maximum chord stress of 136,000 lbs. On account of the truss rods projecting below the floor beams of the old spans, blocking was hung at each end of each floor beam so that the lower surface of the blocking was just below the metal work. These blocks were always in place before a span was lifted. As the work in 1902 was done at a season of comparatively low water, additional blocking, varying from 8 in. to 21 in. in depth, was used on various spans. Pieces of 8 in. x 10 in. and 5 in. x 10 in., two and three feet long, were always kept on the top chords of the Howe trusses at the panel points, so that this additional blocking could be quickly adjusted. The first old span lifted could not be unloaded until the upstream landing trestle was nearly completed, and this span was carried on the scows for six days. The second old span was also kept afloat for four days in the main river channel, from which position it could not be moved on account of heavy winds.

Each of the scows used with the Howe truss carried a 6 in. centrifugal pump with connected engine, two engines being run from one boiler on one of the scows, from which steam was piped to the other scow. Each scow also had a 6 in. gate valve, placed on one side, close to the bottom, and controlled from the deck. Water could be let into these scows at the rate of slightly over one foot an hour and pumped out of both simultaneously at the rate of one-half inch a minute. The scows used under the new spans had two 6 in. gate valves each, and two diaphragm pumps. These scows were generally placed under the spans with about 8 in. of water in them, this being pumped out by hand, and the balance of the lifting done by the tide.

The new trusses were erected on twin falseworks placed side by side, each one just long enough for one span, and situated on the south shore, just far enough up stream to allow the 84 ft. scows to pass between the falsework and the bridge pier. There were two openings through which the scows could be passed, these openings dividing each falsework into three towers, one of one panel, and two of two panels each. Short trestles connected the falsework with the top of the river bank, and the tracks from the unloading derricks. I beams were used as stringers in the falseworks, partly because the contractors had them in the vicinity of this work from another contract, and largely because of the increasing difficulty in buying long timber. The spans were erected by a two boom traveling derrick, running on two rails spaced 10 ft. centre to centre. The working platform was about 10 ft. above the rails, and so supported as to leave room for a standard gauge track beneath it, on which track material was pushed forward on lorries, ready to be handled by the booms. As soon as one span was erected, the traveler was pulled over on greased rails to the second falsework, and a second span erected while the first was being riveted. One 10 in. x 10 in. air compressor, run with steam from two upright boilers, furnished power to the air riveters used. This plant was placed at the top of the river bank. Water was taken from a "spring," which was found near the base of the south abutment, and was, in reality, an artesian well, the flow of water coming from a bore hole, sunk by the engineers thirty years ago to determine the character of the abutment foundations. A hot air engine forced the water up the bank. The rate of progress was determined by the time required (about nine days) for riveting each span. It was impossible to get experienced men enough to run more than four air riveters.

On each of the scows used for floating the new spans five trestle bents were erected with four legs in each bent, making for the two scows a total of forty posts, each 8 in. by 9 in., to carry the weight of the span, which, with the track in position, was 640,000 lbs. The trestles were 20 ft. 7 in. in height and well braced in four directions. The legs in each bent were spaced 3 ft. centres on top, and battered in such a manner as to distribute the loads to the Howe trusses in the scows as had been calculated. The trestles on each scow took their loads from the four track stringers in the next to the centre bridge panel, leaving two panels projecting at each end. On account of the narrow base, 9 ft., afforded by the track stringers, six side braces, three on each side, were also used on each scow; and extended from the lower chords of the span to bearing blocks, which were spiked to the deck of the scows, directly over the centre and outside Howe trusses. Longitudinal and cross 8 in. x 10 in. and 5 in. x 10 in. timbers were provided to go on top of the trestle bents to build them up 8 in., 16 in., or 21 in. higher. Different thicknesses of this blocking were used to float different spans, according to the height of tides expected.

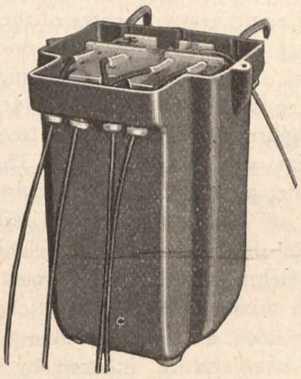
After starting work it was found that the information previously obtained concerning the tides was inaccurate. A fairly regular rise of nearly four feet had been counted on. As soon as gauges were established the records showed the average rise to be considerably less than three feet. As the end stringers hung down 30 inches below the bed plates of the new span, it would have been necessary to float the span 30 inches, plus at least 10 inches for clearance, or 40 inches above its final level or more than the average rise of the tide. It was, therefore, decided not to rivet these stringers until the spans were in place. The ends of the stringers were lifted up, until their bottom flanges were about on a level with the bed plates of the span, and lashed to a 14 in. by 14 in. cross timber resting on the bottom chords of the truss close to the end gusset plates. The falsework had already, before this change in plan was made, been built to carry the new spans, 24 inches above their correct height. As soon, therefore, as a span was afloat it was high enough to clear the masonry two feet and plenty of time could be taken to land it, even on a falling tide, but time was saved by having a less distance to lower than originally contemplated. There were only two days out of five in which spans were floated, in 1902, when the tide rose high enough to have lifted the spans clear of the masonry if the stringers had been left level. One of these tides was unusual and lifted the second span 5 ft. 4 in., while the usual tide raised the spans about 26 inches above correct height. The scows drew 4 ft. loaded, leaving 4 ft. of freeboard. Water could safely be admitted to lower the scows 30 inches, still leaving 18 inches of freeboard. It would have been safer and quicker to have been able to reverse these figures by having the falsework one foot lower. There were two cross bulkheads in each scow to prevent the water in them from rushing to one end in case of tilting by the wind. For the placing of each span a day was selected when there promised to be a suitable tide coming at a time of day to least disturb traffic. At low tide the Howe truss and two scows were placed under the old span, the wooden blocking having been previously suspended from the ends of the floor beams, and the other scows were placed under the new span. If the tide seemed to be coming up to expectations, and if no strong wind started, the track was cut about two hours before high tide and the end panels of the flow system of the old span removed. In the mean time sufficient water was let into the Howe truss scows to just keep the old span from lifting. As soon as the new span was safely afloat the scows under the old span were quickly pumped out with the centrifugal pumps, so that after a few minutes the old span could be pulled to one side and the new span brought into position. The new span was held by two cross tackles at each end, as well as by anchor lines on the scows. As soon as the new span was safely in position the end stringers were lowered to their correct level, and, as soon as the tide had turned, the valves in the scows were opened, and the span lowered. There was a delay of several hours in placing the second span, due to the unusually high tide which, as already noted, lifted this span over five feet too high. There was also a delay with the fourth span, on Nov. 12th, when the tide lifted the span over three feet above its correct height. There was a strong up stream wind which held the tide for two hours, so that it was feared it might rise still higher. No water was let into the scows until the tide had definitely turned, and this delay threw the work of connecting the track into the night. It was necessary in the Northwest bridge to wait for a fairly high tide to lift the new span on account of the shallow water, close to the south shore. Pockets had to be dredged for the inshore scow, both under the falsework to get this scow low enough to go under the spans, and under the bridge to enable this scow to be sunk low enough to land the first span. On the Southwest bridge, with comparatively deep water close to shore, it will be easy to supplement an insufficient tide by admitting water into the scows before they are blocked under the spans, and pumping it out again as the tide rises. Span No. 1 was floated at 21 o'clock, Thursday, October, 9th, and pulled about 100 feet into deep water. This span the railway officials positively refused to have placed until Sunday, on the ground that, until at least one change had been made, there was no way to tell exactly how long it would take, and that they could not afford to have the road open for an indefinite time, except on Sunday. The contractors took the risk of holding this span afloat, for three days and nights, in order to get the use of the falsework to begin the erection of another span. There were very strong down stream winds during this time, half a gale on Friday, October 10th, when it was wished that the risk had not been taken. This span was placed in position at noon, Sunday, October 12, and a freight train crossed over it at 16.30 o'clock. Span No. 2 was placed on the north shore, being towed across the river, just at dusk, Sunday, October 19th, and landed about 9 p.m., as the tide on this night rose for two hours after schedule time. The remaining spans were placed in succession, working from the north towards the south shore, as follows: Span No. 3, Friday, October 31st, at 17 o'clock, and span No. 4, Wednesday, November 12th, about 18 o'clock, in a snowstorm, and a strong easterly or up stream wind, which, although making it harder for the two tugs employed to handle the span, made it certain, that in case of any accident, the scows would be blown away from, instead of towards the old bridge. Span No. 5 was placed at about 15 o'clock, Tuesday, Nov. 25th. Passengers on one local train were transferred on the days that spans 4 and 5 were placed. It was planned to place span No. 6 on Sunday, November 30th, but two intervening days of bad weather made it impossible to get the span riveted in time. This span was to take the place of the second old span out from the south shore, as arranged, so that the distance to move the last span would be as short as possible in case ice formed, as expected, before it could be floated. Riveting was finished on the morning of December 3rd, when the field ice which had been moving up and down stream with the tides for a week previous, was pretty well caught together, leaving some openings in the centre of the river. High tide now came at about 9 and 21 o'clock, with the former averaging about one foot too low and the latter one foot too high. It was, therefore, necessary, on account of the shallow water, to hold this span on the falsework for a few days until, as the time of high tides approached noon and midnight, the day tide would increase in height. The scows were placed under this span about 3 a.m., Sunday, December 7th, with the expectation that the final change could be made on the following high tide at about noon. The cold snap which, for some time after this date, prevailed over the whole north, began on the Miramichi this night. At 5 a.m., the thermometer registered 18° below zero, and by daylight the workmen could walk on the ice, where at midnight there had been open water. The temperature remained so low during the following week that it was found impossible to cut a large enough opening in the ice to enable the span to be floated and pulled out into deep water during one high tide. It was therefore decided, on Saturday, December 13th, to leave the last span on the falsework until next spring, when the contractors would have a force of men on the ground for work on the Southwest bridge. As the first span was floated on October 9th, and the sixth span ready on December 3rd, the rate of progress for five spans was about nine days per span, there having been 44 working days included between these dates.

The old spans were landed in two trucks each having eight 24 in. double flanged wheels (four wheels under each corner of the span) running on a track with rails, 24 in. centre to centre. The wheels revolved on 4 in. axles, two at each end of the truck, spaced 3 ft. 8 in. centre to centre. The 12 in. x 12 in. x 24 ft. timber used for the frame of the truck was strengthened for bending between the axles by having a piece of 12 in. channel bolted on each side. Heavy cast iron blocks, under the timbers, extended from end to end of channels and provided the bearing over the axles. The bed plates of the old spans rested on heavy timbers about 6 feet long, placed across the trucks at each end between the axles. The trestles supporting the tracks extended out about 150 feet from shore into sufficiently deep water for floating the scows. The scows were turned to bring the span at right angles to the line of the bridge, or parallel to the shore, the scows hauled back at high tide until the bed plates were over the trucks, water admitted to the scows until the span came to a bearing, and the scows and Howe truss were then freed partly by letting in more water, and partly by the falling tide. When a span had been rolled back to its correct position on the landing trestles, ship jacks were placed underneath the trucks, between the rails, and the trucks and span lifted a few inches. Blocking was then built up from the caps of the trestle bents to the projecting ends of the cross timbers on the trucks, the jacks were then released and the trucks rolled forward ready for another span. On account of the concentrated loading the bents of the landing trestles were spaced only eight feet apart. The stringers under each rail were made up of two pieces of 12 in. x 12 in. on top of each other, breaking joints over the bents. The trucks were made by the contractors, who landed and rolled back the old spans. The trestles were built by the Railway Company, who took down the old spans, using an ordinary square outside traveler, running on blocking and short trestle bents at the top of the river bank, at the inshore ends of the landing trestles.

The calculations and plans for the erection work were made under the general direction of Phelps Johnson, Mem. Can. Soc. C.E., by the writer, who had charge of the work for the contractors. Wm. B. Mackenzie, Mem. Can. Soc. C.E., was chief engineer of the Intercolonial Railway Company.

THE NEW TYPE "R" PACKARD TRANSFORMER.

In a small pamphlet issued by the Packard Electric Co., descriptive of their new type "R" transformer, wonderful claims are made for its cool operation, close regulation and high efficiency. In the construction of type "R" a departure is made from existing methods of transformer construction, the coils having perhaps three-quarters of their surface exposed and outside the core, promoting greater ventilation, and differing from the old styles where the coils merely project beyond the core, and are imbedded solidly in insulated tape, etc. There being a very low difference in potential between the layers in the coils of type "R," there is a very remote possibility of short-circuiting, and the Packard people claim their insulation is practically indestructible. The style of construction adopted for type "R" makes it much more compact than any other style, and consequently of lighter weight. The coils are assembled in two sets, each set enclosing one side of a single magnetic circuit, the core being placed partly within the coils. The coils are of the pancake type and are assembled side by side. Radiation from the interior is promoted by oil or air ducts between the two sets of coils, while the coils themselves are flared from within outwards. In this manner greater radiation is provided for the coils as well as the core, the heat being rapidly dissipated. There is the same radiation in the secondary as in the primary, and the coils having a uniform radiation surface and being uniformly the same distance from the iron on one side and the cooling medium on the other, have the same rate of contraction and expansion, and there is no local disturbance of the insulation due to unequal expansion such as takes place in other makes. Mica is used throughout for the insulation, a feature peculiar to type "R." Micanite troughs insulate the coils one from the other, and advanced methods of insulating each in-



dividual coil insure the longest life and the maximum of safety to the user. Type "R" is designed for oil or air cooling and with the provisions made for radiation a cooler operation of Type "R" will be experienced than with any transformer yet placed on the market. Type "R" is regularly made for primary voltages of 1,000 and 2,000, and the secondaries are arranged for operating on 50, 100 and 200 volts in the small sizes, and 100, 200 and 400 volts in the large sizes, so that with a primary voltage of 2,200 all transformers over 150 lights capacity can be used for 440 volt motor installations. The Packard Electric Co. claim for type "R" a low difference in potential between layers and consequential greater safety; an almost indestructible insulation between the individual coils and between the coils and the iron; the lowest temperature rise and maximum of radiating surface; the lowest core loss and the use of non-ageing iron; small impedance and little magnetic leakage; a higher efficiency than any other regular line of transformers; the closest regulation. The Packard Company, whose works are at St. Catharines, believe they have overcome the existing defects in other transformers, and have embodied every desirable feature in type "R."

