PAGES

MISSING

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The Canadian Engineer.

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

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THE CASCADE WATER, POWER AND LIGHT CO., CASCADE, B.C., CANADA.

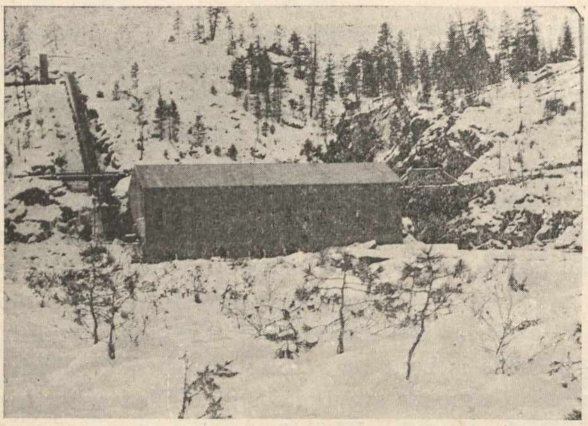
BY W. G. MCCONNON, C.E.

All of the gold extracted from water is not taken directly in the form of metal. A power-house for generating electricity proves a very efficient "stamp mill" for delivering "concentrates" in the form of volts. That this is appreciated by mining men is evidenced by the recently completed plant of the Cascade Water, Power and Light Company, situated at Cascade, B.C., and owned by the London and British Columbia Goldfields Co., Limited, representing an investment, in round numbers, of $500,000.

Cascade is a small town on the Kettle river, twelve miles east of the town of Grand Forks, and about thirty miles directly west from Rossland, B.C. Flowing from the west, the Kettle river descends 120 feet in passing through a half mile of narrow, rocky gorge in a series of rapids and falls. For the utilization of this natural power, the Cascade Water, Power and Light Company has built a large dam, waterway, pipe line, power-house, and transmission line from Cascade to Phoenix, where the largest and most productive copper mines in the "Boundary District" are situated. The dam, placed just above the entrance to the gorge, is of timber cribwork, with a 40-ft. base and 24-ft. top. The mid-section is 50-ft. high, tapering to 25-ft. at the sides, while the total length is 400-ft. This is built on a soli l rock-bed to which the foundation timbers are bolted, and filled with 10,000 cubic yards of rock. This dam raises the water 36-ft. above the natural level, giving an effective head at low water of 156-ft. The permanent water level is 10-ft. below the top of the dam, being controlled during high water by twelve sluiceways, which can be opened to 12-ft. below the natural river level, giving a passway of about 2,000 square feet. These sluices are closed by means of 12-in. by 12-in. squared timbers in grooves, operated by a travelling winch running on a track over the top of the dam. From dam to power-house the water first passes through a 225-ft. open rock cut from which it enters a tunnel driven through 410-ft. of solid rock, passing under the track of the Canadian Pacific Railway, and then into another open rock cut 500-ft. in length, at the end of which the bulkheads and controlling gates are located. These cuts and tunnel, representing an excavation of about 35,000 cubic yards of rock, are of dimensions liberal enough to avoid any appreciable loss of head, delivering the water with a head almost equal to that at the dam level. From the gates the water is conveyed through a wooden pipe, 7-ft. in diameter, for about 1,400-ft. This pipe is constructed of Oregon fir-tongued and grooved staves, 2¾-in. by 7-in. cut in circular segments and machined to the radius of the pipe. The staves are hooped at 12-in. intervals, with ¾-inch round steel bands, with cast iron connecting shoes for clamping. Provisions have been made at the bulkhead and in the width of the cut shown in the first illustration for the installation of a similar additional pipe. From the stave pipe the water is carried through 250-ft. of circular steel pipe, 7-ft. diameter, resting on concrete piers and anchored into solid rock to avoid end thrust. Where this pipe passes alongside of the power house, three 4-ft. pipes and one 2-ft. pipe are taken off below the floor level of the power-house to supply three 36-inch turbines for generators and two 12-inch turbines for exciters.

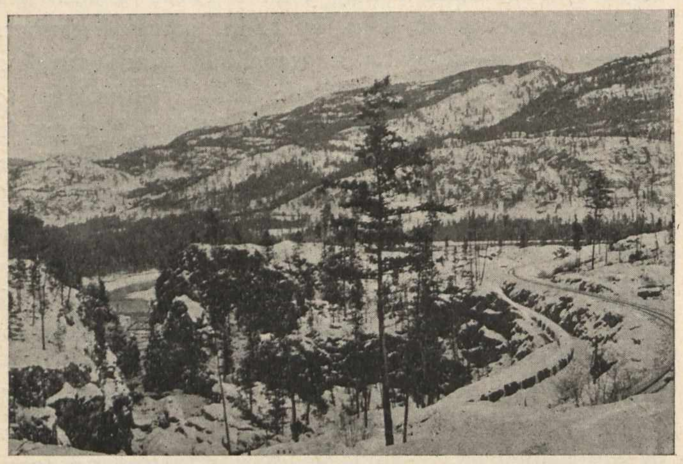
Engraving No. 2 is a general view of the power-house showing the stand-pipe at the junction of the stave and steel pipes. This stand-pipe relieves the pipe line from excessive water-ram strains, and incidentally voids any air taken into the pipes. About

10,000 cubic yards of rock were removed for the site of the power-house, in a natural bay at the foot of the falls. This building is of substantial fire-proof construction, 150-ft. by 50-ft., with stone foundation 22-ft. deep on the lower side, and brick walls 30-ft. above floor level, the height to peak of roof being 45-ft. It has been designed with a view to lengthening it when required.



Cascade W. P. & L. Co.'s Pipe Line.

The third view shows the interior of the power-house, and the generating plant. The three generators are standard Westinghouse, three-phase, two-bearing, direct-coupled, 2,200 volt, 750 K.W., at 80 per



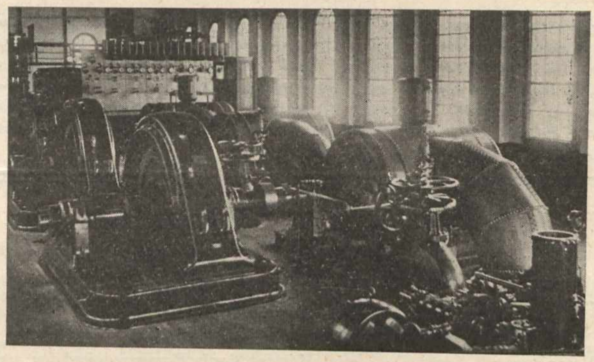
Cascade Company's Power House.

cent. power factor, or 940 K.W. at 100 per cent. power factor, 60 cycles per second, 300 R.P.M. The two exciters, each capable of exciting all three generators at one time, are 45 K.W., 120 volt, shunt wound dynamos, self-contained, two-bearing type, direct coupled to independent turbines, with 500 R.P.M. The turbines are H. Morgan Smith wheels, made at York, Pa., and the governors the Escher-Weis make, from Switzerland.

Cut No. 4 shows the transformers, nine in all, three in each bank, which are Westinghouse, self-cooling, oil-insulated type, having a capacity of 250-K.W. at 80% power factor, or 312½ K.W. at 100% power factor, "Star" connection, and wound for a ratio of 2,000 to 20,000 volts, on both high and low tension windings, with full load efficiency of 97.6 per cent. As the taps are brought out near the neutral point, which is grounded, it is impossible to maintain a dangerous voltage in the auxiliary circuit.

The current from the high tension side of the transformers is carried to a row of high tension fused circuit-breakers, situated alongside of the building behind the main switchboard, as shown in No. 4. These switches are of the well-known Westinghouse type, placed on independent marble slabs, with marble barriers between. The current leaving these switches enters a high tension bus and is carried to the line switches at the rear of the building. These line switches are grouped switches opening all three wires at the same time. Each switch is furnished with a time limit tripping device, and reversed current tripping coils, so that overloads can be carried for a period of from one to ten seconds, as the local conditions call for, or either line can be cut out automatically in case of trouble.

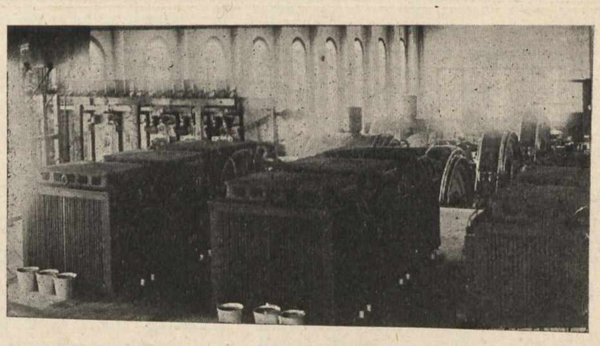
The switchboard for the low pressure side, engraving No. 5, consists of seven panels of blue Vermont marble, one panel for each generator, one for the two exciters, and a feeder panel for each group of transformers. The six lightning arresters, located



Interior of Power House.

just above the switches in the gable of the roof, are the "low equivalent" style of the Westinghouse Electric and Mfg. Co., giving protection against lightning discharges for transmission at 20,000 volts.

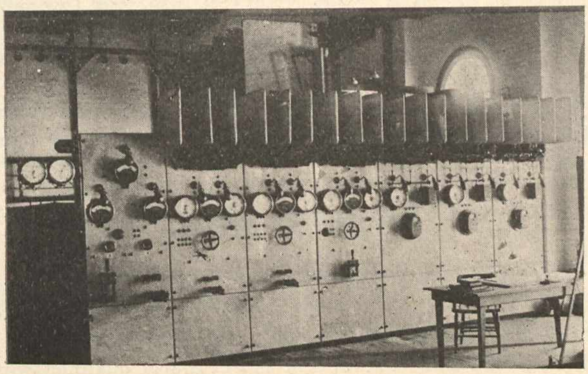
A right of way 132-ft. wide is cleared, and transmission lines erected from Cascade via Grand Forks to Phoenix, a distance slightly over twenty-one miles. The high tension circuit consists of two separate three-phase transmission lines, each carrying three No. 3, B. & S. copper wires, with room on each line for another circuit.



Banks of Transformers.

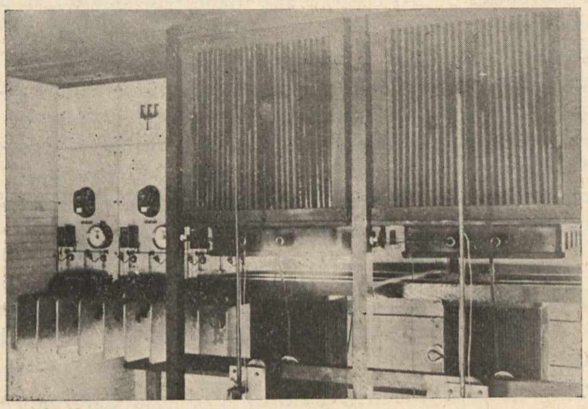
The poles are heavy cedar, and on tangents are spaced not over 100-ft. apart, on curves at less distances, in some cases as low as 50-ft. No angles are turned, but all changes in direction of line made with easy curves. No side or head guys have been used except at extra heavy spans across rivers, etc. The work on this line, as well as all construction of the plant, is a decided credit to the company's local engineer, Wm. Anderson, who has designed and executed the work.