KEROSENE IN BOILERS.

By W. E. Ridenour, Ph.G., Philadelphia.

Much has been written upon the use of kerosene in boilers, chiefly by engineers, who state their practical experience, but give no cause for the action of the kerosene either adverse or favorable. A little chemistry and the opinion of a consulting chemist on this subject may be of interest.

Kerosene is a name given to various burning oils, which are graded according to color and fire-test. The colors range from pale yellow (standard white) to straw (prime white) and colorless (water white). The fire-tests, to which commercial oils are mostly brought are 110°F., 120°F., and 150°F. An oil of 150°F. fire-test and water-white in color, is known in the trade as head-light oil. We will take for discussion head-light oil, commonly known as kerosene. It is neutral in reaction, contains neither acid nor alkali, is not acted upon by either acid or alkali, therefore cannot enter into direct chemical combination. If there is any action upon boiler scale by kerosene, it is not due to changing the calcium sulphate, calcium carbonate, magnesia, magnesium carbonate or silica into other compounds by chemical reaction, but must be due to induced action on the iron.

Several cases have been brought to me to decide whether kerosene was injurious to boilers. In all cases I have asked for samples of scale detached from the boiler by its use, and upon these analyses have based my opinion.

Sample No. 1. Analysis No. 1154.

Organic and volatile	10.5%
Calcium carbonate	7.3%
Calcium sulphate	67.9%
Magnesia	3.1%
Iron oxide	11.2%
Mineral oil	a trace

Sample No. 7. Analysis No. 1201.

Organic and volatile	8.9%
Calcium carbonate	72.3%
Magnesia	13.2%
Iron oxide	5.6%
Mineral oil	a trace

Physical Appearance.—Upon examination of the surfaces of the boiler scale, it is found that the side which was next to the iron in the boiler has a very dark appearance. This dark surface was separated from the rest of the scale as clean as possible and upon analysis gave the following results:

Organic and volatile	3.6%
Iron oxide	88.5%
Calcium sulphate	7.9%

Showing that this dark surface is practically iron rust; thus proving that the kerosene has had no action on the incrustation, but has induced oxidation of the iron of the boiler.

Why the scale is detached.—The incrustation attaches itself to the surface of the iron during the running of the boiler, then the kerosene is introduced and penetrates the scale to the surface of the iron, which it induces to unite with oxygen, forming iron oxide. This compound occupies more space than the iron originally did, consequently pushes the scale off, also carrying with it some of the boiler as iron oxide. A simple experiment to prove that kerosene induces oxidation of iron is: Fill one small bottle with any ordinary water, and another with half water to half kerosene, into each put a piece of bright iron or steel. In the course of a few days it will be found that the iron or steel in the mixture of water and oil is rusted considerably, while the other remains bright.

In conclusion I must say kerosene should never be used in steam boilers, and I am satisfied that the practical engineers who have expressed themselves in favor of its use do not realize that there is injurious action, but are contented if loose scale is found every time the boilers are opened for cleaning.

GAS AND GASOLINE ENGINES.

By Edward Brenton Boggs, of the Fairbanks Company, New York.

The gas engine is the most highly perfected type of the internal combustion engine, or that in which the expansive motive force is generated in the cylinder and not brought under pressure from an outside generator, as in the steam engine.

The first engine of this class was built by the Abbe de Hautefeuille in 1678, the motive power being the gas generated by the explosive force of gunpowder, embodying, however, the principle utilized in the gas engine of to-day. In 1791 there was patented by John Barker, in England, an engine using a hydrocarbon gas, and in France, in 1799 and 1801, patents were issued to Phillippe Lebon, covering an engine with gas for the motive power in which the explosive was ignited by an electric spark, generated by a friction machine. To what degree of perfection this might have been developed is unknown, as the unfortunate assassination of Lebon brought the experiments to an early close. Wright, in 1833, brought out a double acting engine with a pump to separately compress the gas and air and inject them into the power cylinder. We have given this historical mention for the sake of record, and to show how, early in mechanical history, man recognized the possibility of utilizing this force and the advantages it possessed. Even the utilization of steam failed to cause the abandonment of the search for the perfect motor. In fact, it gave rather a stimulus, as scientists were quick to see the profit to be gained by eliminating the intermediary of the steam boiler. So much for history.

The principle of expansion by heat is too well known to require comment. We will, however, recall the fact that solids when heated to expansion do not change their weight, although their volume is appreciably increased. This is even truer of gases which increase immeasurably their volume when heat is applied. The gun is a familiar exponent of this theory—leading as it did to the Abbe's engine. The gunpowder is ignited by heat, releasing an explosive gas which forces the charge out of the muzzle. Equip the gun with a means for checking the outstroke of the projectile and for returning it to the breach in readiness for another impulse, and you have the gas engine. There is something undeniably terrifying to a novice in the explosion of the gas engine and the resistless force with which the piston is driven forward, but when one notes the regular sequence of explosion, forward motion, and return, one loses the fear and imbues something akin to enthusiasm for the smoothness, regularity and cleanliness of the motor.

The gas engine consists of a cylinder, mounted upon a base of sufficient weight and strength to resist the explosive force; a piston fitting therein, carrying the connecting rod, the other end of which is attached to the crank, which in turn drives the shaft to which the driving and fly wheels are attached. These basic members are present in all forms of the motor. Simply expressed, the gas mixed with air is admitted to the cylinder behind the piston and compressed, is exploded by heat, and expanded, driving the piston forward, which allows it to dissipate; the momentum of the fly wheels carries the piston rod past the dead centre and returns the piston to the first position, where the operation is repeated The various operations which produce this result were grouped under the general term of a Cycle by Beau de Rochas, a French scientist, in 1870, though from the fact that the principle was first embodied in a practical engine by Dr. Otto in Germany, in 1876, it is often called the Otto Cycle. The cycle of operations is as follows:

The piston on its first outstroke draws in the charge of gas and air which fills the entire cylinder; on its first instroke the piston mixes and compresses the charge into the rear of the cylinder, called the combustion chamber, which usually contains a volume one-third of that of the cylinder when the piston is at the outer end of its stroke; the igniter now operates, introducing an electric spark into the compressed mixture, this while the crank is passing the inner dead centre; the pressure instantly rises to about 300 pounds to the square inch, driving the piston forward; the instant the piston starts on its impelled journey the pressure begins to fall to about 40 pounds; near the end of the stroke the supplemental exhaust port is uncovered, allowing some of the charge to escape. After the crank has passed its outer dead centre the piston begins to drive the charge through the supplemental exhaust, an operation lasting until the piston covers the port; in the meantime the main exhaust has been opened, permitting further escape, reducing the pressure to about atmosphere, or 15 pounds at the end of the instroke; the induction valve is now opened, admitting the mixture as the piston starts outward, the main exhaust at the same time closing; the new charge mixes with what remains of the products of combustion and a new cycle commences. It will be seen that each cycle comprises four operations; suction, compression, explosion and expansion being one, and exhaust, requiring four strokes of the piston, two in and two out; one impulse, one explosion for every four strokes of the piston. Engines operated under this principle are commonly, though erroneously, called four-cycle. Four stroke cycle is the proper appellation, a cycle being a complete series of operations, not one operation of a series. Let us take each operation in turn. The induction and mixture of the fuel: Both the air and gas supplies are controlled by graduated valves permitting the throttling of each element. The mechanical opening of the induction valve (the valve which controls the opening between the valve chest and the cylinder) permits the gas and air to be sucked into the cylinder by the outstroke of the piston; the fuel charge now fills the cylinder, awaiting the return of the piston for compression and mixing. Chemically the mixture is effected as follows: The component parts of atmospheric air are oxygen and nitrogen, of coal or hydrocarbonic gas, hydrogen and carbon. The oxygen of the air combines with the carbon of the gas, leaving the nitrogen free, the hydrogen of the gas combines with parts of the oxygen of the air, forming a watery vapor, the union of the carbon of the gas and the oxygen of the air form carbonic acid gas and monoxide. The introduction of heat combines the last two elements with the hydrous vapor and the free nitrogen, and forms a gas of great expansive quality. Theoretically the dissipation is absolute, practically it is far from it, due to the imperfect methods of combustion which fail to reach explosively every molecule of the mixture. This is evidenced by the comparative richness of the unconsumed portion of the charge, which when mixed with the fresh charge is recombustible, but which adds a negative value to the mixture, because of the low temperature induced by its expansion almost to the atmospheric pressure of the exhaust. Economy forbids, however, its entire rejection, making its retention advisable until a perfect ignition can be secured. We have thus far said nothing of gasoline. This is the lightest volatile liquid product, commonly obtained from distillation of petroleum, its specific gravity ranging from 95° to 70° Baume. The best results are obtained with gasoline of 74° or 76°, that of higher volatility failing to produce a gas sufficiently powerful for the purpose. The gasoline is brought up by a pump to the carburetter or chamber, where it encounters an air current, which vaporizes the gasoline by admixture with the oxygen of the air, forming hydrocarbonic gas, which together with the other gases is induced by the piston in the same chemical mixture as is gas. For the initial start a priming charge is required, which is fed into the cylinder by hand and vaporized by the compression of the piston. Gasoline will generate from one to three horse-power more in the same engine than will gas. It gives far more satisfactory results, the explosions being practically uniform, not being subject to the fluctuating pressure of the ordinary illuminating or hydrocarbon gas. Because of its extreme volatility and liability through careless handling to explosion its use is forbidden in New York, although permitted in many other less densely populated cities. It is stored in a tank buried in the ground and safely insulated from danger of explosion, such portion as the work in hand requires being pumped into the cylinder as before described. The cylinder is a hollow chamber, shaped very like the cylinder of an ordinary pumping engine. Within is the piston (another cylinder fitting closely and free to move backward and forward only), loose rings of cast iron are placed around the piston, free to expand, and with the assistance of the film of oil to prevent all escape of the charge, the open end of the piston faces the fly-wheels in the direction of the explosion, the connecting rod passes into the piston, being pivoted thereto, the other end being attached to the crank. Upon the tightness of the piston depends the success of the cycle, the slightest leak being fatal to compression, without which the subsequent operations would be ineffective. The first outstroke of the piston opens the induction valve mechanically, sucking in the mixture, the return stroke compressing the charge that the mixture may be more complete, and the expansion proportionately greater; this stroke has also closed the induction valve, preventing the escape of the compressed charge. There is a theory that the gases are stratified or compressed in layers, each being released in turn by the explosion. We do not hold with this theory, believing that the gases are too thoroughly mixed by the friction of their molecules by compression to make this possible. The charge is now ready for the heat which shall release it. For producing ignition many methods of more or less practical value have been tested and abandoned. Three methods at present prevail: Forcing a gas flame into the mixture through an aperture in the end of the cylinder; exposing to the charge a metal tube heated to incandescence by an internal flame; and introducing an electric spark. The last method is undeniably preferable, although its application is far from perfect even in its most desirable form, a tightly closed circuit just previous to the moment of ignition. At the end of the compressive stroke, the two electrodes are snapped apart producing a brilliant spark, which combines the various elements. The contact points of the electrodes are best of platinum, which wears slowly and accumulates comparatively little deposit, that enemy to good electrical contact. This deposit is a product of combustion and is pure carbon, due to insufficient oxygen to turn the carbon of the fuel gas into carbonic acid gas. The carbon usually builds up on the cathode point, often requiring a file to remove; alternating the poles adds much to the life of the electrodes. The current is derived either from a primary battery or from a generator driven by the engine fly wheel, a storage battery being constantly charged to furnish the initial spark. A dry cell is frequently used for this purpose. The efficiency of the engine depends so largely upon the ignition that too great stress cannot be laid upon the necessity for absolute cleanliness in all parts of the igniting mechanism. Circulation is the term given to the supply of water which passes through the jacket surrounding the cylinder and valve chest. The purpose of the water is to keep the interior of the cylinder at an even temperature, which should be about 200° Fahrenheit. If the temperature of the cylinder is too low expansion is checked; condensation accumulating prevents healthy combustion through the consequent presence of excessive hydrogen. If, on the other hand, the cylinder becomes overheated the products of one combustion fail to cool before the new charge is admitted, causing a premature explosion. It has been estimated that higher efficiency by probably 10 per cent. is obtained by maintaining the temperature of the ejected water at a point just below the boiling point of 212° Fahrenheit. The variations of the temperature of the water are of course obtained by feeding a greater or lesser volume of cold water to the water jacket. The water connections are made sufficiently large to admit to the jacket, if desired, a greater volume of cold water than can be warmed by the internal heat of the cylinder. We have already explained how the exhausted charge is driven out of the cylinder through the main and supplemental exhaust openings. These openings are connected by pipes with the open air, permitting harmless escape of the various gases generated by the combustion. The governor is one of the most important members of the engine, governing as it does the speed, fuel supply and exhaust and ignition. When the flywheels of the engine exceed a certain predetermined speed, the arm or arms of the governor are forced outward by centrifugal force, interposing a stop to prevent ignition or induction as the case may be. Several types of engines are fitted with a shaft running outside of and parallel with the cylinder carrying a gear wheel on the end, which meshes with a similar gear on the main shaft. By means of this side shaft the valves and igniter are operated. When the arms of the governor fly out, a stop is interposed, throwing the side shaft out of gear and suspending its functions.