A three-mile feeder is taken off at Grand Forks, twelve miles from Cascade, to the Granby smelter of the Granby Mining and Smelting Co., where current is used for driving Westinghouse induction motors of sizes ranging from three to seven hundred horse-power, and of an aggregate capacity of 2,400 horse-power.



Switchboard.

The sub-station at Phoenix is located at an altitude of about 3,500-ft. above the power-house. The building is of brick, with one end left for future extension, and contains the transformers, line switches, fused circuit breakers, switchboards, etc., substantially duplicating those at the power-house. Engraving No. 6 shows the interior of this sub-station, which, for the immediate present, will be called upon to supply current for two 700-h.p., Westinghouse, type "C" motors for driving two large compressors, a 100-h.p. motor for stone crusher, and a 150-h.p. motor for hoist, as well as furnishing the current for lighting the town of Phoenix.



Interior of Sub-Station.

The Cascade Water, Power and Light Co. estimates that it will have a supply, at low water, for about 6,200-h.p. This will enable the doubling of the present output. All the plans were made and carried out with the view of extending the plant to its full capacity, and from present indications it would seem that the company will have a demand for all the power it can furnish.

—The Engineering News of New York points out that the proposed New York barge canal, estimated to cost about $100,000,000, may mean so much money thrown away, in the event of the construction of the Montreal, Ottawa and Georgian Bay, 22-ft. waterway through French river, Lake Nipissing and down the Ottawa. By the latter the distance from Chicago or Duluth to Montreal would be no greater than to Buffalo, about 900 miles, and allowing for delays in passing locks, the time to Montreal would be only fourteen hours longer. A rate on grain of 1¼ cents to Buffalo would be equivalent to 1½ cents to Montreal. The barge canal would be useless as an outlet for the grain of the West, if the Canadian canal were built, as it will be some day.

—The telephone question is now before Parliament, W. F. Maclean, M.P., having introduced a bill to compel railway companies to give all telephone companies equal facilities at their stations. This would prevent such difficulties as occurred at Locust Hill. The bill went to a special committee.

—The three companies which have been granted franchises on the Canadian side of the river at Niagara are actively at work. The Canadian Niagara Power Company will develop 100,000 h.p., the Ontario Power Company, 150,000 h.p., and the Toronto and Niagara 125,000 h.p. The expenditure on the three works will reach from $12,000,000 to $15,000,000.

—The duty of 57 cents a ton on Nova Scotia coal entering the United States has been taken off. As the Maritime Province coal miners have to look to the United States as a market for a large portion of their output, this will give a stimulus to mining operations, but as there is still a duty of 53 cents a ton on United States bituminous coal entering Canada, our western manufacturers, who are too far away from Nova Scotia to use their coal, are handicapped as to fuel in their competition with United States manufacturers.

—The Government at Ottawa has only made one change of any account in the tariff, as announced in the budget speech. It asks for power to impose, by order-in-council, a duty of $7 a ton on steel rails whenever it can be shown that the mills in Canada are in a position to manufacture steel rails in sufficient quantity to supply the ordinary requirements of the market. The time for free admission of beet sugar and alluvial gold mining machinery is extended. A surtax is imposed on goods imported from countries which do not trade with us on fair terms. This will hit Germany worse than any other country.

—The worst railway accident of the month was a head-on collision on the Intercolonial, near Windsor, between a fast freight and a passenger train, the latter running at a very rapid rate to make up time. The semaphore was up against the passenger train, but the engineer did not stop, and the only explanation he can give is that he must have lost his senses. He will doubtless lose his situation. Four train men were killed, and the passengers had a most wonderful escape. Four cars left their trucks and shot over the engine for two hundred yards, yet, marvellous to say, no one in them was seriously injured. This fact is attributed to their being built with steel frames.

—Prizes for the summer theses at McGill College, Montreal, have been awarded as follows: In the electrical engineering course, the Greenshields' prize will be divided equally between R. Y. Conklin and A. E. Foreman. In the mechanical engineering course, the Crosby Steam Gauge and Valve Company's prize, to F. A. McKay. In the mining engineering course, the Drummond prize to R. A. Chambers and O. Hall. The scholarship for research, with special reference to national industries, goes to H. Lester Cook. It is worth £150 for two years.

JAMES AIKENHEAD.

The hardware trade will have learned with great regret the death last month of James Aikenhead, president of the Aikenhead Hardware Limited, of Toronto. Mr. Aikenhead had a long and honorable career in business, having risen from the foot of the ladder to be founder of one of the most

successful hardware firms in the Canadian trade. He had just celebrated his 86th birthday. He was a native of Ireland, and came to Canada in 1847, securing employment in the old hardware firm of Ridout Bros. & Co. Later the firm became Ridout, Aikenhead & Crombie, and later became the Aikenhead Hardware Co., which was succeeded by the present joint stock company, of which his son Thos. E. Aikenhead is general manager. Another son is the Rev. James R. Aikenhead, of Gravenhurst.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

At the ordinary meeting of the above society, on the 23rd ult., a paper giving an estimate of the discharge of the St. Francis River, was read by K. M. Cameron, a student member.

The following was the result of the ballot for new members in the various classes named:

Members—Robert Arthur Bainbridge, of Nelson, B.C.; William Henry Breithaupt, of Berlin, Ontario; John William Burke, of New York, U.S.; Charles Garden, of Woodstock, N.B.; Frederick Mondelet Gaudet of Quebec; Richard Armstrong Hazlewood, of Sault Ste. Marie, Ont.; Owen McKay, of Walkerville, Ont.; George Albert Simpson, of Winnipeg.

Associate Members—Franklin Clark, of Halifax, N.S.; Abram Silas Code, of Alvinston, Ont.; Francis Algernon Devereux, of Victoria, British Columbia; William Allison Logan, of Cardinal, Ont.; Alexander Macdougall, of Quebec; Earnest Vivian Moore, of Port Colborne, Ont.; Sergius P. Maximoff, of St. Petersburg, Russia.

Transferred from the Class of Associate Member to the Class of Member.—William B. Russel, of North Bay; William Fraser Van Buskirk, of Rossland B.C.; Frederick Richard Wilford, of Iroquois, Ont.

Transferred from the Class of Student to the Class of Associate Member.—Guy Ralston Balloch, of Woodstock, N.B.; Archibald Abercromby Bowman, of Toronto; Frank Taylor, of Montreal.

Associate.—William Herbert C. Mussen, of Montreal.

Students.—Joseph Ulysse Bray, of Hull, P.Q.; Frederick Baylis Brown, of Montreal; Roscoe Y. Conklin, of Montreal; Charles VanDyke Corless, of Montreal; Henri Dessulles, of Montreal; J. Henri Dubuc, of Montreal; Royden Keith Durland, of Montreal; John Hamilton Edgar, of Montreal; Alvah Ernest Foreman, of Montreal; Stanley Howard Frame, of Gay's River, Col. Co., N.S.; Oliver Hall, of Montreal; Thomas Craik Irving, Jr., of Toronto; Edgar Augustus James, of Thornhill, Ont.; Piers Kingsford, of Montreal; Joseph Labelle, of Montreal; Francis C. C. Lynch, of Montreal; Charles Millar McKergow, of Montreal; Alexander Peden, Jr., of Montreal; Herbert G. Pickard, of Montreal; Rolland Prefontaine, of Montreal; Auguste Real Shehyn, of Three Rivers, P.Q., James Herbert Smith, of New Hamburg, Ont.; Altheod Tremblay, of Coteau Ldg.; Logan Manning Waterous, of Brantford, Ont.

CANADIAN ELECTRICAL ASSOCIATION.

At a meeting held on April 24, at Toronto, a committee was appointed to arrange for the entertainment of visitors to the annual convention of the Canadian Electrical Association, which will be held in that city this year on June 10, 11 and 12. A. B. Smith was appointed chairman of the local committee in place of J. J. Wright, who is ill. It is expected that the King Edward hotel will be the headquarters of the association during the convention, and that the annual banquet will be held there.

LITERARY NOTES.

"The Diamond Mines of South Africa," by Gardner F. Williams, M.A., is the title of a sumptuous volume in watered cloth binding, published by the Macmillan Company, New York and London. The author is peculiarly qualified for the work of placing before the world a record of the rise and development of the great diamond mines of South Africa, which have influenced to such an extent both the political and commercial history of the South African colonies. He has had an extensive practical experience in mining, and has acquired expert knowledge of this specific branch of mining and of the inner workings of the South African corporations as general manager of the great DeBeers mines at Kimberley. The book Mr. Williams has here produced is a monumental one and will remain the standard work of reference for years to come. He has made full use of the modern art of illustrating, and almost every aspect of diamond mining is pictured in the 300 or 400 half-tone engravings, the 29 photogravures, and the seven maps that accompany the text. The author in this volume of 681 pages carries the reader from the earliest records of diamonds through the traditions of Ophir land down to the beginnings of mining at Kimberley in the seventies of last century and thence through every stage of mining with machinery operated by steam, electricity and compressed air. It is a cyclopedia of diamond mining, and not the least interesting to Canadians are the chapters giving the most comprehensive account we have yet seen of the memorable siege of Kimberley. In this portion is described that noteworthy achievement, the making of the siege gun "Long Cecil," with illustrations of the gun, and many interesting scenes during the siege by the Boers.

The Canadian Northern will build another elevator at Port Arthur, with a capacity of three and a half million bushels.

The Ontario Electric Railway Co. has determined to develop power for their line at Glen Falls on the Trent, 7 miles north of Trenton.

T. M. Kirkwood, of Toronto, who purchased the Belleville Iron & Steel Co.'s plant was not able to start operations by April 1st and forfeited his deposit of $2,500, but it is believed the city council will not exact the forfeiture if the negotiations now going on are concluded, by which the works may be taken in hand by an Ontario manufacturing concern.

In reply to an enquirer we may say that about 44,000 h.p. is used in Montreal for electric power and lighting, of which about 34,000 h.p. is generated by water. The sources are: from Chambly, 20,000 h.p., from Lachine, 12,000 h.p., from Shawinigan Falls, about 2,000 h.p., and by steam for the street railway, 10,000-h.p. This does not take into account isolated power or lighting plants generating electricity with steam. It is intended to increase the output of electricity transmitted to Montreal from Shawinigan Falls to 4,000 h.p. while about 15,000 h.p. are generated for use in the industries at the falls.

SOME THEORIES UPON RAILWAY LOCATION.*

By J. G. G. Kerry, A.M. Can. Soc. C.E.

Railway location is becoming one of the most important branches of civil engineering, partly because Canada is entering an era of railway construction unequalled in magnitude by any that she has passed through since the completion of the C.P.R. main line in 1885, and partly because the critical study of railway transportation, commenced, in engineering departments at least, after the publication of the revised edition of Wellington's Economic Theory of Railway Location in 1891, has established principles which call for the almost complete reconstruction of the more important of the older lines.

The great factors in any railway location, in order of importance, are— (1) The aims and ideas of the promoters; (2) the position of present and future traffic centres; (3) the topography of the country; (4) the economic advantage of adjusting roadbed and rolling stock to one another; (5) the requirements of modern operating practice; (6) Difficulties of construction.