Of the economy of the gas or gasoline engine for small powers, there can be no question, many being in successful operation up to 100-h.p., requiring no attention beyond that usually accorded fine machinery, the principle requisite being absolute cleanliness. Lack of this virtue causes a clogging of the valves, corrosion and erosion of the electrodes and an imperfect exhaust. A given volume of gas used in a gas engine to drive an electric generator will produce approximately double the candle power of the same volume of gas burned in the usual manner for illuminating. The cost of gas for direct lighting averages 7½ cents per hour for 192 candle power; the same amount of light through the medium of a gas engine consuming illuminating gas with an electric generator, 2¼ cents, or an average cost of 1 cent or less with gasoline for fuel. These figures are, of course, approximate, conditions varying in different localities. In those States where natural gas is obtainable the cost of operating a gas engine is reduced to a minimum. A steam engine transmits to the driving pulley only 10 per cent. of the fuel energy which the coal contains, while the gas engine transmits about 35 per cent.

Careful investigation of the subject will well repay the present or prospective user of steam engines of 100-h.p. or less, as the gas or gasoline engine supplies equal efficiency at a lower fuel cost, eliminates the steam boiler with its consequent evils, such as coal, ashes, licensed engineer, etc., and substitutes a concentrated fuel obtainable at all times regardless of the ever present coal strike.

RAILWAY RECONNAISSANCE.*

By Wm. B. MacKenzie, Chief Engineer, Intercolonial Railway.

Railway work generally begins with an examination of the country through which it is desired that the line shall pass. This is called a "reconnaissance," and may be considered an art rather than a science. The best procurable map of the country, an axe, a pair of steel climbers, a pocket barometer, field glass, and a 7-inch Abney double-tube hand level, having vertical arc, compass and telescope combined, are the only instruments really needed. Good work may be done without any of them, but they are a convenience. The catalogue prices of several very useful pocket instruments for reconnaissance are: Pocket barometer, $27; field glass, $35; Abney's double-tube 7-inch hand level with vertical arc compass and telescope combined, $17; Brunton pocket transit, $25; pocket magnifying glass, 55c. A guide should be employed, and the man who thinks he knows the whole country and every tree in it is, no doubt, the best man to have; but you must be careful to prove the correctness of his knowledge by your own work, and take nothing for granted. If he is a farmer he will lead you along the highways, and if a hunter, he will lead you along the ridges. I once came near making a very serious error in location by depending too such on a guide who "knew it all." After the completion of the survey, I had a feeling that to make assurance doubly sure, I should take two or three days to go crosswise over the country, and thus confirm the route selected beyond question or the possibility of a doubt. By the evening of the first day I had proved that in one place the line was a mile out of the proper position; three miles of new survey was made and the line built on it. That was a bit of experience which I shall not soon forget. I felt very thankful but the guide was correspondingly cast down.

It will be necessary for the engineer to explore the country for several miles on each side of a direct line on the map connecting the terminal points, because, no matter whether he is on the right track or not, every farmer he meets will tell him that the line should be somewhere else two or three miles away, and he must be able to tell them that he has been there already, and knows more about the ground than they do. The general route can be selected by reconnaissance and without the use of a transit or level, and the man who possesses the greatest skill in estimating distances, heights and grades by the eye alone, will do the best work and will do it more rapidly. This is where the "born locator" having an "eye for country" will shine.

Reconnaissance work requires a higher order of mind

* Extract from a Paper entitled "Notes on Railway Work," read before the Engineering Students of the University of New Brunswick at Fredericton, N. B. October 17th, 1902.

than is called for in merely running in or locating the line on the ground in detail by the use of the transit and level, or in constructing it afterwards. The whole question of operating economy depends upon the reconnaissance, and no excellence of construction can correct mistakes in it. Only men of proven ability in reconnaissance should be allowed to undertake this most difficult part of railway work—the part which irrevocably fixes the character of the road. All the railways of the country are now suffering more or less from insufficient reconnaissance work having been done before their final location, and this very serious error should not be repeated in future railway work in Canada. Not a location stake should be set until the reconnaissance is completed, and in difficult country a day to one or two miles will be time well spent.

In future, the reconnaissance man will be the important man, and it will be necessary to seek him with a lighted candle and pay him well when found. He will be a man of tact and judgment—one in a hundred—a man who loves the woods, knows some of its secrets and feels as much at home in the forest as in his own house, if he happens to have one. No matter how difficult the country may appear, always assume that there exists a good line between the two terminal points and that it is your business to find it. Do not allow the mind to become prepossessed in favor of a particular line until you have exhausted all the possibilities. Do not adopt too high a maximum gradient, because it is the ruling grade which governs the cost of operation, and low grades are the most important of all the details. When a valley rules the location laterally, the problem is simple, but when the line runs across the drainage of the country, it is complex. A preliminary reconnaissance should first be made by driving over the country from one terminal point to the other, in a carriage or on horse-back, or on foot when there are no roads, to ascertain the general features, returning again to the starting point. Next, the controlling points should be noted on the map, and examined by walking over them in both directions, and it must be ascertained and decided in a general way whether they can be overcome within the limits of grade and curvature. Of course, the lowest point on ridges will be selected and the highest stream crossings where the grade must be continuous between the stream and ths summit. Where a stream flows east or west the smoothest ground is generally found on the north side, and when the stream flows north or south, the smoothest ground is generally found on the west side. The grade of all streams increases toward the source. It is absolutely necessary to know where the water of every stream goes to. In examining the ground from tall trees or from hill-tops in rolling country, a person is liable to form entirely wrong impressions and imagine the ground to be much more easy than it really is. A rolling, irregular country, having pieces of hills and valleys scattered about promiscuously and trending in different directions, is the most aggravating kind of country to the locating engineer, and it requires a great deal of hard work before he can be assured that he has secured the best line; almost any person can locate along a shore or river valley. Except, perhaps, at summits, do not let the existence of a highway have any influence on your location. The pocket barometer is a very useful instrument, but, like the guide, it is very apt to lead you astray, and requires careful watching.

Things are not always what they seem, and you must be continually on your guard against what is termed "Ocular illusions." For instance: A slope observed in front with the sky as a background always appears higher and steeper than it really is. Looking against a mountain you will imagine the ground falling towards the mountain when it is really rising, and a stream flowing towards you will appear to be running up hill. If, at the foot of a mountain, there is a small hill with a valley the same height on each side of it, the valley next the mountain will appear to be the lowest. Hills overlapping at a distance will give the appearance of a solid ridge; many errors have been made from this cause. Hills are deeper than they seem to the eye looking directly down on them. When a slope is observed from the top, it appears to be steeper than it really is. Longitudinal distances appear shorter than they really are when looked at across water or low land. Lateral distances are exaggerated and appear longer than they really are. In clear air, judging distances is almost impossible without comparison with some known distance, but practice will show at what distance known objects, such as the outline and style of a man's hat, becomes visible. The distance to a rock observed across an unseen valley is almost impossible to estimate. In a hazy atmosphere, the amount of haze between you and the object is some guide to the distance. When looking towards the setting sun, the distances are less than they appear to be. Heights and distances are more easily judged on days when the sun is obscured. Distances can often be taken with sufficient accuracy by observing the time occupied by the passage of the report of a gun from one point to the other. This may be done in the day time if there is a field-glass handy to watch for the smoke, but otherwise the flash, of course, can be best seen at night. The velocity V, in feet per second, with which the sound travels depends on the temperature; thus, at 32 degrees F., V equals 1,090 feet; at 60 degrees F., V equals 1,125 feet, and at 100 degrees F., V equals 1,175 feet. If the wind is blowing hard in the direction from which the sound comes, the velocity of the wind may be added to V. When the observers are not visible to each other, two guns may be used. If one fires instantly on hearing the other, repeating this three or four times, one-half the number of seconds from the firing of your gun to the reply of the other, multiplied by V, will give the approximate distance in feet. Sounds travel to greater distances in cold air; they are not easily heard during snowstorms, but they ascend readily and are more distinctly heard on the hill-tops.

If your pocket compass has been forgotten, and the sun being invisible, you discover that you are lost, a few of the secrets of the woods may be of service. You will find a compass almost anywhere by observing that the moss and fungus grow on the north side of the trees, that a lonely bare rock will show the south side, dry and bare, and the north side damp, mouldy and mossy. The sunny or south side of a hill will be dry and noisy under foot, while the north side is mossy and damp; this also applies to clumps of trees, bushes, big rocks, etc. The golden rod droops to the south, and the color of the club rush (cat-tail), is lighter on the south side. The bark of the coniferous trees is of a lighter color, harder and dryer on the south side, and is darker, damper and sometimes carries moss on the north side. The gum or balsam is clearer, cleaner and harder on the south side, and soft, sticky and full of insects and dirty and gray on the north side. Nests and webs of insects are in the crevices of the bark on the south side. Birds' nests are usually built and woodpeckers' holes usually made on the south side of the trees. The green leaves are of a lighter color on the south side. On steep hills or mountains, trees grow larger and more uniform on the north slope, next best on the east slope, while on the south and west slopes, the ground is often bare. It is well to note the direction of the wind each morning and the dip of the rocks, if uniform, as this knowledge alone may help you out of the difficulty. If the direction of the prevailing wind in that part of the country is known, an isolated and exposed tree will show it, as it will be found to lean more or less away from the prevailing wind. If it is known that a noted gale from a particular quarter once blew down large sections of the forest, look at the fallen trees. If you wish to know the age of a blaze on a tree, cut squarely through the wood which has grown over or partly over the blaze and count the annual rings from the black mark outwards. In the eastern part of Canada quartz veins run nearly east and west, and ice markings on the rocks run southeast.

After you have succeeded in finding yourself again, some of the important considerations may occupy your mind, such as the following: The difference in gross receipts between different lines. The difference in interest charges between different lines. The difference in operating expenses between different lines. Deviations to outlying villages which may be made to secure local traffic, and these may extend to 1-10 the air line distance between terminals measured on either side from the air line itself. Ten per cent. of the traffic originating in small towns will be lost for every mile the line is placed away from the town. Such towns, however, gradually build up towards the railway; 25 per cent. to 50 per cent. of the traffic originating in cities where there is competition will be lost for every mile the line is placed away from the city. Stations should be as nearly as possible in the centre of the cities or towns, particularly at terminals. For lines of heavy traffic (say ten trains per day, round trip): If the gross revenue can be increased 1-5 the whole investment may be doubled. If the gross revenue can be increased 1-10 the cost of track and roadbed may be doubled. If the gross revenue can be increased 1-20 the cost to subgrade may be doubled.

Distance.—For savings of three miles or less, assume that the cost of operation is 80 cents per mile for every daily train making a round trip (going and returning). Then 80 cents x 350 days in the year = $280 per year per daily train round trip (going and returning). If borrowed money costs 5 per cent. interest, we are entitled to spend $5,600 extra on construction of a certain route, if by so doing we can save a mile of level track, because this is the sum which at 5 per cent. interest will produce $280. For two trains making round trips per day (going and returning), we should spend twice as much, and so on.

Rise and Fall.—Assume an operating cost of 80 cents per mile for every daily train making a round trip (going and returning), then on grades between 0.75 and 2.00 per 100, when hills are 40 to 50 feet high, the annual cost for operating one foot of rise and fall per daily train round trip (going and returning) may be estimated at $1.44. If borrowed money costs 5 per cent. interest, we are entitled to spend $28.80 in the reduction of one foot of rise and fall, because this is the sum which at 5 per cent. interest will produce $1.44. For two trains making round trips per day (going and coming), we should spend twice as much, and so on.

For such a summit as "C" in Fig. 1, spend 2 x $28.80 = $57.60; but if "C" is the terminus of the line "AC," spend only s28.80.

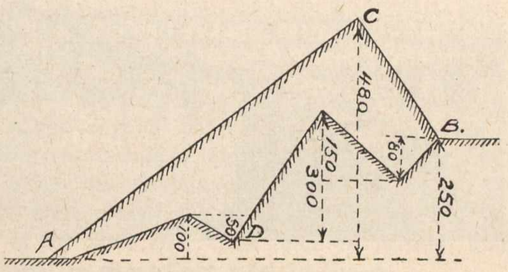


Fig. 1.

A foot of rise and fall means one foot of rise and one foot of fall, going in one direction only. Thus in Fig. 1, the total rise and fall between "A" and "B" by either route equals 710 feet.

Curvature.—Assuming an operating cost of 80 cents per mile for every daily train making a round trip (going and returning), the annual cost of operating one angular degree of curvature per daily train round trip (going and returning), may be estimated at 28½ cents. If borrowed money costs 5 per cent. interest, we are entitled to spend $5.70 to lessen a curve by one angular degree of curvature, because this is the sum which at 5 per cent. interest will produce 28½ cents. For two trains making round trips per day (going and returning), we should spend twice as much, and so on.

Locomotive Haulage.—To find the load which a locomotive can haul up a given grade at ordinary freight speed, use the following formula:

$$L = \frac{100W}{1 + 4r} - E \qquad (1)$$

L = Load in tons of 2,000 lbs., which can be hauled behind tender.

W = Weight on the drivers in tons of 2,000 lbs.

E = Weight of locomotive and tender in tons of 2,000 lbs.

r = per cent of grade.

The above is based on a rolling resistance of 5 lbs. per ton on straight level track.

Note—Deduct 20 per cent. from L in winter.

Comparison of Routes.—A line is 50 miles long between terminal points and has a ruling grade of 1¼ per 100. How much additional money would we be entitled to spend to secure a 1 per 100 grade, having to carry 2,000 tons of freight in one direction every week day. By applying formula (1), it is seen that our engine will haul 1,000 tons up a 1 per 100 grade, and only 824 tons up a 1¼ per 100 grade—a difference of 176 tons per train. On the 1 per 100, therefore, we would require two trains per day, carrying 1,000 tons each, while if we used the 1¼ per 100 grade, we would have 176 tons × 2 trains × 6 days = 2,112 tons of freight piled up at the receiving end at the close of each week. This would require two special trains per week = 0.33 of a daily train, and to operate these two special trains would cost annually: 0.33 of a daily train × 80 cents per mile per daily train round trip × 50 miles × 350 working days in the year = $4,620, and this capitalized at 5 per cent. = $92,400, which is the additional sum that we would be entitled to spend to secure a 1 per 100 grade instead of a 1¼ per 100 grade.

Now, we may accomplish this in either of two ways; either spend the $92,400 in cutting down the 1¼ per 100 grade to a 1 per 100 grade, or, if this cannot be done, divert the line on to new ground which will afford a 1 per 100 grade and add 3½ miles to its length. This latter proposition is proven thus:

To operate one train round trip over one mile additional during one year........	= $280 = 80c. × 350 days 2 trains
To operate two trains round trips over one mile additional during one year........	560 3½ miles
To operate two trains round trips over 3½ miles additional during one year.......	1,960
Assuming construction to cost $52,500 for 3½ additional miles 5%	2,625
Annual outlay, which nearly equals the $4,620 that we are entitled to spend annually to secure a 1 per 100 grade.................	$4,585

Business and ruling grade should determine the general route. Most of the lines of 20 and 30 years ago were pioneer lines, and steep grades and sharp curves were freely used to lighten the cost of construction, as nothing else would have been paid for at that time. There was not then the same necessity for the extensive and thorough reconnaissance which is now imperative in this day of heavy traffic and low grades.

Far too little time was formerly given the engineer for reconnaissance work. In my own experience I once, because of an incorrect plan, ran my preliminary line into a lake, instead of passing by the end as I intended. As the work had already been advertised for tender, no time was left to make changes, and the road to-day runs through the middle of the lake. Once, after completing the reconnaissance, I put on two survey parties, and, while keeping ahead of the preliminary party and giving them general directions, I was able, with the aid of 20-in. x 30-in. sheets on which the preliminary work had been plotted the night before, to lay down the location at odd times in the day, using the flat wooden case in which the sheets were carried as a table. These sheets were, one by one, carried back to the locating party, and the whole combination was thus kept moving. Such work is too much for one man, and those who do it receive few thanks as a rule.

Be sure that you do not use the maximum grade or curve oftener than is absolutely necessary. When you are climbing toward a summit, try to avoid losing elevation by inserting reverse or down grades, but look well for supporting ground to right or left, and thus by gaining distance reduce the cost of grade. If the country is such that high grades must somewhere be used, try to bunch them in one division, and reduce grades to the utmost on all the other divisions.

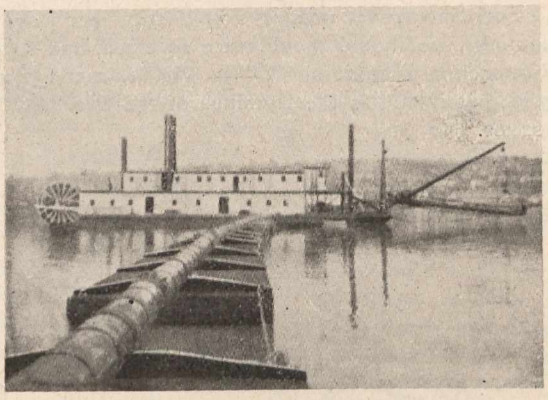
Reconnaissance should be so thorough that a close preliminary line can be run and sufficient topography taken within 300 or 400 feet on either side. This may be shown on plan by contour lines or elevations in figures. From this data, a paper location plan and profile is made. When running in this paper location is the time to study the ground in detail and make necessary changes. This general method of reconnaissance and preliminary, having the details filled in to the extent necessitated by the character of the country, should result in good location at reasonable cost.

For practical information on railway location and construction, consult "The Economic Theory of Railway Location," by Wellington, 1887; a series of articles by Wm. G. Raymond, in the Railroad Gazette; "Rules for Railway Location and Construction," November and December, 1898, by E. H. McHenry, chief engineer of the Northern Pacific Railway, now chief engineer of the Canadian Pacific Railway. The latter book is the most comprehensive and complete book of instructions so far published on the subject, and it has recently been reprinted by the Engineering News Publishing Co., New York. Price, $1.

TWENTY-IN. HYDRAULIC DREDGE KING EDWARD*

By A. W. Robinson, Mem. Can. Soc. C.E.

This dredge is one of the more recent acquisitions of the Department of Public Works of Canada to its fleet of dredges, and is intended for work on the Pacific coast. The plant of the department in that district up to the present has been small, comprising the dipper dredge Mud Lark, clam shell dredge Muskrat, snagboat Samson, and some other small plant, the whole under the jurisdiction of G. A. Keefer, M. Can. Soc. C.E., resident engineer. The works in contemplation include principally the rectification of the Fraser river in its lower part, and also such incidental dredging at various points as may be required. It was decided to adopt a hydraulic dredge as being best suited to the conditions. This type of dredge is sometimes termed a suction dredge, but the writer has adopted the term hydraulic dredge as being more suitable, for the reason that the suction principle is not employed at all for purposes of dredging. The dredge consists essentially of a mechanical excavator, by means of which the material is dug up or loosened and fed into the mouth of the suction pipe and the remainder of the process is simply one of transportation. A centrifugal pump is employed to create a rapid flow through the pipe from the point of excavation to the point of discharge and the solid matter is carried along with the water. In view of the fact that the percentage of solid matter is small and the volume of the water transported is large, it might be supposed that this method of dredging would be a very wasteful one, but there are several other incidental advantages gained at the same time, and in the light of practical results the process is not so wasteful as it seems. In the first place, the essential feature of this type of dredge is the disposition of the material, and, therefore, in comparing the results of its work with any other type, the cost of disposing of the material as well as dredging it must be included. It is also especially adapted for filling up and reclaiming low lands, and, in work of this kind, the presence of a large volume of water with the discharged material is a great advantage as it serves to distribute it over a large area while the water is flowing off. The velocity of flow in the discharge pipe of dredges of this type varies from eight to sixteen feet per second, and different kinds of material require different velocities of flow for the most efficient work. Material like clay or soft mud can be transported at a slower velocity than sand or gravel material, which tends to quickly precipitate. A high velocity of flow means a greater friction in the pipe and pump, and, consequently, greater expenditure of power. It must always be borne in mind that a fluid mixture of sand or mud and water is heavier than water alone and, therefore, takes more power to pump it against a given head, and, also, the friction in the pipe is greater. In the earlier hydraulic dredges great trouble was experienced with the abrasion and wear of the interior of the pump. As the first pumps used were similar to centrifugal pumps for water only, it was not an infrequent occurrence for the pump to be renewed after three or four weeks' work. By successful improvements, however, we have been enabled to increase the durability of the pump so that, under ordinary conditions of service, they can be made to last two or three years and, in fact, the principal parts of them are now so designed as to last indefinitely with the parts subject to special wear arranged to be renewable. The interior of dredging pumps are now made of cast steel instead of cast iron as formerly. This is not, however, on account of the greater resistance to abrasion of cast steel as compared with cast iron, because practically, there is very little difference, but it is due to the fact that the cast steel piece can be worn very thin before breaking. Somtimes centrifugal pumps for dredging purposes are lined throughout with renewable steel plates. This is an advantage in some cases, but as a rule, the delay and expense of renewing the linings amounts to more than the occasional renewal of an entire pump shell as the latter can be put in in less time than linings. Also the bolts or fastenings of the linings tend to produce abrasion and wear at that particular point. Wherever there is a crack or joint in the interior of the pump, it is liable to produce an eddy or change of direction in the flow, and a stream of gritty material acting in this way will soon cut out the fastenings and joints of the linings. A great deal can also be done to reduce the interior wear of the pump by careful design. It is better to allow ample clearance for the flow at all points, especially the periphery of



Dredge King Edward.

the pump, and this can be so proportioned that the abrasion is comparatively slight and evenly distributed. If experience shows that there is undue wear at one point, it means that there is a stream of gritty material flowing or impinging against the surfaces at that point and at a high velocity. This can be remedied by removing those surfaces further away, thus giving the stream more room at that point. Many pump designers are of opinion that the throat or cut-off of the interior of the pump should be as close as possible to the periphery of the pump runner, in order to prevent any flow past this point. Careful experiments have shown that this makes very little difference, and that for dredging pumps especially it is better to allow great clearance at this point, otherwise it will cause great wear.

Hydraulic dredges may be divided into four leading types: First, the sea-going hopper type; second the lateral feeding or ship-channel type, with floating discharge pipe; third, the forward feeding or Mississippi type, with floating discharge pipe; fourth, the radial feeding with spud anchorage and floating discharge pipe. The dredge King Edward VII., which forms the subject of this paper, belongs to the fourth class—that is to say, it is anchored by spuds and has a radial feed, the cutter de-

*Read before the Canadian Society of Civil Engineers.

scribing an arc of a circle about the spud as a centre, and the material is principally deposited on shore or to a distance through the floating discharge pipe. It will aid in understanding the construction of the dredge and the reasons for adopting this particular construction, if we first give some consideration to the statement of the conditions to be fulfilled by this dredge. After an examination of the ground and a consideration of the subject these conditions were defined as follows: First, the dredge must be capable of dealing with sand and soft material at an ordinary rate of 500 cubic yards per hour. Second, it must also be able to dig and discharge hard clay, gravel, shell or difficult material and to pass occasional stones up to 10 in. diameter without difficulty, and also to encounter snags, roots or logs, and cut them up if necessary. Third, it must be capable of working at any depth down to 40 feet and making a cut of any width up to 120 feet. Fourth, it must be capable of cutting its own flotation through a solid bank. Fifth, it must be able to work in a current of five miles per hour, in either direction and in ebb or flow of tides. Sixth, it must be able to discharge its material in three different ways, viz.: 1. Into scows alongside. 2. On shore or over an embankment by means of a suspended side-pipe. 3. To distant points through a pipe up to 3,000 feet. Seventh, it must be self-propelling at a speed of not less than eight miles per hour, and be seaworthy enough to cross the Gulf of Georgia, or go up or down the coast. Eighth, it must contain quarters for captain and crew with all supplies, and coal for at least ten days. To fulfill the above conditions the dredge herein described and illustrated, was designed by the writer and built by the Polson Iron Works of Toronto, Ont., and was completed and went into commission in November, 1901. The hull of the dredge is 32 ft. wide, 125 ft. long and 7 ft. 6 in. deep. It is built square ended at bow and stern, with corners well rounded, and a rake on the under body fore and aft in order to make it fairly easy to propel. The bilges are rounded and the frame of the vessel is built of steel, while the plank and sheathing are of wood. By this construction great strength is obtained, the steel frames being practically indestructible, while the planking can be renewed at any time when necessary, from injury or decay. This form of construction was also especially suitable for erection on the Pacific coast, as the entire frame of the hull could be fitted and erected at the works where built, leaving only the planking to be purchased and put on at place of erection. The hull is stiffened by two additional steel trusses extending the entire length. These trusses are fifteen feet deep, and serve to strengthen and carry the weight of the upper deckhouses. They also sustain the weight and thrust of the front A frame and furnish the necessary support for the wheel beams, at the after end. The hull is further stiffened by four transverse water-tight steel bulkheads.

The engines are of the triple expansion marine type of 500-h.p. There are no special features about this engine which call for detailed description. It is simply a first-class marine engine without the link motion. The work of driving a centrifugal pump is somewhat analagous to that of driving a screw propeller, and, therefore, the type of marine engine is well adapted to the purpose. There are, of course, many little practical details concerning the manner of attachment of the pump, and providing for the special wear and thrust that occur in the pump that are different from marine practice.

The dredging pump itself is of the centrifugal type, of a pattern which has been arrived at through the correction of defects of earlier designs. The pump has a cast iron shell with cast steel runner and blades. The suction and discharge pipes are both 20 in. diameter. The blades of the pump runner are faced with renewable steel blades at points of greatest wear and the pump is so designed that it can be readily taken apart and the pump runner removed without taking down the pump shell or discharge pipe connections. The internal passageways of the pump are of large area so as to freely pass any stones or solid bodies that may enter through the openings of the suction head without injury or liability to choke it. It will readily be seen that if the passages of the pump were of smaller size than the openings through the cutter head that stones or other obstructions might lodge in the pump, but by the foregoing precaution this liability is obviated. The entire suction pipe projects in front of the dredge and swings thereupon, its lateral movement being accomplished by means of a block and tackle on each side, the hauling parts of which are carried to the drums of the auxiliary engines. The suction pipe has a universal movement on the hull so that it can raise and lower as well as swing. This movement is provided for by a section of rubber suction hose where it passes over the deck, the suction pipe being attached by hinges to a revolving base plate on the bow of the dredge.