The general route of a railway is rarely determined by engineering considerations. The promoters of the line—be they politicians, railway men, or speculators—have some political or financial end to attain, and to that end all other considerations will be subordinated. . . . It has frequently happened that the route has been determined before an engineer has even been called in for consultation, and in easy country such a practice cannot be considered altogether objectionable. An engineer's training does not fit him in particular, as distinguished from other classes of railway officials, to foresee the great economic and commercial changes that will be sure to follow the opening up of railway communication, and at times he would be almost at a loss to choose between competitive routes, had they to be judged from an engineering standpoint only. The four lines that now connect Montreal and Ottawa furnish a good example. They connect termini that are about 100 miles apart and yet are as much as 50 miles distant from each other, and their lengths vary from 112 to 125 miles; it can, however, hardly be said that the proportions of the traffic they carry are materially affected by this variation or by any other difference in the engineering detail of the lines; that proportion is determined by terminal facilities and by the support of connections. Instances, on the other hand, are not unknown where the promoters have undertaken to locate a line through what is by no means easy country, and the history of such attempts is the most forcible argument that an engineer can bring forward when opposing any repetition of the same policy. The writer conceives it to be the duty of a chief engineer to form and express an independent opinion upon the merits of any route that he is instructed to examine, the adoption of the route being a question for his employers to decide. . . .

Making an exception of those numerous lines which have been built in Canada for the set purpose of opening up new regions for settlement, and whose very existence is due to public liberality, it may be said that all railways are built as business concerns to transport passengers and freight, and that the share of the business offering that they secure is a fair measure of their success. It has been pointed out in the most recent economic discussion, that the possibility of any producing district shipping into a given market is largely controlled by its transportation facilities, and that therefore every improvement made by the railway will increase the business opportunities in the district, and consequently the traffic of the line. There have been many bankrupt lines in Canada on account of lack of traffic; there can be none that will succeed without it, and every effort should be made to secure it where it exists and to create it where it is lacking. The control of through traffic is hardly affected by the details of location. It is a question of terminals and alliances, and lies within the special province of the general manager or president. It may be advisable to modify the general route to secure such traffic, it certainly will be worth while to reduce the grade line in order to handle it, but it is wise to recognize that it may be entirely cut off from even a powerful system. . . .

Much of the railway line now projected will run through practically unsettled districts, and it may be safely predicted that the situation of the future centres of population that will control local trade will be determined by the presence of natural resources, and by the location of the railway. It follows that the more nearly these two causes can be brought together the better it will be for the future of both country and railway. It is not easy in preliminary survey to recognize the existence of the natural resources, nor to realize how great their future development may be. The location engineer, indeed, gets but few opportunities to observe the growth of traffic on the lines that he has planned; but he should certainly know what staples constitute the bulk of the traffic in adjoining districts, and why they are produced there. Statistics are published annually by the Department of Railways and Canals giving the tonnages of different articles of freight handled upon various railway lines. The location of the Great Northern Railway is a recent example of a line avowedly laid out to approach as nearly as possible to the great Laurentian water powers, which were considered to have the greatest traffic producing possibilities of all the resources in the district. In Eastern Canada the commercial centres are well established and practically all traffic originates near them. Any effort to ignore these existing centres will result in the material disadvantage of both town and railway; the town will be handicapped in its commercial growth and the railway will lose the business that would have been created. The locations of fifty years ago are full of efforts of this kind, made, it is said, largely in the hope of inducing the town to move on to land in the immediate vicinity of the railway station, and owned by the railway promoters. The series of towns along the north shore of Lake Ontario, between Toronto and Kingston, are proof of the inability of a railway company to compel an eastern town to move; they still stand where they stood 50 years ago when the railway was built past them. Brantford has furnished the most remarkable example of the power of an established town to hold its own against a railway company. The Great Western passed it by about 1850, when it had a population of 3,877, and located through its rival, Paris, which had a population of 1,890, the final choice having been influenced, it is said, by a subsidy. To-day, after over fifty years of struggle, Brantford has at last succeeded in getting the main line traffic of the old Great Western diverted into it, and in spite of transportation difficulties, has grown into a city of over 16,000 inhabitants, one of the most active manufacturing centres in Canada. It may therefore be taken as good practice in Eastern Canada to carry the location directly into the existing towns, no matter how great may be the cost of right of way or the sacrifice of engineering niceties, for the return will in nearly every case give ample profit on the expenditure. In exceptional cases it may be necessary to construct a freight loop around the town if too serious a sacrifice of grade would otherwise be required, but by the use of momentum freight can be carried directly through a town situated in a hollow. The C.P.R. line into the town of Lachute has 1.00 per 100 falling grades on each side of the town, and runs its traffic straight through without stopping, unless there is local business to be attended to.

That any man who can handle surveying instruments is popularly regarded as entirely competent to make a railway location is but a most general proof of the important influence exercised upon the details of location by topography. The engineer must know his country thoroughly, and it may be said that any man who is sent out on location without having opportunity to study all the information that has been accumulated in the past about his district is improperly equipped. The various Canadian governments have for years been sending out exploring and surveying parties to gather information about unsettled areas, and when it is remembered that these parties are generally in charge of trained observers and surveyors, the value of their reports and of their maps cannot be overestimated. The very fact that these reports

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

are not made by railway engineers increases their value, for the observations deal largely with the general and mineral resources of the country, which should be controlling factors in the location, but which are often not noted by an engineer absorbed in the study of those details which appear on plan and profile. . . .

It is to be remembered that the great engineering errors in railway location are made in most cases before the instrumental surveys are even started, and that the more widely the preliminary explorations are extended, and the more completely all local sources of information are utilized, the better will the engineer be fitted to deal with the problem that he has been given to solve. The policy now adopted by some Canadian lines of keeping small reconnaisance parties in the field to work up information requisite for future locations is admirable practice, the value of the result being, however, in direct proportion to the character of the men employed, for there is no task that calls for more steady, thorough-going, conscientious hard work than the complete exploration of any piece of country. Exploration should never be regarded as complete until the engineer is able to select the route along which his detail surveys will be made.

When the exploration has been completed, railway location becomes a problem of detail surveying, in which the necessity of reducing first cost to a minimum has to be constantly balanced against the demands of the operating departments for a straight and level track. Surveys with instruments of precision are necessary to adjust the alignment so nicely to the local contour that no stretches of track will be built over which rolling stock cannot be advantageously operated; and the area that can be covered by a precision survey is so limited that nothing but this local adjustment should be expected from it. In making such an adjustment the fact that a railway is simply a great machine for moving traffic must always be kept in mind. It is a machine which has the unique distinction of having two great and often apparently independent parts, the track and the rolling stock; and these are designed by two distinct bodies of men, who have been trained along entirely different lines, and whose views as to the best schemes for future improvement are often antagonistic. The work of the locating engineer will, in most cases, remain unaltered in service for a much longer time than that of his mechanical confrere, and should therefore be designed so that the operating department will always be able to take full advantage of the improvements in rolling stock that are constantly being made. The engineer certainly cannot make this provision without some knowledge of the mechanical principles which control locomotive design and of the developments that may be expected in the immediate future. These developments are usually foreshadowed by the practice of the lines carrying the heaviest traffic, and are thoroughly discussed in the current technical press. . . .

That the most efficient railway is the one whose track and motive power are best adjusted to each other is the lesson of modern operating, but before considering how this adjustment should be made, it will be well to notice the great development in rolling stock that has taken place since the days of the C.P.R. surveys. The specifications of about 1885 called for the use of rolling loads, consisting of engines weighing 110,000 lbs., followed by 3,000 lbs. per lineal foot; those of to-day require engines of 225,000 lbs. followed by 5,000 lbs. per lineal foot. The modern car for heavy ore and coal traffic has a nominal capacity of 100,000 lbs. and a weight of about 36,000 lbs. Remembering that it is not unusual to overload these cars, and that some of them are not above 30 feet in length, it will be seen that the extra heavy specification of to-day is not in advance of the extremes of present practice, and that weights as high as 40,000 lbs. are sometimes concentrated on a single car axle. These ore cars are, however, somewhat exceptional, and for regular freight traffic cars of 60,000 lbs. capacity, with weights slightly over 30,000 lbs., are most common. During an extensive discussion before the New York Railway clubs in November, 1901, Mr. Vauclain stated that a load of 45,000 lbs. per axle might be considered the limit of good locomotive practice at that date, and although in special cases it has been exceeded, there are but few engines in service on the continent to-day with axle loads exceeding 50,000 lbs. In Canadian practice the maximum axle loads vary from 45,000 to 50,000 lbs. on the various roads, the heaviest loadings being found on engines of the 10-wheel and mogul types. In the discussion referred to, the increase of grate area and boiler heating surface were pointed out as being the latest achievements of locomotive engineering.

It has often been stated that the increase of rolling stock weights must very soon cease, and as often the prediction has proved to be entirely wrong. There are some facts that to-day point to at least a temporary suspension in this increase. These are the establishment of a standard box-car, the proven difficulty in economically handling trains more than 70 cars in length, and the difficulty of obtaining satisfactory rail to use under existing rolling stock.

In order to adjust his line so as to permit the easiest train movement, the engineer must thoroughly understand the action of the forces that affect that movement. These forces are locomotive power, momentum, gravity, curve friction and that miscellaneous group known as running resistance, and all of them are variable in amount according to circumstances. (These forces are then treated of in detail).

The safety of using momentum grades in location is one of the disputed points of present practice. Comparing momentum with locomotive tractive power, it may be said that tractive power is directly dependent upon the condition of the engine and the skill of its crew, and will often be much below its calculated value, and that momentum is equally uncertain if the velocity which is essential to its existence is obtained from surplus engine power. Momentum which is obtained by the action of gravity is the most dependable of mechanical forces. The use of momentum grades is universal in operating practice. As a case in point the Lachute example, already referred to may be quoted, or the action of the Grand Trunk Railway in moving Gananoque Junction about 1½ miles eastward in order to place it at the top of a long upgrade, which included a stretch of 50 feet to the mile gradient. The possibilities of using momentum to advantage are greatly limited by topographical conditions. As already remarked, it gives no assistance at the upper end of long grades, and the use of short, sharp grades is limited by the necessity of changing the rate of grade slowly at summit and hollow, which will sometimes altogether prevent their introduction. Its assistance can be gained only at the price of reduced speed, which may be undesirable where fast service is necessary, and there is always an uncertainty as to the continued existence of the conditions which make the required velocity of approach a possibility. The necessary control of speed due to features of the existing track, the demands for new stations and sidings by future industrial development, and the establishment of level road on railway crossings may at any time render momentum operation impossible. During the past year the Railway Committee, in one instance, sanctioned the putting in of a level railway crossing across a line carrying one of the fastest and most important passenger traffics in Canada, and in the very centre of a long grade averaging 35 feet to the mile. This example—the crossing of the Grand Trunk line by the Aurora and Schomberg Railway—indicates very clearly the caution that should be observed in planning momentum grades. When used, they should be introduced as close as possible to the foot of the hill, and there seems no strong objection to rates of grade as steep as the pusher equivalent of the ruling grade. A stalled train cannot be divided into fewer than two parts, and for certainty of operation a doubling siding should be placed at the head of every serious momentum grade. . . .

Concluded in next issue.

—Alex. MacPherson, manager of the Toronto branch of the Canadian Rubber Co. for the past five years, is returning this month to headquarters in Montreal. On the occasion of leaving Toronto a farewell dinner was tendered him by the Wholesale Shoe Association, at McConkey's, as an expression of the esteem in which he has been held by the trade.