The material is excavated by means of a rotary cutter head, which is formed of a cast steel hollow shell and removable cast steel blades. These blades are arranged on a spiral, and so as to give the maximum effect with the least liability of choking. The action of the cutter is such that the blades slice off or excavate the material and feed it into the interior of the shell through the openings, from whence it is removed by the pump suction. The cutter head with its shaft, gearing and all connections are of ample strength to stall the engines which drive them. Thus, in case of an immovable resistance being encountered, nothing worse can happen than the stoppage of the engines, and by slacking off the feed of the cutter a little, they are enabled to proceed and try again. It is worthy of note that since this dredge has been in commission she has worked in all kinds of material, including roots, stumps, hard-pan and stones, and that no breakage or injury has occurred to the cutter head or its driving gear. The suction pipe when swinging on the hull will make a cut about equal to the width of the hull, while the latter is anchored by its two spuds. When it is desired to make a wide cut the suction pipe is secured in its mid-position and the swinging lines are carried out on each side to a shore anchorage, and the entire dredge swings on its stern spud, thus making a cut from 150 to 175 feet wide at one time. The spuds are oscillating so as to permit the dredge to move up without drifting out of position, and when the move is made, they are lifted and dropped again in vertical position and the work proceeds. The moving up is accomplished by giving a turn or two to the stern wheel by the propelling engines. There are auxiliary engines on the forward deck, placed there for the purpose of working the swinging lines and also hosting the forward spud. The operator of the dredge controls all the movements of feeding and moving up through the medium of these engines and by bell signals to the engineer. The entire dredge is, therefore, under the control of one man.

The boilers are of the Heine water tube type. This type of boiler is not, strictly speaking, a marine boiler, although it has answered very well for this class of work. They are of the usual land type, cased in steel, lined with fire-brick. The boilers are designed for a working pressure of 200 pounds per square inch, and have an excess of capacity to provide steam for all machinery, and in case of necessity the dredge can work at fair capacity with only one boiler in commission, while the other is under repairs. In the engine room the usual auxiliaries are found, such as surface condenser, air pump, centrifugal circulating pump and independent feed and fire pumps. These are all of ample size and conveniently arranged for ease of access and repairs. The propelling engines are of the stern wheel type, so often seen on the western rivers. They are of the direct acting long stroke horizontal type and have cylinders 16 in. diameter by 6 ft. stroke. They are mounted on a steel frame and have answered the purpose very well. The whole of the main deck is occupied with machinery and the whole of the upper deck is given up to quarters for the officers and crew.

The performance of the dredge has been quite satisfactory, although no very large or continuous outputs have been made, owing to the fact that the work to be done has been principally small jobs at different points, and in various kinds of material, some of which has been of a very difficult nature. The capacity of 500 cubic yards per hour has frequently been obtained, and, under favorable conditions, the output, for short periods of time, has approached 1,000 cubic yards, but the average, owing to the reasons already stated, has been much less than this. When pumping material ashore a floating pipe line is laid to the shore, after which plain lengths of sheet steel pipe are used, laid on the ground and blocked up where necessary. These pipes are simply slipped into one another like stovepipes, with no special arrangements for keeping them tight. The gravel and clay in the interior soon block up any small openings, and absolute tightness is not required. The material distributes itself over a large area of ground. Thus for land reclamation the value of this type of dredge is evident. The manner of working the dredge and disposing of the material must of course be determined by the local conditions, and while the hydraulic type of dredge has its limitations, its sphere of usefulness as exemplified in the King Edward is considerably widened.

DAMS AND UNEQUAL LOADING.

By John S. Fielding, C. & M. E., Sydney, N. S.

The many instances of dams giving way, which are recorded by the public press and engineering journals, lead one to think that the breaking of a dam is quite excusable from all points of view, and is impossible of prevention. Only a short while elapses between the account of a failure at one place and its successor at another. Now, what is wrong with designers and builders of this class of engineering work? Are they not away behind their brethren of other branches of the profession? Are they any further on than their forefathers were? Are modern dams any surer of staying where they are placed than dams of one hundred years ago? I think not. Anyone who cares to investigate the history of dam construction will find the record of an enormous amount of hard work, of patient investigation of minute hypothesis, profound mathematics, and all ending in what? Why, in being as far from the object sought as they ever were!

The old designers of Spain built dams which have stood all tests, but our modern engineers have claimed they wasted material and money by making them too secure. Now, it is quite possible that the ancient kings and emperors could better afford to build a dam, and repair it again and again, and eventually rebuild it than can the shareholders in a modern industrial enterprise.

I know of an instance of a number of business enterprises being crippled and their owners ruined by the failure of a dam, and upon visiting the site, I was informed by one of the sufferers that one particular man was responsible for the disaster, and continuing, he explained that this man had put up a splash board which raised the level of the water about one foot, and by so doing had increased the pressure to such an extent that it had carried the dam away. The original height of the dam was 20 feet, but this man had increased it to 21 feet. The original average pressure was 625 lbs. per foot in the dam, the increased pressure was 651, or an increase of 5%. Of course this is ridiculous, but it is very much in line with a great many of the discussions that appear in print after the failure of a dam. One prominent engineer will claim that the dam went out because a core wall was used, another because a core wall was not used, again it was the method of binding, or coursing, the mixture of the cement, the use of clay puddle or grouting, rolling the earth wet or rolling it dry, rolling vs. tamping, using pure clay or using a clay with an admixture of loam, the presence of springs under the dam or a crevice that was overlooked while the engineer in charge was away to lunch, the presence of a vacuum in the down stream side, back water, ice in the stream, logs or debris, a fault in the sub-strata, the wrong figure in the third place of decimals in a formula, etc. The whole matter is very surprising.

I think the history of these structures will show that too low a factor of safety is used. How is it that engineers do not admit this, and do not immediately change their practice? Is a factor of safety of 1¾ to 2½ sufficient for safety in such important structures? Is an engineer fair to himself, who, for the sake of a paltry commission for services rendered, will take chances on a dam of any design that shows such a low factor of safety? Custom seems to have got this branch of the engineering profession into a groove that they are unable or unwilling to extricate themselves from.

The water powers of Canada are a great heritage, and if a proper construction of dam be found and adopted, they can be utilized to great advantage. I am convinced that no reason exists why a dam should not be as stable as any other engineering work, with provision made for moving loads and unequal loads, and a factor of safety of four to six. It is absolutely essential that the existence of unequal and moving loads upon a dam be admitted. By unequal loads I mean either lack of uniformity in the pressure of the water or lack of uniformity in the strength of the structure. In the case of a stone dam, if the pressure of the water be uniform throughout the length of the dam, but the strength of the structure varies, there must then be unequal loading, for at one point the dam will have a strength equal to three times the pressure; at another point it will be as one to three and a half; at another point one to two. Possibly at some point where a splendid bottom exists and excellent work has been done in the wall, the ratio may be as 1 to 4, 5 or 6. Possibly at some other point where a poor bottom exists, and inferior work has been done in the wall, the ratio may be as 1 to 1½. Present construction does not enable one part with a ratio of 1 to 6, to assist another part that has only a ratio of 1 to 1½, consequently there is no provision for unequal loading. It is quite possible that changes may occur in the relative strength of different portions of the wall, and various causes could be assigned as liable to bring this about, admitting this and we have unequal loads varying in intensity, and location, or moving loads, that is, unequal and moving loads. The only form that will sustain this economically is the truss form. We are thus brought to use a dam formed on plan like a Pratt truss or Warren girder. If such a dam could be built that would be homogeneous, and would be able to take up tensile strength, be secure from injury from temperature stresses, and would not be too expensive, we would be securing that which we are in search of. Now, concrete would be homogeneous, and concrete reinforced with iron would take up tensile stresses. In Engineering News of October, 1890, I have gone very fully into this matter, and have shown that a factor of safety of 5.4 can be obtained in this way at a slight increase in cost.

With such a safety factor, a dam would require to have exceedingly grave faults in workmanship to bring it to the danger point. With such a safety factor the designing engineer could possess his soul in peace and rest assured that he will not be called upon to give evidence at the inquest over the remains of the dam or of any of the inhabitants of the valley below the site of the dam. With a safety factor of 5.4, any capitalist would loan money or take stock in the enterprise with the conviction that his money was safe. With greater security money could be obtained at a much lower rate of interest, so that the total interest charge would not be increased even with 15% increase in the amount of the original investment.

I am firmly convinced that these facts cannot be successfully disputed, and that any design of dam that does not provide for unequal loads will not be a proper structure.

Sydney, N.S., January 26th, 1903.

An agitation is going on for a subway where the Storrington road crosses the Grand Trunk at the Kingston station, the crossing being a dangerous one.

—Perhaps the most remarkable bridges in the world are the kettle bridges in Russia and Siberia, of which Cossack soldiers are expert builders. They are built up of the soldiers' lances and cooking kettles. Seven or eight lances are placed under the handles of a number of kettles and fastened by means of ropes to form a raft. Each of these rafts will bear the weight of half a ton.

Industrial Notes.

It is stated that no satisfactory method of soldering aluminum has yet been discovered.

The management of the Guelph Tube Works have decided to go into the manufacture of galvanized iron.

The steamer Louisburg has loaded a cargo of steel billets at Louisburg for New Haven, Conn. They came from the Sydney works.

The Hamilton Steel and Iron Company has three shifts at work on the lining of its ovens at the smelting works, each working eight hours.

It is rumored that Beach, the Winchester stove manufacturer, may move his foundry to Brockville to obtain better shipping facilities.

A. Child & Son's hardware store, Gravenhurst, burned. Moir, Son & Co.'s large bread, biscuit and confectionery factory, at Halifax, burned.

The Hamilton Motor Works, Hamilton, are so busy with orders that they are installing a lot more machinery and a much larger power plant, and are taking on more hands.

F. H. Clergue states that the first of the blast furnaces in connection with the steel rail mills, at Sault Ste. Marie, will be in operation by the middle of April, and the second early in May.

From data prepared by the Ontario factory inspectors, 384 accidents were reported during the year, of which 20 were fatal. In the previous year there were only 325 accidents and eight fatalities.

Lessees of water power on the Hull side of the Chaudiere are protesting that lessees on the Ontario side are diverting hydraulic power to the detriment of their interests. The matter will be referred to the courts.

The Hiram L. Piper Co., Limited, 12 St. Peter street, Montreal, have issued a splendid calendar for 1903, the centre-piece being a reproduction of "Advance Guard," from the famous painting by George Ford Morrisson.

The Canadian General Electric Co., Toronto, and the Waterous Engine Works Co., Brantford, have contributed $500 and $400 respectively towards the cost of equipping the new engineering laboratory of Queen's University.

The big sawmill, at Sidney, Vancouver Island, is to be reopened by a Seattle company. It was built about nine years ago, by The Toronto and British Columbia Lumber Company, and has been closed for about seven years.

Spence & Dean's basket factory, at Waterdown, was wrecked by the boiler exploding. It is supposed that the steam gauge went wrong and the engineer was unable to tell what pressure of steam was up, or that the water got low. The boiler parted, the pieces going out at each end of the building.

The Canada Foundry Co. has made arrangements with the Canadian Shipbuilding Company, whose works are to be on the Niagara River, at Fort Erie, to manufacture the marine engines, boilers, and other machinery required by the company. They hold the Canadian patents of the Curtis steam turbine for both land and marine use.

The Recovery of Tin Scrap was the subject of a very clear and interesting paper read by J. M. Neil, before the Canadian section of the Society of Chemical Industry at Toronto University, on February 26. The writer described the process discovered by himself and Mr. Brown of the Ontario Nickel Co., whereby the tin is separated from the iron, and samples of the tin and pig iron were exhibited. Works for the purpose were in operation in Toronto for a short time, but they were removed to the United States, as sufficient tin scrap could not be procured, and old tin cans and refuse of that character cannot economically be used. We hope to give the paper in full in a future issue.

The Ontario Wind, Engine & Pump Co. have received a repeat order for another 16-ft. airmotor outfit for South Africa for installation on a railway contract at Simon's Bay.

One of the open hearth furnaces at the Collingwood steel works is nearing completion. One of the heating furnaces in the bar mill is finished. The works have been kept back for want of fire-clay and brick.

The Amherst Foundry Co. is being formed, at Amherst, N.S., to acquire from the Robb Engineering Company the right to manufacture and sell the well-known Robb Hot Water Heater. J. Avard Black will be manager.

The Vermillion River Boom Company is applying for a charter permitting them to make improvmeents on the Vermillion and Spanish Rivers. They wish to build slides, dams and piers in connection with lumbering operations.

Active steps are being taken in Montreal towards establishing a technical institute. A delegation consisting of Dr. Baby, of McGill University; Col. Burland, Robt. Munro, William McMaster and E. H. Cooper, have gone to New York and Philadelphia to study the technical schools in those cities.

James L. Newton, Watertown, N.Y., has closed a deal with the Quebec Government by which he becomes owner of two water powers on Pentecost River, Lower St. Lawrence, and adjoining land for $13,500. These water powers are 70 and 54 feet high and are considered very valuable, as they are situated in a great lumbering district. Mr. Newton will manufacture pulp and timber and will commence operations as soon as navigation opens.

To meet the demand for a varnish which will give a smooth, hard finish, and enhance the beauty of the surface upon which it is applied, and for general purposes, the Canada Paint Company have introduced the universal Sun varnish. It is said to have been made from selected, clear bright gum, and every tank is thoroughly matured and tested before being put into tins. The name Sun, which is registered, is a happy hit for this varnish, which gives brightness wherever used.