ELECTRICAL CURRENT IN THE HUMAN BODY.

When ordinary precautions are observed, says Alfred M. Hayes, in The Electrical Engineer, supply at 250 volts presents practically no danger, and the possibility of such even at 500 volts may be overestimated. It will not be exceeding the bounds of ascertained knowledge to assert that volts alone can neither injure nor kill, and also that amperage alone is in no sense dangerous. In order that injury may result it is necessary that the conditions be such that a certain number of watts of electrical energy are expended in overcoming the resistance of the human body, the action of passing through and overcoming the resistance of the tissues causing the sensation usually described as shock.

In order to remove any misconception with regard to the writer's meaning in making the above statement, and to prove that high voltage alone presents no element of danger, let us take a Wimshurst or other similar statical machine, and having put this into operation until the main collectors become so highly charged that they commence to discharge themselves into the atmosphere (which will mean, in all probability, that they are at a potential some millions of volts above earth), let us place one hand upon a suitable earth connection, say a wire connected to a water pipe, and then bring the other hand into contact with the highly charged collector in question. The result will be that an infinitesimal current, as regards amperage, but at some millions of volts, will pass through the tissues of the body and go to earth, the current being so small that the wattage expended is not sufficient to cause the slightest inconvenience, in fact, practically no sensation will be felt.

Perhaps the machine which presents the most directly opposite characteristic to the above is that most useful article of commerce, the plating dynamo. Here we have a machine producing, say, 2,000 amperes at a potential of six volts, but, notwithstanding the enormous electrical current produced, the possibilities of obtaining the slightest shock are even more remote than in the previous instance. The reason for this is clearly that the voltage of the machine is insufficient to force the number of watts through the tissues which are requisite in order to produce a sensation either unpleasant or dangerous. The exact number of watts which must be expended in the human frame before fatal results ensue will vary in the case of different individuals, and will be largely governed by the physical condition of the subject.

At as low a voltage as 110 volts, the danger of shock is very remote, and the charged conductors may be handled with perfect impunity in any part of the building. If the conductors are touched by the hand, the state of the skin at the moment of making contact will largely govern the quantity of current which will pass, a hand moist with perspiration offering the most favorable conditions for increasing the severity of the shock, a dry condition of the skin having just the opposite effect. Should accidental contact be made with one hand with a conductor at this potential by a person standing in a damp basement the resulting shock will be very slight, even should the person be wearing a pair of wet or imperfect boots. Thus, we see that the resistance of the human body is so great that, when interposed in the path of conductors having a difference of potential amounting to 110 volts, it will limit the current passing, and consequently the watts expended in the tissues to such a small value that no serious results can accrue.

All other things being equal, the watts expended in the body, should contact be made with a conductor charged with 220 volts, will be exactly four times the amount in the first instance, and the shock will be consequently increased in severity. A case was recently reported in which a person met instant death by grasping a conductor charged at this potential —namely, 220 volts above earth—but the writer's experience justifies him in saying that the circumstances surrounding this occurrence must have been altogether abnormal.

Reaching the question of power supply at 500 volts, we shall find that an element of danger really exists, but one which merely demands a few extra precautions in order to reduce the possibility of mishap to a remote contingency. Contact between a conductor carrying current at a pressure of 500 volts and the bare flesh will under some conditions result in a severe and possibly fatal shock to the system, the nature and severity, however, entirely depending upon the details mentioned above. One may, again, with perfect safety make such a contact when standing in a dry workshop upon a boarded floor, but given a damp situation or an earth connection with some other part of the body at the same moment, the result may be extremely serious, as at such a voltage the combined resistance will be insufficient to cut the current down to a safe limit.

It will be noted that in the foregoing remarks the voltages have been definitely stated, and the writer thinks it will be understood that the current available was in each case practically unlimited, as this article deals with conductors charged from the supply mains, the point being that it is possible to have a potential difference of 500 volts or any other value, but with such a small amperage available that practically no physical effects are obtainable, taking, for instance, the case of the statical machine mentioned, or a set of small batteries having the requisite voltage, but merely a trifling capacity. It has been stated as a somewhat remarkable fact that a person has grasped the 500-volt trolley line whilst standing upon the top of a tramcar without the slightest inconvenience resulting. Really there is nothing at all remarkable in this, as it simply, again, resolves itself into a question of Ohm's law, the electromotive force being 500 volts and the resistance being represented by that of the person's body, plus the resistance to earth through the dry woodwork of the car, the total being so high that the current passing was reduced to a safe limit.

POWER REQUIRED FOR MACHINE TOOLS.

The following tests were made at the locomotive shops of the Buffalo, Rochester & Pittsburg Railway at DuBois, Pa., with the purpose of ascertaining the amount of power used by various machine tools when operating in regular, routine work, and at the same time the power lost in shafting and belting in a group-driven system. If all the machines in a group were thrown on and driven at their highest capacity at one time, they would probably require the full power of the motors as installed in this plant; but in actual operation, this never happens. Some of the tools are always either standing idle or working lightly, and the amount of power demanded hardly ever reaches half of the possible maximum total.

The plant consists of five buildings, viz., the power house, a building containing the locomotive erecting, boiler and machine shops, the round house, the blacksmith house, and the storehouse and offices. These buildings are located on a plot of ground 32 acres in extent, and the equipment is intended to handle the repairs of about 150 locomotives, with provision for an increase of 75 engines, which is expected to cover about five years, making an estimated ultimate total of 17 engines per month. The machine, boiler and tank shops are under one roof, covering an area of 134 by 524 feet. The blacksmith shop is 80 by 140 feet, the power house 63 by 93 feet, the office and store-house 60 by 120 feet; and in addition to these there is an oil house 30 by 60 feet, a 16-stall round house, and a 26 by 140 feet coal, coke and iron storage building.

The power plant is designed for the transmission of power by electricity and compressed air, and furnishes all power needed for driving the machinery, lighting the shops, grounds, a large car-building plant, and neighboring stations, and the further supply of steam for heating the buildings. All pipes and wires pass from the power-house to the several buildings through underground galleries. The boiler equipment comprises four 200-h.p. water-tube boilers, the furnaces of which are hand fired. The engine room contains the following machinery of Westinghouse make: A 200-h.p., compound engine, direct connected to a Westinghouse, 125-k.w., D.C., E.T., compound-wound generator, operating at 250 volts and 280 R.P.M. This generator carries the day load and supplies power for machine tools, cranes, lighting, etc. A 100-h.p., simple engine, belt connected to a Westinghouse, 75-k.w., D.C., compound-wound generator, operating at 250 volts and 750 R.P.M. This generator carries the night load, and supplies power for lighting, motor driving for special night work and the turntable. The night and day load generators are interchangeable at the switchboard. A 100-h.p., simple engine, belt connected to a Westinghouse, 60-k.w., two-phase, A.C. generator, operating at 2,200 volts, 7,200 alternations and 900 R.P.M. This generator furnishes power for lighting the yards, the Falls Creek station, the passenger and freight stations at DuBois and the DuBois car-shops. A 2½-h.p. exciter, operating at 125 volts and 180 R.P.M. An Ingersoll-Sergeant, steam-driven compressor, furnishing compressed air for the plant.

The results of the tests are given below. It is to be noted that the net power consumed by the several tools and by the line shafting was not obtained directly, but by subtraction. All measurements were made by means of a voltmeter and an ammeter in the motor circuit. These indicated the electrical horse-power delivered to the motor. The brake horse-power delivered by the motor at any given load was then determined by means of the motor efficiency curve. This is a source of considerable error at low readings, since the actual efficiency of the motor as installed may differ from that given on the curve sheet. The amount of power consumed by the shafts and belts being known, and then the amount consumed with the tool running being taken, the first quantity was subtracted from the latter to give the amount actually consumed by the tool. This probably gave very nearly the correct results, since the energy lost in shafting and belting is very nearly constant at various loads. The tests were made while the shops were in full daily operation, and it was for that reason impossible in many cases to make as direct measurements as might seem desirable. In order, therefore, to present the actual conditions of each test the log has been given below in full as recorded, except that all readings are translated into brake horse-power delivered at the tool. In explanation of the small loads allotted to some of the motors, it should be stated that when they were selected provision was made for the probable increase in the capacity of the shop. Experiments are, also, being conducted with high-speed cutting steels, which, if adopted, will considerably increase the demands for power. These tests, in addition to furnishing accurate data relating to the power required for various tools when starting, running light and cutting, also make possible some estimation of the merits of roller bearings for shaft-hangers. The line shafts are cold rolled steel, and are carried on Hyatt roller bearings and a shaft 200 feet long without belts could be turned by hand. But in spite of the unusual efficiency of the bearings, it will be noted that the power consumed by the tool is often less than that lost in transmission. Nevertheless, the capacity in motors required for the group drive is two to two-and-a-half times smaller than it would have been had each tool been provided with an individual motor. It is a question as to how far the low average power taken by large groups of tools in operation may be due to the fly-wheel action of the shafts and pulleys.

The locomotive-erecting, boiler and machine shop consists of a middle aisle for erecting, and two shed bays equipped with shafting for driving the machine tools. Two 50-ton, electric travelling cranes have a runway in the middle aisle. There are five lines of shafting driven by five shunt motors in the shed bays and the sections are designated as wheel section and boiler section in one bay, and lathe, tool and flue sections in the opposite bays. In the wheel section the shafting is driven by a 40h.p., shunt-wound motor and operating 42-in. car wheel boring mill, 48-in. car wheel lathe, two 79-in. wheel lathes, quartering machine, 60-in. by 60-in. by 18-in. planer, 84-in. boring mill, single axle lathe, 6-ft. radial drill, 18-in., slotter, band saw, No. 7 grinder, water tool grinder. The line shaft is 200 feet long, 2½ inches in diameter, and has 26 hangers. It was inconvenient in this instance to obtain a test of the line shaft alone. A test of the line shaft and counters only gave 1.5-h.p. A 15-minute test was made of a group of machines comprising a 72-in. and a 66-in. wheel lathe each with two cuts, a wheel press operated at 50 tons, and an 84-in. Niles boring mill, a band saw belt, an emery wheel, a Pond radial drill, and a 60-in. planer with one tool cutting cast iron, with an average result of 4.6-h.p., a minimum of .88-h.p. and a maximum of 10.43-h.p. The speed of the line shaft was 160 R.P.M. Two machines were then thrown in, a 42-in. wheel lathe cutting with one tool and an 84-in. boring mill—with the wheel lathe cutting—the boring mill on starting up took 6.9 h.p., and cutting 3 h.p. To the above two machines were added, a tool grinder and a 79-in. wheel lathe cutting, which starting up took 6.3 h.p., and running steadily 3.95 h,p.

To these was added a 60-in. planer, cutting a cast iron cylinder, which at starting took 10.3 h.p., and running steadily 4.2 to 7 h.p., or an average of 6.1 h.p. during the whole time.

To these were added another tool grinder and an 18-in. slotter. The maxium reversals of the planer and the slotter at the same instant, gave 15.5 h.p. and steady running showed 5.2 h.p. The planer interfered somewhat with the readings.