The following enquiries, relating to Canadian trade have been received, among others, at the Canadian Government Office in London. The addresses of the firms may be learned on application to the Canadian Engineer: A London firm having accommodation in a central position is willing to let space for the purpose of showing the goods of any Canadian engineering firm which may require such facilities. Enquiry is made respecting an opening in Canada for business in structural iron and steel work, columns, stanchions, staircases, floors, girders, bridges, tanks, etc.

The following fires have occurred among industrial works: Flour mill of Thamesville, Ont., Milling Company, burned.——Foundry of St. Paul's Industrial School, near Winnipeg, burned.——Washing plant of the Dominion Iron and Steel Co., at the coke ovens, Sydney, C.B., burned, with three adjoining buildings. The main building contained valuable machinery, and the motive power for running the same, consisting of thirteen motors and two engines, all of which were destroyed. Loss from $100,000 to $200,000. Insured. Will rebuild immediately.——A. Child & Son's hardware store, Gravenhurst, burned.——Moir & Co.'s large bread, biscuit and confectionery factory, at Halifax, burned.

The King Construction Co., of Toronto and Lockport, N.Y., have closed the contract for iron framed greenhouses for the Dale Estate, of Brampton, Ont., aggregating over one and a quarter miles in length. The contract includes automatically-operated lines of ventilating apparatus aggregating two and one-half miles in length, 12 water tube steam heating boilers, economizers, automatic stokers, coal conveying machinery and ventilated storage for soft coal slack. Upon the completion of this contract, the greenhouses comprised in the establishment of the Dale Estate will have a total length of over seven miles, and the plant will without doubt be the largest in the world, devoted exclusively to the growing of cut flowers. Robt. W. King & Co., of 32 Church street, Toronto, are the consulting engineers and designers for the Dale Estate.

The Henderson Roller-Bearing Mfg. Co. is fitting up a factory in Toronto.

The Vulcan Iron Co., Winnipeg, are about to erect a new moulding shop.

The new barrel factory of the Lake of the Woods Milling Company, at Keewatin, is now in operation.

The Stuart-Arbuthnot Machinery Co., Winnipeg, is changing its name to the Stuart Machinery Co.

Two sash and door factories are being put up at Fort William, Ont., Thomas Kennedy's and H. H. Dale's.

The Pearce Co., at Marmora, is putting in a new water wheel and other improvements at their sawmill.

The Toronto Steel Co., which asked for a site at Ashbridge's Bay, has withdrawn from further negotiations.

The name of the Dominion Oil Filter and Metal Company has been changed to the Guelph Foundry Company.

A 5 per cent. increase in the price of foundry products has been determined upon by the Maritime Foundry Association.

The Dominion Iron and Steel Company produced 16,000 tons of steel and 14,000 tons of pig iron during the month of January.

Goldie & McCulloch, the machinery firm of Galt, Ont., have secured twenty-six acres adjoining the town and will erect large new works.

It is announced that the various works at the Sault will be pushed to completion, and that open hearth furnaces will probably be built.

A meeting of Sydney, N.S., ratepayers has voted in favor of exempting the Dominion Chemical Co.'s proposed tar distilling plant from taxation.

The Baldwin Locomotive Works, Philadelphia, are turning out six locomotives a day. The plant is being run day and night, and 13,000 men are employed.

The engine and boilers of the sawmill formerly operated by James McCuan, at Waba Creek, near Arnprior, will be removed to Gillies Bros.' mill, at Folger.

The Ellis smoke consumer has been recently introduced in a number of soft coal furnaces in Toronto, and is said to work well. R. J. Wylie represents the patentee.

The International Gold and Copper Co., the Centrifugal Windmill and Manufacturing Co., and the People's Gas Supply Co. have been licensed to do business in Ontario.

The McLaren-Ross sawmills, the largest on the Fraser river, B.C., which have been idle for twelve years, are to be restarted by a syndicate from the State of Washington.

The following industrial works at Berlin, Ont., will extend their works this year: Lang Tanning Co., Berlin Rubber Co., Star Whitewear Co., W. G. & R. shirt, collar, and cuff factory.

J. T. Wing & Co., of Windsor, Ont., are meeting with much success in their graphite metal. They recently received an order from Rhodes, Curry & Co., of Amherst, N.S., for a ton.

Alex. Dobson, of Beaverton, has shipped a peat machine to Mexico, also a carload of compressed peat to Boston for trial, the result of which, if satisfactory, may lead to several very large contracts for peat-pressing machinery.

The Montreal Rolling Mills Co. has determined to enlarge its plant. E. S. Clouston, Wm. McMaster, Hon. G. A. Drummond, H. Montagu Allan, James Ross, J. S. Maclennan, Hon. Robert Mackay, and J. M. L. Waldie are the directors of the company, with Mr. Waldie, secretary.

The contract has been let for a 5,000,000 bushel annex to the King elevator at Port Arthur to be of steel and concrete, resting on a pile foundation. The Canadian Northern will this season put up a 3,000,000 bushel elevator at that place, and will build extensive coal docks, to do away with the inconvenience of handling coal at the temporary docks, some miles up the Kaministiqua river.

The McLennan Paint Co., of Buffalo, will establish a branch at Hamilton, amalgamating with the Hollywood Paint Co. A large building will be erected.

The John Gillies Estate Co. have disposed of their engine and machine shop, at Carleton Place, to a joint stock company, principally Ottawa and Montreal men. The capacity will be doubled, and the manufacture of gasoline engines and launches pushed.

Over a year ago, Governor McClellan offered the Regents of Mount Allison University $5,000 towards a school of applied science, on condition that the friends of the university raised a like sum. Of this $3,000 has now been promised, leaving $2,000 yet to be secured.

The Niagara Falls Power Company has contracted for three million feet of redwood timber, to be used instead of steel for their great tunnel. The reason for using California wood is that when water passes over it continuously there forms a surface of a soapy nature, which is proof against corrosion, whereas in the case of steel, particles of sand, carried with great velocity from the Niagara river, cuts into and destroys the steel in an incredibly short time.

ONTARIO LAND SURVEYORS.

The eleventh annual meeting of the Association of Ontario Land Surveyors was held at Toronto, February 24th, 25th, and 26th. The following members were in attendance: Peter S. Gibson, Willowdale; James Dickson, Fenelon Falls; E. G. Barrow, J. W. Tyrrell, Hamilton; C. A. Jones, Petrolea; E. T. Wilkie, Carleton Place; Thomas Fawcett, Niagara Falls; H. J. Bowman, Berlin; H. Dixon, Eglinton; J. H. Shaw, North Bay; L. B. Stewart, Killaly Gamble, A. J. Van Nostrand, E. B. Kirkpatrick, Cyrus Janes, T. B. Speight, H. S. Holcroft, Henry De Q. Sewell, W. McLean, I. F. Watson, R. P. Fairbairn, W. A. Browne, J. F. Whitson, and V. Sankey, Toronto.

The secretary-treasurer's report showed an active membership of 215, with the finances in a satisfactory condition.

H. De Q. Sewell read a paper on Laying Out Town Sites, in which he defined the principles to be considered as three in number; the degree of accuracy to be observed, the selection of a desirable plan, and the method of conducting the survey. The first principle was considered at length, Mr. Sewell concluding that the degree of accuracy should depend largely upon the amount paid for the survey. The plan selected should be marked by uniformity and simplicity. The paper called forth an animated discussion and considerable adverse criticism, most of those who took part asserting that accuracy should be observed, no matter what amount was paid for the work.

At the evening session, J. W. Tyrrell, of Hamilton, read a paper on Notes from an Explorer's Diary, recounting his experiences on his long trip through the barren lands of the Northwest in 1900. The paper was an exceedingly interesting one, and was illustrated by maps and photographs. A hearty vote of thanks was accorded Mr. Tyrrell.

J. F. Whitson contributed a series of extracts from the original diaries of David Thompson, astronomer royal, on the survey of the international boundary. They will be preserved, along with other papers, in transactions of the association.

The second day the report of the Polar Research Committee was presented by Willis Chipman, and highly commended Capt. Bernier for his persistence and energy in endeavoring to promote and finance a purely Canadian Polar expedition. It was thought that the Governments of the Dominion and of the various provinces ought to furnish him with aid sufficient to enable him to proceed with his enterprise. It was urged that the Dominion Government take immediate steps to determine the northern boundary of Canada. United States explorers had been active out there recently, and it was feared unless something was done at once that the United States would set up a claim to the lands to the north of us. They were reported to contain the most extensive deposits of coal on this continent, and were an extremely valuable possession.

An interesting paper was read by Arthur Harvey, on Terrestrial Magnetism. He dealt with the solar magnetic disturbances and their connection with variations of the compass, and exhibited diagrams and illustrations of the results obtained by him in observing these deflexions, which were due, he believed, to the movements of the magnetic pole, which pole, he thought, had much to do with changes in temperature. There was a greater declination of the needle in some quarters than in others, and he believed the cause of so many shipping disasters off the coast of Labrador and Newfoundland was owing to the greater variations of the compass there than elsewhere.

P. S. Gibson took up Public Works, and described the system of road-making adopted in the township of York, where the statute labor system has been done away with. Instead of working on the roads, a statute labor tax is imposed, and the work is done under foremen, with very satisfactory results.

A paper on the Survey of Water Lots was read by G. E. Ross, of Welland.

In the evening, the annual banquet was held at McConkey's, with T. B. Kirkpatrick, of the survey branch of the Crown Lands Department for Ontario, in the chair. There was a good attendance.

On the third day, the report of the committee on Engineering, of which E. G. Barrow is chairman, was presented by P. S. Gibson. It departed somewhat from the usual form and was devoted largely to setting out the importance and responsibility of the surveyor's profession. A number of instances were cited by several of the members in the discussion which followed the paper, in which distinguished engineers had commenced their careers as land surveyors.

A paper on Country Roads, by A. W. Campbell, was in the absence of the writer taken as read, as well as several other papers and reports, which will be printed in the proceedings.

The following were elected office-bearers for the ensuing year: President, W. R. Aylesworth; vice-president, C. A. Jones; secretary-treasurer, Killaly Gamble; auditors, Messrs. McLean and Whitson; scrutineers, R. B. Fairbairn and Henry Smith.

The following were proposed as councillors: A. J. Van Nostrand, James Robertson, Alex. Niven, Thomas Fawcett, J. D. Silvester, E. G. Wilkie, W. G. McGeorge, and H. D. Sewell. Voting for members of council will be by ballot papers.

A number of unfinished items of business were disposed of and gratuities voted to the secretary and others, after which the convention came to a close.

In the absence of the president, W. R. Aylesworth, who was unable to be present through illness, the vice-president, C. A. Jones, presided throughout the meetings.

Railway Matters.

A speed of 82 miles an hour, for fifteen miles, has been attained on the Midland Railway of England, with their new compound locomotives, with a 350-ton load.

The Canadian Railway Club, Montreal, organized last year, is enjoying a vigorous existence this winter. Papers have been read, and animated discussions held on Terminal Passenger Car Cleaning; Blacksmithing, by D. B. Swinton, master blacksmith of the C.P.R.; Piece Work, by Gus. Giroux, mechanical inspector, C.P.R., and a paper is ordered on Method and Appliances for Handling Snow on Railways. The question drawer is an interesting feature. Meetings are held monthly.

The Winnipeg street railway is to be extended on Portage avenue to the city limits.

Steps are being taken to set aside the recent sale of the Brockville and Westport Railway.

A railway is projected from Fort Churchill, on Hudson's Bay, to Port Simpson, by Lake Athabasca and Peace River Pass.

Railway building in the United States for last year aggregated 6,026 miles, a total which has not been exceeded since 1888.

The C.P.R. has awarded the contract for double tracking its line between Fort William and Rat Portage to Foley Bros. & Co.

A railway is projected which will connect Cranbrook, B.C., with Spokane, Washington. The C.P.R. will build that part which is in Canadian territory.

An electric interurban railway, forty miles in length, is to be built from Rochester, through Canadaigua, to Geneva, N.Y., to be known as the Rochester & Eastern Rapid Railway. The Westinghouse Electric & Mfg. Co., of Pittsburg, will furnish the electrical plant.

Premier Haultain, of the Northwest Territories, advocates a railway to Hudson's Bay, which, he declares, will do more to solve the transportation policy than any number of transcontinental lines. Ex-Premier Greenway, of Manitoba, has recently inaugurated an agitation in his own province of a similar character.

Among the applications to Parliament for railway charters is one for a line from Golden, on the C.P.R., northwesterly along the Columbia and Canoe rivers to Tete Jaune Cache, thence along the Fraser, Nichalo and Skeena to Port Simpson, with a branch to Barkerville. The road is to be called the Kootenay, Cariboo and Pacific Railway.

It is said that the C.P.R. may shorten their transcontinental line by making a short cut between Ottawa and Pembroke, thereby saving about forty-one miles in distance. The route would be across the Ottawa river by the Interprovincial Bridge, thence over the Pontiac and Pacific Junction Railway to Waltham, crossing the Ottawa again at Pembroke. This, with the use of the short line between Ottawa and Montreal, would save about three hours in time, and obviate the necessity of a line through Ottawa to reach the central station.

Municipal Works, Etc.

Toronto Junction residents are discussing a local telephone system.

Winnipeg is asking for tenders for from 300 to 600 tons of asphalt for street paving.

Dalhousie, N.B., is taking steps to provide water and electric light systems for the town.

A deputation from Alberta has been in Ottawa to urge on the Government better roads for the settlers.

The Carleton County Council has decided to submit a by-law for the expenditure of $270,000 on good roads.

A new bridge will probably be built at Gannon's Narrows, from Ennismore to Harvey, Peterboro County.