Then a band saw cutting 4-in. oak, was added which took 5.6 h.p. Whether the saw was cutting or not seemed to make no difference in the reading. Tests of single machines were then made; that is, of the power consumed by the one machine tool thrown in at a time. A 42-in. wheel lathe with one tool cutting on starting up 4.6-h.p., and on steady running .5-h.p. An emery wheel took .7-h.p. A 79-in. wheel lathe, with two tools making roughing cuts on a pair of drivers, took 4-h.p. An 84-in. boring mill boring an 8-in. cylinder took 2-h.p. A 60-in. planer cutting a cast-iron cylinder took 2-h.p., and a maximum at reversal of 8.5-h.p. An 18-in. slotter with tools of ¾-in. face, cutting steel, took .3-h.p., and a maximum at reversal of 1.2-h.p. A band saw starting up took 6.3-h.p., and running light or cutting 4-in. oak, 4-h.p. A group run of an 84-in. boring mill, a 79-in. wheel lathe, a 6 ft. radial drill, a 60-in. planer, and an 18-in. slotter, gave at steady running 6.9-h.p., and with the planer at reversal took 14-h.p.

The boiler section had shafting driven by a 30-h.p., shunt-wound motor and operating a 12-ft. bending roll, bolt cutter, stay bolt cutter, drill press, tool grinder, Brooks plate planer, horizontal punch, shear and punch, 6-ft. bending rolls, 6-ft. straightening rolls, 6-ft. radial drill.

All the counter-belts were thrown off, and the line shaft tested alone, with a result of .3-h.p. This line shaft is 170 feet long, 2½-in. in diameter, and has 19 hangers. The speed of the line shaft was 158 R.P.M. A test of the line shaft and countershafts, only, gave an average of 2-h.p. The machines, comprising the first group tested, were: A stay-bolt cutter and a bolt cutter, a No. 4 Hilles & Jones punch and shear. The No. 4 punch and shear was punching 13-32-in. hoes in 3-16-in. steel plate. A 15-minute test showed an average of 1-h.p., with a minimum of .2-h.p., and a maximum of 3.5-h.p. A single tool, the No. 4 Hilles & Jones 48-in. punch and shear was thrown in, and starting up light took 6.9-h.p., settling down to .4-h.p. Shearing 5-16-in. steel plate, it required 3-h.p. A 6-ft. radial drill was then added, and at starting up light took 3.6-h.p., settling down to 1.1-h.p. A 1½-in. drill cutting in steel gave 1.5-h.p. A 6-ft. radial drill and bolt cutter required 1.1-h.p. The 12-ft. rolls were then added, and starting up light showed 7.3-h,p., settling down to 4.75-h.p. Rolling steel plates, ½-in. by 8-in. required 5.3-h.p. A test of line shaft and counters with the 6-ft. radial drill cutting steel with 1½-in. drill, and a punch and shear running light showed 2-h.p. A 1-in. stay-bolt cutter added to the above took on starting up 4.5-h.p., and cutting 12 threads per inch gave 2.1-h.p.

The lathe section was operated by shafting driven by a 30-h.p., shunt-wound motor and taking care of a 24-in. crank planer, 36-in. by 36-in. by 20-ft. planer, 51-in. boring mill, 16-in. shaping machine, 24-in. lathe, 24-in. drill press, 37-in. boring mill. two 22-in. lathes, three 16-in. lathes, two 18-in. lathes, 28-in. lathe, 43-in. lathe, 2-in. by 24-in. flat turret lathe, two 26-in. by 26-in. by 10-ft planers, 60-in. horizontal boring machine, water tool grinder, centreing machine.

The line shaft and counters gave 4.1-h.p. A test of the line shaft with counterbelts off gave .7-h.p. The speed of the line shaft was 155 R.P.M. The line shaft is 180 feet long, 2½-in. in diameter, and has 22 hangers. A 15-minute test was made of a group of machines comprising two 26-in. planers and one 36-in. planer, cutting steel with one tool each, a turret lathe, an emery wheel, three 16-in. lathes, two 22-in. lathes, a 36-in. boring mill, drill press, and a shaper, all in operation. The readings gave an average result of 6.9-h.p., a minimum of 4.74-h.p. and a maximum of 15-h.p. A group run of a 26-in. planer, three 16-in. lathes, an 18-in. lathe, a 24-in. lathe, a 16-in. shaper, a 24-in. drill press, and a centering machine in operation required a steady running 2.4 h.p., and at reversal of the planer 7.6-h.p. A single 26-in. planer cutting cast-iron took 1-h.p., and at reversal 3.5-h.p. A 16-in. shaper cutting 1/32-in. steel at 12-in. stroke took .9-h.p., with a minimum of .2-h.p. and a maximum of 1.4-h.p. A 24-in. turret lathe cutting required .3-h.p. A 24-in. lathe boring brass took .03-h.p.

The tool section has shafting driven by a 20-h.p., shunt-wound motor and operating tool grinder, drill grinder, 21-in. drill press, 16-in. lathe, milling machine, grinding machine, three 18-in. turret lathes, 24-in. drill press, 28-in. lathe, No. 10 vertical milling machine, 2-spindle rod drills, 14-in. pillar shaper, 16-in. lathe, 26-in. x 26-in. x 6-ft. planer. 32-in. drill press, surface grinding machine, water tool grinder. The line shaft and counters required 2.8-h.p. The line shaft is 140 feet long, 2½-in. diameter, and has 20 hangers. It was not convenient to obtain a test of the line shaft alone. The speed of the line shaft was 155 R.P.M. The line shafts of the lathe and tool sections can be connected by a clutch coupling and the whole operated from either motor. A group test was made of a 16-in. lathe, a drill press, and a grinder, all in operation, with a result of 1.9-h.p. A single grinder took in starting up 9.7-h.p., and grinding 1.95-h.p. A 28-in. lathe took on starting 4.7-h.p., and cutting steel 2.5-h.p. A group run of two 16-in. lathes, a shaper, and two grinders in operation showed 2.5-h.p.

The shafting in the flue section is driven by a 10-h.p. shunt-wound motor, and operating a flue welder, flue cleaner, two No. 7 Jarecki pipe threading machines, and two pipe cutters. A test of the line shaft with all counters gave .6-h.p. A test of the line shaft gave .035-h.p. The line shaft is 90 feet long, 2½-in. in diameter, and has 12 hangers. A single flue welder with blowing fan attached required on starting up 7.1-h.p. Running light it took 3.4-h.p. The pipe cutter cutting 2½-in. pipe took .06-h.p. The auto-flue cleaner, cleaning 2-in. flue, took .2-h.p.

Outside at the end of the machine shop is a flue rattler operated by a 7½-h.p., shunt-wound motor.

The blacksmith shop is driven by a 40-h.p., shunt-wound motor, which is belted to 75-ft. of 2½-in. line shafting with 12 hangers. The apparatus driven comprises a bolt header, a 25-in. punch and shear, a cutting-off saw, a tool grinder, a 40-in. planer, a drill press, a 50-lb. hammer, a blower, and an exhaust fan. A test of the line shaft and counters with grindstone and two blowers constantly in operation gave 14.5-h.p. The bolt header added to the above gave on starting 7.8-h.p., running light .5-h.p., and heading 1-in. bolts 3.5-h.p. A No. 2 Hilles & Jones punch and shear added to the above, first condition, gave on starting up 5.5-h.p., running light .5-h.p., and shearing 1½-in. round bar 4.3-h.p.

The turntable is 70-ft. long and is operated by a 10-h.p., D.C. motor of the street railway type, geared to an independent traction wheel, the driving combination being supported in a pivoted frame, or "donkey," which rests with all its weight upon the turntable track, even when the table is tipped by a locomotive. The power is led to the motor through a sliding contact placed on the bridge above the centre of the turntable. With the table running light and the controller on full, a test gave 4.45-h.p. In throwing on the controller and accelerating up to full speed, 5-h.p. was attained, which dropped to a constant of 4.45-h.p. With a class S-2 locomotive on the table, weighing with tender approximately 286,000 lbs., a test gave 7.35-h.p., when accelerating to full speed. When full speed was attained, the test showed 5.43-h.p.

Switchboard readings of the ammeter and voltmeter in the power-house were taken every five minutes from 1 p.m. to 5.30 p.m. with averages of 220 volts and 250.7 amperes, or 73.8-h.p. The minimum current was 200 amperes, or 59-h.p., and maximum current 300 amperes, or 88.5-h.p., the average of which is 250 amperes, or 73.75-h.p.

These tests were carried out by H. M. Palmer and George H. Gibson, of the Westinghouse Electric and Mfg. Company.

MARTIN'S METHOD OF COPPER MANUFACTURING.

Editor Canadian Engineer:—

Sir,—Referring to my article on Copper Manufacturing, etc., I am under the impression that the copper business in Canada is nearly wholly confined to smelters using the blast furnace process for producing matte, and then afterwards bessemerizing this in converters (Manhes' patent), and producing crude or blister copper, which they dispose of to the refiners, who after refining it, sell to the manufacturers. These refiners, I take it, would not be very numerous in the whole of the United States and Canada, but they are the people who would be the likely ones to adopt any such process as I have described in my article, and really the only ones who would derive the most important advantage, viz., that of utilizing the refinery heat for rolling, and also the effect produced by working on the metal whilst it is still in a somewhat plastic condition, viz., that of a sounder and more compact structure, a most important one as well, as you will understand. By partially carrying out manufacturing, and adopting the process, the above refiners might then supply an unfinished product, such as "broken-down plates" and "broken-down bar ingots," to the manufacturers of the final products (such as sheets, plates, bars, rods, etc.), the above unfinished products of the refiners taking pretty much the same place as billets in the steel trade, being a product which the steel producers sell to bar rollers, wire drawers, etc. Here in Wales, the smelters are usually manufacturers as well, but there are one or two big exceptions, and of course the smelting process is the Welsh or Swansea method by reverberatory furnaces. I shall be glad to be put into communication with the copper refiners and manufacturers in the United States and Canada. H. J. Martin.

49 Walter Road, Swansea, Wales, April 8th, 1903.

MAGNETIC STORMS AND VOLCANIC ERUPTIONS.

The following is an abstract of a paper read before the Association of Ontario Land Surveyors at its recent annual meeting by Arthur Harvey, F.R.S.C., Toronto, who has made a special study of his subject and carried out a series of original investigations:

Disturbances in terrestrial magnetism are certainly connected with activity on the sun. A kind of solar fever occurs about every eleven years, developing for three or four, during which spots break out upon his face in increasing numbers and area. Then, during four or five more years, they slowly die away, and the ensuing period of repose is followed by renewed and similar symptoms. Thus the great heart of our system beats, and the pulses are felt through the universe; for magnetic forces are most active upon the earth, as they are on every planet and comet, when the sun is most bespotted. Sun-spots are only a product of solar activity, but they serve as indicators of the processes going on within or upon the huge ball of glowing gases, which radiates heat, light, and (it now appears), electricity. The quantity of this electric energy is so great that we can scarcely think it all comes directly from the sun at the time it is displayed in magnetic storms. The force exercised in a few hours of such a storm is more than that of all the heat and light radiated by the sun for months—so Lord Kelvin proves by a simple transformation of the equation of energy—which appears impossible if it is all to come from the sun in that limited time. It rather seems as if the magnetic forces accumulated near the earth's surface are brought into play by the excess of the solar impulses which now and then occurs, as a powder magazine may be exploded by a torch. Such magnetic disturbances are usually associated with particular spots or spot groups.

Any of the components of magnetic strains can be used to demonstrate this association, but I prefer the records of the horizontal force. If a magnetized bar be suspended east and west by a couple of threads, it strives to get into a north and south position, and the effort varies with the magnetic stress of the moment. A mirror on one end of such a bar is made to reflect a ray of light on a strip of sensitized

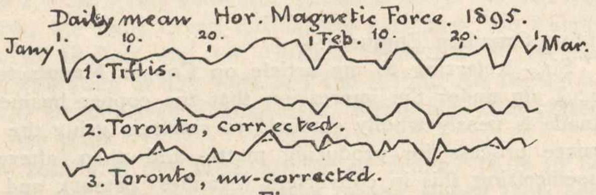


Fig. I.

paper moved by chronograph, and we thus get a record of the changing power of the earth, considered as a spherical magnet. Disturbances, not masked by local circumstances, are to be noticed at the same time all over the globe, and the curves in Fig. 1 exemplify this fact. No. 1 shows the "daily mean" readings for January and February, 1895, at Tiflis, in the Caucasus; No. 2, the "daily means" at Toronto, corrected; No. 3, the same, uncorrected; that is, as read from the actual photographic traces. In the last you will notice a hump every seventh day, and if you will remember that in 1895 our Sunday street cars were not running, which caused this variation in the local earth currents, you will understand why in Montreal they object to have a wireless telegraph station near their observatory. We had to get our magnets moved from Toronto to Agincourt because the readings were interfered with, as you may see, and the small variations, of great importance to science, became unreliable. Making allowance for differences of scale, of magnetic saturation, of latitude, etc., the two curves 1 and 2 are alike, though the observatories are a hemisphere apart.

For years I have been insisting, and the fact is now becoming recognized, that there are regions on the sun more active than others, just as upon earth there are volcanic and non-volcanic areas, and, since the sun seems to turn around in about four weeks, magnetic disturbances should be repeated here in that period, so long as the special solar activity which produces them continues. This is a necessary consequence of the association referred to, and that it does take place, though with certain irregularities yet to be explained, is an additional proof of the connection. It may be seen in the curves of Fig. 1; the dip of January 6 repeats in the storm of February 1 and 2, and again February 28; the disturbance of January 20 repeats on February 16. The storm of January 2 appears slightly January 29, and intensely on February 24 and 25. Whether sun-spot area or magnetic disturbance is the better measure of solar activity has yet to be determined; they harmonize remarkably. Whether the active areas continue at work for a few months only, or again break into eruption in the course of time, is not yet certain. Possibly I have, by the aid of the fine series of Toronto magnetic records, traced the more or less intermittent action of a particular region for forty years.

The magnetic traces often exhibit peculiar jerks at the beginning of disturbances. Prof. Young, in his work on the sun, mentions having seen a rapid movement in a spot, and on obtaining from Greenwich the photo-magnetic record, noticed a couple of these jerks or nicks at about the time he saw the solar phenomenon. We have had no confirmation from subsequent comparisons of such etherograms from sun to earth, and that the immediate cause of the jerks is solar is, I think, "not proven." The storm warnings are there, however, to be as plainly read as if they were messages sent in the Morse alphabet by mortal telegraph operators.

Another close coincidence connected with these jerks is now giving rise to a belief which is more certainly erroneous, viz., that the volcanic explosion which destroyed St. Pierre, Martinique, caused a magnetic storm. There have long been suspicions that sun-radiations had something to do with causing eruptions and earthquakes, and the two schools might be left to combat each other, since their theories are mutually destructive, but it is rather cowardly not to join in the fight. Wild as the latter theory may seem, I regret to attack it, but after tabulating the dates of scores of eruptions

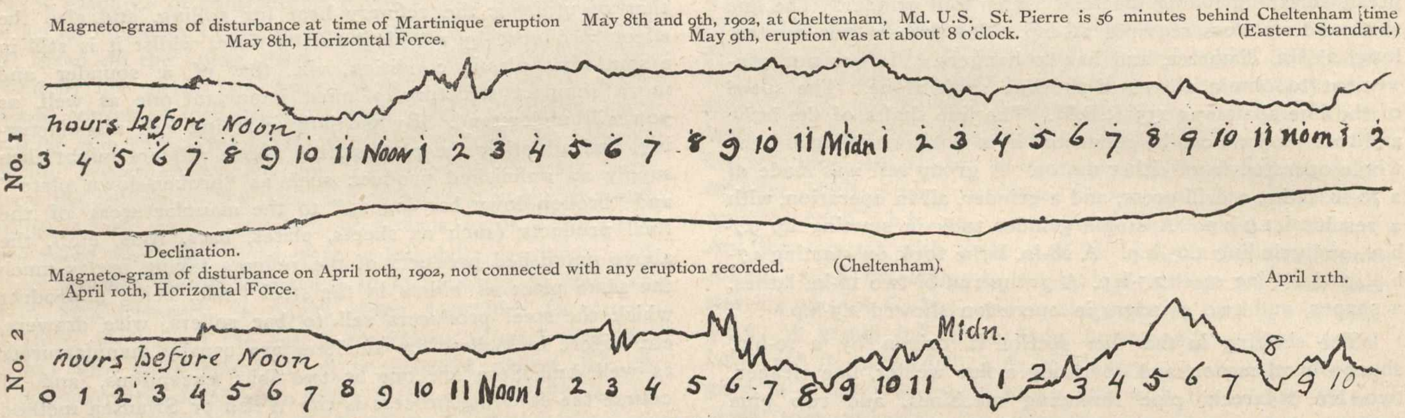


Fig. II.

I find that while those of some volcanoes seem to agree with the periodical sun-spot curve, others do not. I have in my desk a series of figures, sent in MS. by the International Solar Institute of Montevideo, in which it is shown that, assuming the rotation period of the inner and radiating sun to be 27.25 days, all the 44 Mexican earthquakes from 1611 down, recorded by the Antonio Alzate Society, correspond to the time at which a certain solar meridian faced that part of the world. This I can comprehend, but I do not yet understand how Don Carlos Honore, the director, can locate, as he does, the solar latitude, and I hesitate to accept the honor of having this exact solar region, between 17°-50 and 19°-50 solar longitude, named after me "Seisma de Harvey." Leaving this theory then also with the Scottish verdict, I will review the other.

Figure 2 shows the photographic trace of the Horizontal Force, as recorded at the observatory of the U.S. Coast and Geodetic Survey at Cheltenham, Md. Mr. Stupart has kindly shown me the Toronto trace, which is of course similar. I have also a despatch from Prof. Wolfer, of Zurich, that at Munich, Bavaria, a precisely similar storm was recorded at the same time. The "jerk" to be seen at 7 o'clock occurred nearly at the minute when the Cathedral clock at St. Pierre is said to have stopped—allowing for difference of longitude. The deviation from a straight line of the following part of the trace marks the subsequent magnetic storm. But the disturbance as a whole was only a repetition, at the usual interval, of one which occurred in April, and that again of one which had taken place in January, of which feeble echoes were noticeable in February and March. These disturbances were also connected with sun-spottiness, which reached its maximum for January on the 10th, was nil in February, attained the maximum for the year on March 7th, was nil in April, but was evinced again on May 5th or 6th. These dates are separated by the solar rotation period of about 28 days. And in all cases the magnetic disturbances followed within three days, that is, after the related spots had been central on the disc, possibly carried in advance of the active region by currents in the solar atmosphere. The argument then is: If the storm of May 8th, 1902, was the recurrence of a periodic disturbance, and was connected with sun-spottedness of the usual rotational kind, it had its real origin months before, and was not caused by the eruption of that date.

To prove the above assertions as to recurrence, Fig. 3 may be referred to, which is the curve of daily mean readings from January 1st to June, 1902, Hor. Mag. Force, Toronto.

At the time of the Mont Pelee eruption a readjustment of the earth's equilibrium was in progress, all around the Carribean basin, and is still proceeding, with eruptions and earthquakes in St. Vincent, Mexico and Guatemala, as well as in Martinique. Apart from its dreadful human interest, the destruction of 30,000 lives in one brief instant, the St. Pierre eruption was a comparative trifle. Dr. Tempest Anderson, one of the commissioners sent to examine it by the Royal Society, sums up this aspect of it in the "Geographical Journal" for March: "Not only has the amount of erupted material been much less, but its distribution has been much more local than in St. Vincent. . . . It is wonderful how small have been the changes produced, smaller than even those in St. Vincent, and from the point of view of the physical geographer they can hardly be called considerable, neither the carrying away of a few small bridges, nor the formation of a small mud-delta at the mouth of the Riviere Blanche."

Curve of daily means, Hor. Force, showing the second to be a return of the first, at the usual interval, a solar rotation. (Toronto Records). Also of storm of Jan'y. 15th and 16th.

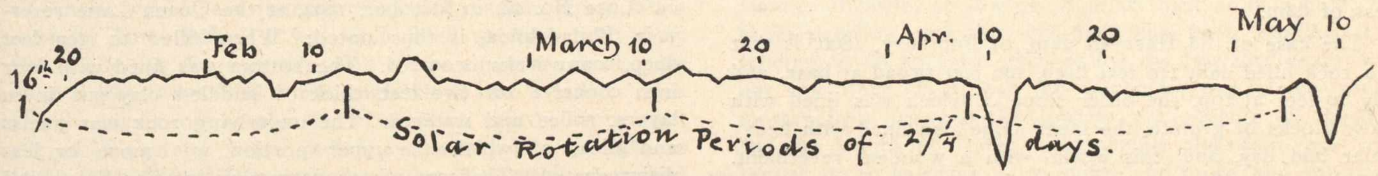


Fig. III.

In comparison with the explosion at Krakatoa in August, 1883, which flung up towards the heavens half a good-sized islet, of which the noise was heard thousands of miles away, of which the very dust was floating over the earth for years in sufficient quantity to change the character of summer sunsets, this Martinique eruption bore a very insignificant proportion. There was no magnetic storm in August, 1883, no jerks in the traces, and I am forced to consider that the storm and the jerks which are to be noticed at the time of the destruction of St. Pierre are merely fortuitous coincidences. Such, at least in the meantime and pending other investigations, ought to be the attitude of science, which should never be afraid to look facts fairly in the face, and honestly question them before arriving at conclusions.

Note.—On March 6, Colima, in Mexico, broke out into violent eruption. On consulting the magnetic record here it appears that on the 4th at 16.20 o'clock the peculiar jog in the trace appeared, which often marks the beginning of a storm. The subsequent disturbance lasted until March 5th at 18 o'clock, when it ceased, all but the small serrations and minor waves which continued for another day. There were no sudden jogs on the 5th or 6th. The solar energy which caused this terrestrial magnetic disturbance also produced at the usual rotation interval the sun-spots which have been recently observed, and it is interesting to note that exactly eleven rotations of twenty-seven and a quarter days elapsed between the magnetic disturbance of May 8th, 1902, which succeeded the Mont Pelee eruption, and that of March 4th, which preceded that of Colima. But the Colima eruption cannot have caused the storm, which it followed, and since the sequence of events differed in the two instances, it is evident that a means of reconciling discordant facts must be found before the new theory can be adopted—that volcanic eruptions cause magnetic storms, which in the preceding article the author has opposed.

A plant has been erected at Charlotte to crush the feldspar obtained near Kingston, Ont. It is then shipped in bags to Philadelphia, where it is worked up into door knobs, generally known as porcelain.