The Road Committee of the Montreal City Council wants half a million dollars for street improvements this year.

A move towards improving the character of the roads is being made in the province of Quebec, and it is probable the Ontario act will be copied.

A West End sewer overflow is to be constructed at once at Hamilton, over the property of the T. H. & B. Railway.

The Eastern Ontario Good Roads' Association will hold a convention at Ottawa, March 12th and 13th.

A claim is being made for $100 for the cutting down of a tree in Hamilton by order of the city engineer.

Berlin, Ont., ratepayers have voted to take over the gas and electric light plants. The transfer will be made March 1st.

Steps are being taken to have obstructions in the form of boulders and sand bars removed from the Teeswater Ont., river, as they cause flooding of low lands. The cost will be about $10,000.

The people of Plattsville and neighborhood recently purchased by subscription a road machine for the purpose of clearing ice and removing snow from the streets. Other places might do likewise with advantage.

Maclean Bros. have finished their contract for dyking at Chilliwack, B.C., which has taken about three years. The dykes extend about 15 miles and have reclaimed a large quantity of land. The cost was about $160,000.

Winnipeg proposes to establish municipal gas works. It is figured that gas could be sold by the city at $1.25 per 1,000 feet for fuel and $1.50 for illuminating. A committee has also been appointed to consider a municipal telephone system.

The new hydraulic engines shortly to be installed at Springbank, will pump 4,000,000 gallons daily, or double the amount available with the old ones. There is also a smaller pump, constructed solely for the lower Colville springs, which will pump 400,000 gallons a day.

The Hamilton Bridge Co. has been awarded the contract for a new iron bridge across the Speed at Pipe's mill, near Guelph, for $1,500. A tender from Sarnia was only $9 higher. Some of the committee wanted stone, of which there is a good supply at hand, but iron was finally determined on.

The cement sidewalk work done in Hamilton last year has just been figured out by the assessors and amounts to 197,717 feet frontage, which with crossings, cost $165,471. A contract for this year's cement has been again made with the Cayuga Lake Portland Cement Co. at 56 cents a barrel above last year's rate, that is $2.16 a barrel.

A company in Maine asks authority to construct a dam by which the waters of the Allagash river would be diverted into the Penobscot. The natural flow of the Allagash is into the river St. John, and lumbermen on the latter say serious damage would be caused by lowering the water. The Canadian Government is asked to protest at Washington, and has promised to forward a statement of the facts to the United States Government through the British Ambassador.

C. H. Rust, city engineer, Toronto, reports that the cost of a civic asphalt plant with a daily capacity of 1,500 to 2,000 square yards would be $25,000, and the cost of maintenance $1,000 or $1,290 a month during the working season. The staff required would be a superintendent, chemist, yard foreman, clerk, engineer and fireman, a man to look after the kettles and conveyors, and the necessary laborers.

The British Fire Prevention Committee, which has done good work in the sphere which it has laid down for itself, has issued a preliminary notice, calling an International Fire Prevention Congress to meet in London, England, July 7th—10th, 1903, at the time of the International Fire Exhibition. The congress will be divided into sections, taking up the following points: Building construction and equipment; electrical safeguards and protection from lightning; legislation and administration; fire survey and fire brigade patrols; insurance and fire losses; standards and tests for materials. H.R.H., the Duke of Cambridge, is president, and the Lord Mayor of London one of the vice-presidents. E. O. Sachs is chairman of the executive, and Ellis Marsland the general secretary.

The question has been raised before the customs authorities whether California asphalt, known as Alcatraz, which has been displacing Trinidad asphalt to some extent for paving purposes, is not really a product of petroleum, and therefore subject to duty. Newton J. Ker, city engineer of Ottawa, when asked to give an opinion said he considered it to be an asphalt and not petroleum. The question is of considerable importance in engineering works.

Prof. Amyot, provincial bacteriologist for Ontario gives some valuable information respecting the septic tank system of sewerage disposal, as tested at Berlin, Ont., which was selected on account of its great variety of industries, sending out all kinds of sewage matter. The experiments show that the capacity is limited and either precipitation or bacteriological treatment fails to render the affluent at all pure, though a very large percentage of the impurities is removed.

The Provincial Board of Health has approved of plans submitted by Listowel for a septic tank system, the effluent of which is to flow to filter beds half an acre in extent. The approval is conditional upon the purification of the sewage being effective in bringing it to a certain chemical standard. If the existing plant fails to do this extra filtering beds are to be provided. The board advises that as the soil of the Berlin sewage firm is of clay a neighboring property, which is higher and composed of sandy soil, should be purchased which will provide an efficient intermittent system of filtration to supply the required standard of purification, that at present not being satisfactory.

Marine News.

Dry docks are to be built at Montreal and New Westminster.

The steamships Algonquin and Rosedale are being repaired at Owen Sound.

A faster and larger boat will, it is said, be put on the Toronto-Hamilton route by the Hamilton Steamboat Co.

Montreal Harbor Commissioners have decided to equip the harbor with a 50-ton floating crane at a cost of nearly $50,000.

The old railway wharf, at Gananoque, is being replaced by one of stone and cement from the water line. It will be one of the most substantial on the St. Lawrence.

The Government steamer Scout is being lengthened at Davis' dry dock, Kingston. She has been stood on her stern in order to put an addition to her bow, a unique way of lengthening a vessel.

The contract for the lengthening of locks Nos. 1 and 2 of the Lachine Canal has been awarded to Coulson, Quinlan & Robertson, of Montreal. The new locks are to be 270 feet in length, with a width of 45 feet and a depth of 14 feet of water on the sills.

The steamer Lady Laurier, the latest addition to the Canadian Government's fleet, arrived recently from Glasgow. She is a fine-looking craft of 1,000 tons, has a speed of 14 knots, and has a cable grappling gear sufficient for working in an ocean depth of 2¼ miles. Her interior fittings are in polished oak and plush. One of the cabins is marked "Minister," being the accommodation reserved for the Minister of Marine.

The Inland Lakes Transportation Co. has bought three boats in England and will bring them out for the season's business. They were built for the Black Sea trade, are each 212 feet long, 44 feet beam and 27 feet in depth, and will carry 140,000 bushels of wheat on an 18-foot draught. It is said that the three boats can be delivered in Toronto for $450,000, which is very much less than they could be built for on this side. They will carry grain between Port Arthur and Collingwood.

The stone work on the Collingwood dry dock has been begun.

The Government cruiser Kestrel has been launched at Vancouver. She is 145 feet in length, 24 feet beam, and will carry a crew of 20. Her engines were built at the Polson works, Toronto. She will be used for fisheries' protection.

The Hamilton Motor Works, Hamilton, have a number of contracts on hand for marine gasoline engines. They have several for multiple cylinder engines, among others, for a 12-h.p. four cylinder engine for a boat being built for a Hamilton gentleman.

The first of a number of freighters for the Great Lakes and St. Lawrence Transportation Co., to be built at Buffalo, was launched on January 31st. She is named James S. Keefe, has a capacity of 2,400 tons, and cost about$150,000. A second, the Robert Wallace, is being built. The vessels are to be equipped with the latest improvements. The machinery is to be built in Detroit. The line is a Canadian one, and is known as the Wolvin syndicate.

The Canadian Lake and Ocean Navigation Co. is building three new steamers in England for the package freight and grain business between Port Arthur and Montreal. The steamers will be modern and up-to-date in every respect. The four turret steamers now on the lakes are being put in good shape for next season's work. Side hatches are being placed on the side of the hull for quick despatch discharging. The officers' and crews' quarters are being remodelled to suit lake requirements, and the ships are being repaired and made suitable for lake work.

The SS. Canada, of the Dominion Line, which was chartered as a troopship during the South African war, has returned to her place on the line to which she belongs. She made fourteen round trips to Africa without mishap to ship or machinery, and made the record voyage, performing the round trip from Southampton to the Cape and back in thirty-eight days. She is a combined passenger and cargo vessel, and has accommodation for 250 first-class, 250 second-class, and 900 third-class passengers. She has been thoroughly refitted in the most modern style.

The SS. Stanley, which is employed on the Prince Edward Island winter ferry service, has been imprisoned in the ice and drifting up and down Northumberland Strait since January 14th. The Minto, which went to her relief a couple of weeks later, was in a like predicament for twelve days, when she succeeded in reaching the Stanley, and put forty tons of coal on board, which will be kept for raising steam when her crew see an opportunity to release her. There will doubtless be a renewal of the agitation for a tunnel. The SS. Bruce was six days making the passage from Port Aux Basque, Nfld., to Louisburg, where she had to go instead of North Sydney, her usual port.

The following new steamers are under construction: Two tugs for Lake Temiskaming, side wheelers, 150 feet long, 26 feet beam, compound engines, by Bertram Co., Toronto; boat to take the place of the Henry Bate, between Montreal and Ottawa, 100 feet long, 25 feet beam, to cost $20,000, at Canal basin, Montreal; passenger steamer for Rainy river, side wheel, 200 feet long, draft, 3½ feet. to carry 250 passengers, speed, 20 miles an hour, to cost $150,000; steamer for Owen Sound and Manitoulin Island route, for United States and Dominion Transit Co.; Westmount and Fairmount, building in England for Montreal Transportation Co., 248 feet long, 42 feet beam, 23 feet deep, triple expansion engines, Scotch boilers, capacity, 100,000 bushels, to cost $100,000 each; two tugs for Upper Ottawa Improvement Co., at Long Sault; two steel steamers at Collingwood, one 257 feet long, the other smaller; steamer from England to replace the Admiral on the Baie des Chaleurs route between Campbellton and Gaspe; new steamer for the Allan line. The Knapp tubular boat is to be lengthened 250 feet.

ENGINEERS' CLUB OF TORONTO.

The Engineers' Club of Toronto listened, at its meeting on February 3rd, to the inaugural address of its new president, C. H. Rust. He referred to some of the advances made by engineering in the present day.

At the meeting on February 19th, Strachan Johnston, barrister, read a paper on the Authority and Duties of an Engineer, from a Legal Standpoint. The paper created great interest, and caused quite an animated discussion. We hope to give it in a subsequent issue.

Light, Heat and Power

Nelson, B.C., has installed an electric plant, driven by water power, at a cost of $150,000.

The C.P.R. is about to substitute electrical for acetylene gas lighting at all their important stations in the mountains.

The Canadian General Electric Co. will spend about half a million dollars at Peterboro in new buildings and other improvements to its works.

The directors of the Lake Electric and Power Co. at Waterloo, Que., have decided to change from the flat rate to the metre system .

The Nova Scotia Steel & Coal Co. is having plans prepared for an electric plant to supply the light to the town of Sydney Mines, and to light their own shipping piers.

The British Columbia Electric Railway Co. purposes to substitute a water power plant for steam power, from which a large incease of revenue from the sale of power is expected.

The Queen's Hotel, Toronto, has arranged with the Bell Telephone Co. to place a telephone in every room with local and long distance connection, 220 in all.

Toronto Junction council has determined unanimously to cancel its contract with the Humber Power Co. and to take possesion of all poles and wires on streets on account of the failure to supply current for street lighting.

Mr. Harvey, who has been running the Magog electric light for some time, has removed to Montreal. L. Pratte, who has been in the employ of the D. C. M. Co. for seven years, has taken charge.

R. D. Foster, a young man in the Testing Department of the Canadian General Electric Co. at Peterboro, took hold of two live wires, one in each hand, and received a shock of 1,200 volts. His hands were horribly burned, and it is likely that he will lose both index fingers.

The Metaphone Co., 16 Yonge Street Arcade, Toronto, have installed during the past week, for the following: The Dunlop Tire Co., Rossin House, Grace Hospital, the T. Eaton Co., Eby, Blain Co., General Postoffice, John Taylor Soap Works, Garside & White, James Robertson Co., D. W. Thompson & Co., Toronto. They are prepared to establish sole agencies throughout Ontario, and applications for such agencies should be made to the above address. Their advertisement appears in our advertising pages.

Experiments are in progress in wireless telegraphy between Toronto and Hamilton, the De Forest system, which is claimed to be simpler than that of Marconi, being employed. The Morse alphabet is adopted, as in ordinary telegraphy, instruments being used for conveying the message from the sender by a series of five heavily-insulated wires to the top of the tall mast, 175 feet high, outside the building, in which the operator works. The current first used, over 30,000 volts, was found to be too strong, and burned out the fuse, and the wires, which were 10 feet apart, had to be increased to 20 feet. The Morse alphabet has been audibly ticked off, however. The Toronto end is being looked after by H. M. Horton, an electrical expert from New York, and H. E. Athern, another well-known elctrician from the same city, is working from the Hamilton station.

Prince Albert, Sask., is advertising for tenders for the construction of an electric light plant.

A new copper long distance telephone wire was strung by a gang of men from Cornwall to Brockville in exactly one week.

Kemptville is to be lighted, and the Milling Company's mill driven by electricity generated at the flats on the Rideau near Merrickville.

The Canada Corundum Co. will erect electric works at Bell's rapids dam, foot of Bark Lake, with a wire to the mines at the mouth of York River, where the new mining works will be operated by electricity.

The suit of the city of Toronto against the Gas Co., which has been hanging fire so long, is being pushed to a conclusion. The evidence is all in, the argument heard and judgment was reserved.

Three new independent telephone lines are being organized, to connect Pickering village with other villages in the township, to run from Mount Forest to a number of places in the neighborhood and to build from Dundalk to Hopeville and in other directions.

The first daily paper with telegraphic news on shipboard, was published on the Cunard steamer Etruria on her last voyage between Liverpool and New York, with Marconi on board. The first mid-ocean newspaper contained items of news, in all one hundred and sixteen words.