DAM CONSTRUCTION AND FAILURES OF THIRTY YEARS.

Charles Baillairge, C.E., of Quebec, who has rightly held that there is more to be learned from the failures than the successes of engineering works, and who has in the past given the readers of The Canadian Engineer some interesting notes on cases of failure in Canada, contributes to the Canadian Society of Civil Engineers a paper dealing with celebrated dam failures of the past thirty years.

The following is a summary of Mr. Baillairge's paper:

The Camden, N.J., reservoir, which failed last October, had an embankment made of sandy loam, measuring 70 feet at base, 10 feet across the top, with a height of 20 feet. The inner face was lined with some 18 to 24 inches of stiff clay, covered with one layer of common brick, set on edge, and, apparently, at one time grouted, although when failure occurred nothing remained in the joints but mud. It had been built some thirty odd years ago.

Accidents thus lead us, while looking for the cause, to discover deterioration which might otherwise have remained unnoticed for years to come, or until, as occurred at the Bouzey dam in France, by the rotting away of its binding matter, the carrying away bodily of the dam or of a portion of it, by the mere weight of water moving it forward on its bed; as also, at Austin, Cal., in 1900, though not, in that case, due to the same cause of deterioration of binder. The Camden dam did not, however, fail through this cause, though it might have done so later, by percolation, through the stiff clay underlying the brick lining and thence through the sandy and non-retentive material of the embankment proper. It was due to omission to close the influent pipes to the reservoir, thus allowing the water to overtop the embankment, and gradually breach it from the top downwards by erosion.

The writer would remind those who construct dams for water powers for the diverse purposes of pulp mills, waterworks and electric and other works, of the theory advocated by him in a paper read before the Society, on "Dams and Retaining Walls," which is, that in designing dams in general, the thickness at any point of their height should be equal to the height of water above that point, including depth of overflow. Had there been no overflow at Austin, the dam would have stood the pressure; but the overflow was twelve feet, which would have required an extension of or addition to the thickness, of as many feet, and have required the dam at top to be at least twelve feet in thickness or equal to the height of water overtopping it. The author then quotes from "A list of failures of American dams," reported by W. R. Hill, C.E., to the American Waterways Association.

Out of forty-nine cases during the last thirty years the following are given as samples of different dams:

The first case was an earthen dam, some twenty feet high, fifty feet broad at base and twenty feet at top, at Middlefield, which, in April, 1901, was destroyed by an overflow; though, on account of its having a double core or walls or partitions in it of sheet-piling, with rip rap faces on the up and down slopes, it could not be seen how such a thing could happen. It was destroyed by overflow, and it could not be well seen how the overflow had brought about the result, on account of the two walls of sheet-piling within the dam and reaching to the top of it or nearly so. The over-rushing water had first worn and carried away the outer or lower section of earthwork with its rip-rap. When this was gone, the outer partition or wall of sheet-piling, only a few inches thick, being unsupported, leaned forward and fell over. The scour then took hold of the earthwork intervening between the fallen row of sheet-piling and that remaining; washed this away, causing the other, or inner wall, or wooden partition or bulkhead, to follow the first, and finally, the upper third, or inner section of the embankment to go with the remainder.

In the next case which occurred at Victor, Cal., in May, 1901, and another at Lebanon, Ohio, in July, 1882, the dam in each case being of earthwork, without either core or protecting walls, and the heights respectively twenty-five and thirty feet, the destruction occurred by overflow or erosion; an inadequate spill-way obtaining in the first case, and no spill-way at all in the second.

Five other cases are of earthen dams; but one of these failures was due to an insufficient spillway. The second had a central wall of sheet-piling. The third and fourth core walls of stone masonry. The latter had a stone core and wall of puddled clay, the better to secure its impermeability. All these earthen embankments which would have probably withstood either percolation or displacement forward, are said to have been destroyed by flow of freshet water over crest of dam.

The case of the Hassyan dam, of February, 1890, is that of a rock filled dam 110 feet high, 140 feet broad at base, and only 10 feet at top, the outer slope of which was lined with heavy blocks of granite, the inner slope also lined with heavy ashlar laid dry, and this again with a wooden revetment. Such loose structured embankments might, sooner or later, have failed by percolation, except possibly through the wooden lining, so long as undisturbed, and if driven to an impermeable foundation; but, as it is, the above is said to have been destroyed by overflow, its 26 feet waste-weir being entirely inadequate.

In the foregoing cases, the damages done to adjoining or riparian property ranged from $50,000 to $800,000, and the loss of human life from 7 to 150.

In the memorable case of the Johnstown dam, across the south fork of the Conemaugh River, in May, 1889, the people drowned have been variously estimated at from 4,000 to 10,000, and the damages at $9,000,000. This dam had been constructed in 1852 as a feeder for the Pennsylvania canal. It was of clayey earth, some 75 feet high, 20 feet wide at top, and with outer slope of one and a half to one, and inner ditto of two to one, with slight rip rap lining; its breadth of base being 272½ feet. It contains 5,000,000,000 gallons of water, and hence the immense destruction and loss of life. The grave mistake, says Mr. Hill, was made of having a depression in the crest of the dam towards the centre of its length, and again the spill-way, already too narrow in its construction, was further obstructed by a fish screen, grating or railing. Freshet waters overtopped it, wearing it away, of course, to begin with, at the depression in the crest, until some four hundred feet of its length were washed away.

The next ten cases are all those of earth dams, some with core walls of masonry or puddle, others with outer or inner protection walls of stone, clay, puddle, brick, stone or wood lining, in each of which cases, it is stated, leakage made its way around influent or effluent conduits of iron or steel, where it is extremely difficult to form an impermeable junction; and this cannot but be a caution to engineers to see that all areas around pipes running through embankments be most carefully attended to, some process of roughening the surface of conduits for the purpose, either by striation or hacking with a cold chisel being necessary.

The next category of occurrences is where the foundation has proved unreliable, and has either settled under the superincumbent weight of the dam or proved pervious to water, as at the city reservoir of Ronoake, Va., in 1888, as well with the double reservoir at Knoxville, Tenn., and at Coushahochen, near Philadelphia, in 1873, where the bottom lining of clay, 18 inches thick, broke away, was repaired, and failed again in 1876, 1879 and 1880.

In 1894 the reservoir at Portland, Oregon, lined with five to six inches thick of concrete in which were imbedded at every two feet, both ways, three-eighths inch square twisted steel rods; the concrete cracked before water was let into it and a serious leak and other cracks appeared in bottom lining.

At Philadelphia, in 1894, after the Roxbury reservoir had been in use for nearly a year, fissures occurred in the bottom, through which the water leaked out, coming to the surface 1,200 feet off, and to repair which it cost $140,000. Now, in explanation of these fissures, Pennsylvania, not being subject to volcanic action, or the seismic workings of earthquakes, the writer suggests that the fissures brought to light had, theretofore, existed and been filled in with earthy, sandy, or clayey material, which under the pressure of water, were, within the delay mentioned, washed out, thus allowing the water to percolate through them, and crop out as it did at a distance from the site of the reservoir, and the settling of the embankment; and the washing out of the clay from under the brick lining can be due to nothing else than percolation of this clay by the water through said fissures to the outcrop at a distance; showing that any such fissures should be looked for in advance by denuding the surface, cleaning out the fissures of their clayey material and filling the interstices with concrete.

Case No. 28, in October, 1894, at the Queen Lane reservoir, Philadelphia, is thus stated: When filled to ten feet deep, many leaks occurred. The bottom was lined with four inch concrete on two feet thick of puddled clay put in in layers, rolled and watered. The underlying rock was gneiss and mica, of which the upper portion was more or less disintegrated. The cost of reconstructing interior lining and foundation was $275,000. It is probable in this case that had the surface been thoroughly examined and all soft and spongy places picked out of material honey-combed by worms or other burrowers or dissolved out by surface water or swollen out by the action of frost, and the voids properly filled in with concrete and rammed down, or with solid clay, before the bottom or puddle of concrete was put in and settlement thus avoided, this expense of repairing would not have had to be incurred.

Another case was a stone dam, 40 feet high, 8 feet thick at top, and 25 feet at bottom. This, according to the writer's views, was too thin, the thickness being ⅝ only of the height, instead of equal or nearly equal thereto, which it should have been. In January, 1869, while under construction, a freshet carried away 160 feet of it, and scoured out a cavity 20 feet deep in the river bed. The cavity was filled with loose rock, and a timber apron, filled with concrete placed upon it. Twenty-two years afterwards (1891), 250 feet of the dam were carried away by the undermining of the loose rock under the apron.

A clay dam with no core to it, at Dallas, Texas, 29 feet high, failed, and it is supposed by the running away of quicksand from beneath it, which caused it to settle, emphasizing again the necessity of investigating the nature of the foundation to a solid rock or unyielding bottom.

A masonry dam at Calaveras, Cal., 35 feet high, was carried away in 1895, supposed to be due to undermining as an excavation was being made along its upper face to remove a cotton tree stump of which the roots extended under the wall; but it is just as likely, the writer thinks, that it failed, due to want of proper weight to resist the water pressure, its thickness at bottom being only two-thirds the height and reduced, thereafter or higher up to a thickness of 13 feet, or less than half of the remaining height.

The Mill River reservoir dam at Williamsburgh, Mass., was of earth, 600 feet long and 43 feet high. It is stated to have been undermined by its core wall not extending down as it should have done to a solid and impermeable bottom.

Another case is that of a dividing wall of a reservoir, at Little Rock, Arkansas. This wall of masonry, 36 feet high was but 12½ feet thick at base, and 7 feet at top, with 7,000,000 gallons of water at each side of it. Now, when the water was drawn off from one side for repairs it is evident it had the same pressure to bear as a dam wall proper, and as its thickness at base was but one-third the height, it must have been evident in advance that it would give way the moment one side of the reservoir was emptied.

A reservoir at Scranton, Penn., failed in 1895. It was of rubble masonry with dressed granite faces and only ten feet thick, with a height of 20 feet. It was flanked with buttresses, but these were 24 feet apart when they should have been but half that distance to be of any service. The wall failed for want of thickness, the base being but half the height instead of equal.

An interesting case, bearing on the question of curved dams, was that at North Field, Vt. This was of wood, 100 feet long, or length of arc with radius, 40 feet. It was entirely built (evidently not by an engineer) of hemlock timbers, all 10 feet long and 12 inches square. The logs were laid only one thick or deep, the one overlying the other to a height of not less than 25 feet. All the logs were butted the one against the other without any halving or dovetailing, each series of 25 logs in height forming a chord or face of a polygon, or, rather, of a portion of a polygon of 40 feet radius. This circular or polygonal wall of 100 feet on the curve was lined on the inside with three inch deals, laid upright, and even these were not laid "broken-jointed," but butted the one upon the other. All the logs were tree-nailed the one to the other. Had such a dam been straight, it is evident it would have immediately failed, broken down, fallen over, or burst before it was even filled to its height of 25 feet, while, on the contrary, due to its curvature, it is only after it was twice filled within eight days that it failed. This may be taken to warrant the assumption that a stone dam curved in plan to proper radius, and with joints so tight as to be incapable of one stone becoming dislocated or pushed through between those adjoining it, would offer more resistance to the water pressure behind it; though, as Mr. Mansergh, the ex-president of the Institution of Civil Engineers of England, says, the advantage of a curved dam could only be advocated for one short span, with absolutely unyielding abutments. This, Mr. Baillairge argued in a paper before the Canadian Society last year, where he showed that the lock gates of a canal, if straight across the lock, would be burst open by the pressure, while they derived their strength from being thrown into a curve and thus rendered equivalent to a trussed structure.