Sir Sandford Fleming points out that so far not a single press message has been sent over the new Pacific cable, not even between England and Australia, and suggests that the Government open the cable free to press messages for, say 500 words daily, for a period of three months, in order to build up a constituency.

Power from the Shawinigan Falls was turned on at Montreal for the first time on February 6. The transmission line is 84 miles long,, carried on cedar poles 25 feet high, 100 feet apart. The electricity is carried on three aluminum cables, held five feet away from each other by cross-arms, and each consisting of seven wires, No. 6 gauge. Each cable is half an inch thick, and weighs almost three ounces per foot. The line is working satisfactorily.

Peter Cooper Hewitt, of New York, is said to have made an important discovery in wireless telegraphy. The device, which is a development of the Cooper Hewitt Mercury Vapor Lamp, takes the place of the usual spark gap for discharging in the antena or sending mast. It consists of a glass globe eight to ten inches in diameter, with two mercury electrodes contained in tubes sealed in the lower part of the globe. The device is very effective, and will enable a much more powerful electrical wave to be set up than is possible with the methods at present in use, and will also make secrecy in transmission easily possible.

The power house switch-board, recently constructed by the Lachine Rapids Hydraulic & Land Company, is spoken of as the best in Canada. It is absolutely fire-proof, is four stories high, and is so arranged that the operator only handles 110 volts, so that there is an absolute impossibility for anyone to get killed in operating the board. The operator stands or sits on the fourth story in front of a small table, on which a miniature switch-board, so to speak, is constructed, and by means of these switches and motors, he is able to regulate the whole power house, starting, stopping and regulating, not only the various circuits, and dividing up the power between the various generators, but he can start and stop any or all of the wheels and can divide or change the load from one wheel to the other, without assistance The bus bars of the 12 generators can be all connected together or divided in accordance with the power or load requirements. The circuit breakers and overload relay switches are in fire-proof compartments, as are also the cable heads. The current is led from this switch-board to the tower of the building in vitrified tile and concrete ducts, carried in steel tubes, whtch makes it impossible for this power house to be burned down by electric fire.

Athens, Ont., is considering a proposition made by a Toronto company represented by A. E. Donovan, to light the village with acetylene gas.

Prof. W. J. Loudon, of Toronto University, has invented a new photometer for measuring the illuminating power of gas or electric light. It can be used for commercial purposes and can be made of any degree of sensitiveness. Its advantages consist chiefly in the comparative freedom from color, the absence of the error due to the use of both eyes, and in a special reversing arrangement for overcoming the error of inequality of the two surfaces illuminated.

The Stromberg-Carlson Telephone Manufacturing Company, of Chicago, Illinois and Rochester, New York, recently gave a banquet to enable their men to meet each other, and to explain to the salesmen the use of a book of Standard Switchboard Specifications, which the company has recently prepared, and which has been pronounced by many prominent telephone men as one of the most complete treatises on telephone switchboards that they have ever seen. The gathering was the largest of telephone manufacturers' representatives ever held.

One of the most complete and up-to-date electric power plants recently installed in Japan is that at the Osaka Military Arsenal. This installation was made for the purpose of operating the electric cranes and blowers for the cupolas in the new foundry just completed. The design of the power house and foundry, together with the lay-out of all machines in the latter, came directly under the supervision of G. Kuwada, the mechanical engineer of the arsenal. The foundry is a model of completeness, and reflects great credit upon Mr. Kuwada, who is one of the most clever engineers in Japan. All of the electrical apparatus, as well as the cranes, blowers and two cupolas were supplied by the Westinghouse Electric & Mfg. Co.

A rival company to those at Niagara Falls proposes to generate power 5½ miles back of Jordan, where a fall can be obtained almost 100 feet higher than Niagara, with water drawn from the Welland River. The flow of the Welland would have to be changed so that the waters of the Niagara would flow up to the point where the power canal begins. The capacity of the Welland is such that 100,000-h.p. could be developed at the bluff. The company offers to deliver to the city of Toronto 30,000-h.p. at $20 per horsepower, or 20,000-h.p. at $22.50, or 10,000-h.p. at $25, should the city not desire to take more than that, the power to be available for the whole 24 hours. The company desires simply to generate electricity, and would prefer that the city itself should build the pole line. In that case they will supply 30,000-h.p. at $10 at Jordan, 20,000-h.p. at $12.50, or 10,000-h.p. at $15. The transmission line from Jordan would cost considerably less than from Niagara, and experts believe that it can be built for less than $1,000,000. The company is known as the Hamilton & Lake Erie Power Company, and Pierson Judson, of Oswego, is chief engineer.

The Ohio Brass Company has decided to substitute alternating-current power distribution for the direct-current system at present in use in its shops at Mansfield, Ohio, on account of the superior economy of the former. A recent purchase from the Westinghouse Electric and Mfg. Co. comprises a 180-kilowatt, 7,200-alternation, two-phase alternator, a direct-current exciter, switchboard equipment and the following induction motors: Two of 40-h.p., four of 30-h.p., one of 20-h.p., one of 15-h.p., and one of 2-h.p. This apparatus is to provide increased capacity and to replace the following direct-current machinery: One 75-kilowatt, 125-volt generator, one 35-kilowatt generator, three 40-h.p. motors, two 25-h.p. motors, and two 5-h.p. motors, also a three-panel, direct-current switchboard. This action has been taken after a careful and thorough examination into the relative merits of direct current and alternating current motors for power distribution in this company's factory. The alternating-current motors have been chosen on account of their low cost of maintenance and freedom from breakdown.

It is the Warren Electric and Specialty Co., of Warren, Ohio, not the Incandescent Lamp Trust of the United States, which has bought the factory building, at St. Catharines, for an electric lamp factory.

The late Spanish-American war seems to have impressed upon the engineers of the Spanish Government the need of adopting the most modern methods in the manufacture of munitions of war. They are installing Westinghouse motors in their gun shops at Trubia, and the Spanish arsenal at Ferrol is also shortly to be equipped with a number of motors and other electrical machinery.

The lighting contract of the Farmers' National Bank Building, which is to be the largest structure in Pittsburg, and one of the tallest office buildings in the world, was the most hotly contested of any, and the outcome is that the entire building is to be lighted with Nernst lamps, which was decided on because of the beautiful quality and steadiness of the light, the absence of shadow and the high efficiency. There are to be installed in all nearly 3,000 lamps.

NEW CATALOGUES.

Copies of these catalogues and booklets will be sent to persons interested by mentioning the Canadian Engineer:

Robb Engineering Co., Amherst, N.S. Robb-Armstrong Engines.

Jenkins Bos., New York, Boston, Philadelphia, Chicago, London, E.C., valves, packing discs, steam traps, pipe hangers, etc.

John F. Allen 370-372 Gerard Ave., New York, riveting machines,

The Fairbanks Co., New York, Cement Testing.

The Underfeed Stoker Co., 302 St. James Street, Montreal, and National Trust Building, Toronto, More about the "Jones."

The Jeffrey Mfg. Co., Columbus, Ohio, Barney Brick Conveyor system.

S. R. Earle, Toronto, Steam and Air Injector.

Henry Pils & Co., 66-68 Broad St., New York. About Punching and Shearing Structural Shapes.

H. W. Johns-Manville Co., 100 William St., New York. Keystone Hair Insulator.

Fisk & Robinson, 35 Cedar St., New York. Concerning Iron Making.

The Garvin Machine Co., New York, Plain Milling Machines.

Buffalo Forge Co., Buffalo, N.Y. A comprehensive Engine Test.

The Metaphone Co., 42 King St. W.,Toronto. The Metaphone,

Westinghouse Co., Pittsburg Pa., The Steam Turbine, Its Commercial Aspect.

Twenty-fourth Catalogue of the American Society of Mechanical Engineers, Prof. F. R. Hutton, Secy., 12 West 31st St., New York.

Joseph Dixon Crucible Co., Jersey City, N.Y, Souvenir of an Inspection Trip of Am. Society of Civil Engineers to the new terminal of the North German Lloyd Steamship Co.

Lachine Rapids Hydraulic & Land Co., Montreal. Annual Report.

A five days' gale in the British Islands the last week of February played havoc with the telegraph lines and disabled three cable companies. Up to that time the month had been the driest and warmest on record.

Hon. Charles Rolles, riding in an 80 horse-power Mors automobile is said to have made a speed of 82 4-5 miles an hour. It is uncertain whether this will rank as the world's record, as a slight gradient favored the machine. The start was a flying one.

Mining Matters.

Strikes are on among the coal miners at Fernie and Nanaimo, B.C.

Preparations are being made at the Canada Corundum Co.'s mines at Combermere for the building of a new mill next summer.

The International Asbestos Co., of New York, have leased a mill in Actinolite, and gone into mining and milling asbestos.

A new process for concentrating ores by the use of petroleum, known as the Elmore, has been successful in England, and is being introduced in the British Columbia copper mines.

An immense seam of coal is reported to have been struck on Thalton Creek, ten miles from Telegraph Creek, B.C. The coal is well defined for several miles, and is pronounced of the highest quality.

The Cordova Exploration Company propose doubling the output of their property, which is now thirty stamps, with a capacity of 75 tons per day, and utilizing the whole of the 1,000 horse power at their command. The ore is improving in quality on the lower levels of the mine.

Quartz mining is being carried on upon a large and increasing scale in the gold region tributary to Dawson. During 1902 more than 1,000 claims were staked and over 700 were worked. The Dominion Government is assisting in the development of quartz mining by crushing free of charge sample lots of ore in a prospecting mill erected near Dawson.

The electric railway between Berlin and Galt is open for traffic.

—The Hamilton, Grimsby and Beamsville Railway has arranged for 300 additional horse-power.

—The Canada Atlantic Railway is applying for power to build an extension from Whitney to Sault Ste. Marie, a distance of 290 miles.

—In the spring work will be commenced on the extension of the radial railway line from Burlington to Oakville. There is no intention to extend the line to Toronto.

—The Canada Fish Co. has agreed with the Ontario Government to build a railway from the Canadian Pacific, where it crosses the Nepigon river, to Lake Nepigon, a distance of about forty miles.

—An Italian engineer has invented a method of turning the light and heat of the sun into an alternating electric current, and believes that all will soon be able to manufacture their own power, light and heat. What tremendous possibilities are implied in this conception of Signor Pansa.

Thos. Tait, manager of transportation of the C.P.R., has been appointed chairman of the Board of Railway Commissioners of Victoria, Australia. The appointment is for four years at a salary of $18,000. The railways are state owned and are to be vested in a board of three members, of which Mr. Tait will be the head. He commenced his career with the Grand Trunk and in 1882 went to the C.P.R. as private secretary to the general manager, from which he rose to his present position.

—One of the sheds of the Ottawa Street Car Company collapsed and demolished ten cars.

—The Marconi Co. will establish stations on the Californian Coast, and it is expected there will soon be wireless communication across the Pacific Ocean, and the continent of America.

—A 15-mile railway now in operation between Whitney and Lake Opeongo saves 50 miles in the transportation of logs by water to the sawmill at the former. It is the second line passing through Algonquin National Park.

—The survey of the railway line across Manitoulin Island has been completed. It will not be a difficult road to build. The line follows the shore from Little Current to Manitowaning, thence south to Horse Island.

—The Government has extended its telegraph lines from Port Hood to the Strait of Canso, thence to St. Peter's and to Scatterie. There will be a cable from the mainland to the island and a branch from Gabarus to North Sydney.

—The Grand Trunk is gradually discarding the use of numbers for private cars, substituting distinctly Canadian names. For instance, Mr. Hays' car is the "Canada," Mr. Morse's, the "International," Mr. Wainwright's, the "Muskoka," and Mr. McGuigan's, the "St. Lawrence."

—The New York Central Railway has a plan to minimize loss of life and injuries in accidents by employing 60 surgeons, who live along the line, and are easily reached at any time. Each surgeon has charge of a section, and every train will carry a full kit of surgeon's tools.

—At a meeting of the Cornell Electric Society, Prof. Bedell, of Cornell University, announced a discovery in electric power transmission, whereby an alternating and a direct current may be sent at the same time. Experiments show great economy, the amount of copper being reduced one-half.

—By the crossing of an electric cable and a telegraph wire at Sydney, an explosion took place in the I.C.R. despatcher's office, completely destroying all the instruments and switchboard and setting fire to the office. The electrical display on the wires and about the office was a fine sight.

H. Cooper, a famous engineer of New York, who has been engaged in large undertakings in Brazil, and who is connected with a scheme to bring water power to the City of Mexico, a distance of eighty miles, has been engaged by the Heat, Light and Power Company to give advice in regard to the break at the Chambly dam.

—The annual report of the Bell Telephone Co. in Canada shows that they have 48,481 instruments earning rental, and that 5,623 subscribers were added during the year. The company owns and operates 377 exchanges and 553 agencies. The long distance lines now operated comprise 26,848 miles of wire on 6,991 miles of poles.

—Marconi has about perfected a system to determine the distance between a ship and the station on shore. This will be carried out by means of an apparatus in the shape of a disc. The vibrations from one apparatus will be felt on the other apparatus disc. The current from fifty miles will naturally be weaker than that from ten miles or still less from five miles. The current will make the disc turn, and the marks at different points will indicate the distance of the ship from the station. Ships will thus be able to locate their exact position, even during the darkest nights or in the thickest fog.

—The bridge by which the street cars cross the Grand Trunk at Merritton was badly damaged by a derrick on a flat car running into it. Till repairs were made, passengers had to transfer.