A Montreal dam, built of stone masonry, backed with puddle and then with an earth and stone embankment, which is said to have leaked in 1896 to the extent of 350,000 gals. per diem, due to ice pressure, near the high water line. Other failures have been ascribed to ice pressure.

The last case cited by Mr. Hill is the dam across the Colorado river, near Austin, Texas. It was 68 feet high, built of masonary, with cut stone facings, costing $1,000,000; some 500 feet in length of it, out of a total length of 1,275 feet, having been bodily carried down stream, due to insufficient weight or thickness to stand the pressure, when the flood overtopped it by 12 feet, as already stated. Of course, it cannot be argued in this case that there was inadequate spill-way; for since the dam was nearly a quarter of a mile in length, and the flood rose to 12 feet above it, no adequate spill-way could have been provided to deal with such an overflow. The only reliable provision in such a case would have consisted in foreseeing the probability of such a rise in the water, or the remotest possibility thereof, by even going back forty to sixty or one hundred years for flood statistics of the river. Such a costly structure would endure a century or more, as it would, if of a thickness or weight calculated to resist the water pressure capable of being brought against it by such an overflow. It should have been of such solid construction as that of the Eddystone lighthouse, where the stones are dovetailed and bolted together.

The author advocates that unless dams be built either in courses normal to the apron of the structure, so that to give way, the water pressure behind the dam would have to force it up and over an inclined plane, or unless its component stones be dovetailed together, both horizontally and vertically, and bolted together and to a solid rock bottom, as just mentioned in relation to the Austin dam and Eddystone lighthouse, failure will likely occur. Where, in the course of time, the binding material or cement as at Bouzey, in France, already alluded to, may become disintegrated and reduced to its primary elements of sand and lime dust, the dam should, at any point of its height, be of a thickness equal to the depth of water above that point, and of such additional weight or thickness as may correspond to any probable or even possible overflow during freshets. He is glad to see that engineers, of their own independent bent of mind, are now reaching this standard. The Lachine dam is fully up to this standard of thickness. The Chambly dam would also have reached the same standard had its weight not been so much decreased by a series of sluice gates in such close proximity to each other. The Chaudiere dam is also more than fully up to the standard required, though in this case it may be prudent, as suggested by the writer, to build within it an inclined apron of crib work to allow ice shoves in the spring to pass clear over it; as, otherwise, the additional pressure due to a large body of floating ice driving against the dam, might overcome not only its weight, but also its adherence by frictional resistance and jagging into the bed of the river, even though toothed or keyed into the bed rock.

Our Lorette dam, Quebec waterworks, is, in respect of solidity and durability, a model of its kind. Built by the late George Baldwin, of Boston, it is as thick as it is high, even at its overflow, and this overflow has been eroding it or tending to do so since 1852, or for the last fifty years, without any other effect than the washing away of the cement mortar from between the granite components of the dam; and the height of water overtopping the dam has often ranged up to as much as 20 inches and more, and sometimes even to a depth of 30 inches, and during all this interval of half a century, nothing more serious has happened than the disintegration of the binding mortar from between the apron stones and of some of the outer face stones thereof.

The Quaker dam, New York, now under construction, which will be the highest and longest in the world, comes up to the required standard. If the ratio of its breadth to its height at every point is not equal to depth of water to be impounded above that point, the structure makes up for deficiency in weight by its splendid and thoroughly bound construction.

The dam by Sir Benjamin Baker, across the Nile, at Assouan, some 600 miles above Cairo, in Egypt, also thoroughly sanctions the idea that to be on the safe side, in view of the possible destruction or disintegration hereafter of the binding material, leaving nothing but the weight of structure to resist that of impounded water, the dam should be twice the weight equivalent to any pressure of water, so that the friction of stone upon stone or the force to be exerted in overcoming such friction, being 0.5 of its weight, water being only a little less than one-half the weight of masonry, one may be on the safe side in making the dam at least twice the weight due to pressure of the water impounded.

At the Quaker dam a spill-way is provided, and where a dam has only the watershed behind it of a mere island as Manhattan, there never can be such a danger of overflow as at Austin (or elsewhere), where a large portion of a continent may bring in its contingent now and then, and where the overflow of the dam might possibly have been guarded against by such a system of flood gates as Baker has provided at Assouan, not only for irrigation purposes during drought, but to prevent the eventuality of such an overflow as that which, at Austin, carried away the very dam itself.

We have, fortunately, few cases to register for Canada, that of Chambly being one in point, and one at Chicoutimi, referred to elsewhere.

For the benefit of those who have not read Sir Benjamin Baker's recital of how he mastered the difficulty at Assouan, of building a dam through a rapid where there were fifteen feet depth of water rushing past at a velocity of fifteen miles an hour, over the roughest rock and bouldered bottom; upon consultation with the contractors, he caused to be dumped into the river, below the site of dam, an immense quantity of the heaviest stones obtainable, many of which weighed from twenty to thirty tons or more. As some of these were moved by the rush of water, he caused to be dumped into the rapids, railway cars with heavy irons and stones, tied and bolted to them, so as to obtain masses of fifty tons weight, which could resist the force of the stream, and then covered the whole with thousands upon thousands of sacks of sand. Having thus created over one-half of the river, at a time, a comparatively impervious barrier, and raised the waters on the inside of it to the quiescent state of a lake, he could thus employ divers pnt in his temporary dams, and lay out his foundations in a more leisurely manner, though even so, as quickly as possible, and under almost constant anxiety that some flood would occur in the interval and wash everything away.

To bring this paper down to date in its conclusions, the author refers to the engraving published in The Canadian Engineer in February, 1903, showing the second failure of the Chambly dam, but this time of a section where there were no sluice gates to weaken or lighten the structure, as in the portion previously washed away. The conclusion is therefore inevitable that the dam was not of sufficient weight, nor was its base so grooved into the underlying bedrock, to prevent it from being pushed bodily forward.

THE GRADIENT-TELEMETER LEVEL AND ITS ADVANTAGES ON PRELIMINARY WORK.*

Now-a-days, when events are making such rapid history in the engineering world, the most deeply-felt want is for methods which will yield the necessary information at the minimum cost of time and expense. With this object in view, instruments of the Gradient-Telemeter type have been invented and placed before professional men for trial from time to time. The present article merely deals with the particular class of instrument mentioned above, as in the writer's opinion it is in many respects unique and worthy of a separate niche in the temple of instrumental fame.

Now that transcontinental railways, colossal irrigation systems and other engineering enterprises are actually taking definite and practical shape, the question of improving upon the old-time methods of gathering preliminary details (especially in unexplored territory) becomes a momentous one, which is to some extent satisfactorily solved by the telemeter. The instrument consists of an ordinary Y level (14 inch), with the addition of a compass and a gunmetal circle. The whole principle upon which the instrument works is contained in this circle, which is a casting made in the shape of a cam; that is, in place of the circle being truly horizontal or at right angles to axis it is curved out of the horizontal, and consequently causes the telescope to tilt either upwards or downwards when revolved, through a vertical angle. The circle (or gradient limb) is graduated around three-fourths of its circumference with numbers commencing at 1,200 and terminating with 10. Certain numbers are selected and classified as pairs, each pair being engraved on the remaining one-fourth of the gradient limbs circumference for reference. The advantages of the telemeter are: 1. The automatic measurement of distance, which dispenses with the services of two chainmen; (2) increased accuracy in measurements through rough and broken country; (3) the measurement of vertical distances either up or down hill from 1 to 140 feet (in ordinary practice) with one sight and from one station, in place of the limit being length of rod as with an ordinary level; (4) compass being adjusted to read at right angles to line of sight, so that telescope can be clamped on rod and magnetic bearing taken, thus dispensing with picketman. Briefly, then, two men (an instrument man and rodman) can make a traverse, with accompanying levels at all necessary points, leaving the two chainmen and picketman available for duty elsewhere. For more accurate traverse work, the makers add a horizontal circle at small additional cost.

As to the method of using the instrument, it may be understood that no particular technical or mathematical difficulties bar the way, in fact, the strong point in this instrument is its perfect simplicity in design and theory. By clamping the index at zero on the cam, the telemeter becomes an ordinary Y level, and any readings taken at this stage are treated exactly as those of a level in the field-book. By moving the index from zero to 100 in the cam, we use the first pair, i.e., 0 and 100, and the difference between the two readings (on rod) gives the horizontal distance without any calculation, each vertical foot on the rod representing 100 feet horizontal measurement. With all succeeding pairs, however, the telescope is necessarily tilted for each reading, being directly influenced by the position of index on cam, and although the method of obtaining horizontal distance remains unchanged throughout the pairs, the calculation for difference in elevation follows this formula: For a rise reading (uphill), divide the distance measurement by either of the pair numbers used; add height of instrument to quotient; deduct the rod reading belonging to the pair number used as divisor, and the result will be difference in elevation between ground surface at instrument and ground surface at rod. For a fall (or downhill) reading, the same formula applies, except that the rod reading is added and the height of instrument deducted.

A most important automatic check on each pair of readings, together with the calculated result, can be obtained by unclamping the index and swinging the telescope until the horizontal cross-hair intersects the rod at the exact height of instrument, which is measured by a tape with a plumb-bob attachment hanging beneath centre of instrument. Assuming the H.I. to be 4.85', the leveler moves telescope around gradient limb until he obtains this reading on rod; the vernier is then clamped and the reading on 8. limb taken; this reading is the distance in which a rise or fall of one foot occurs between ground at instrument and ground at rod, so that the difference in elevation (between these points), divided into the distance, should give gradient reading as quotient. This check is especially valuable in tracing clerical errors where the pair numbers are correctly entered, etc., and in obtaining the grades of country traversed with rapidity.

In telemeter work it is necessary to reduce the levels as they are taken in the field. This of course involves constant calculation all day long, but a little practice soon renders it a mechanical process performed mentally, and the prospect of reducing several miles of telemeter levels after reaching camp is a strong incentive to rapid field-work.

As regards the distance that can be covered in a day with the telemeter, the writer has completed nine miles through fairly rough country, but this included the picketing of a line by the writer and his rodman, and the sketching of all topography along the line in a specially designed field book. Generally speaking, the telemeter is at a slight disadvantage with the level in level country, as two readings must always be taken, but this is more than compensated for by distances being obtained without the aid of chainmen; also, all the information is entered in the leveler's field book, and thus condensed. In rough country, however, the telemeter (being able to negotiate vertical heights up to 140 feet in one sight) can leave any level a long way behind, to say nothing of the chainmen. Of course, to obtain a large vertical difference in one sight, a long base is necessary, owing to the fact that the vertical angle increases in direct proportion to distance between rod and instrument. It, therefore, follows that, to obtain the best results with a telemeter, a really first-class telescope, with powerful lenses, is necessary, and any telemeter telescope not fulfilling this condition should be promptly rejected. The instrument used by the writer gives a very clear reading at 1,200 feet distance (horizontal). It may here be noted that the distances obtained by telemeter pairs are in all cases horizontal ones between rod and instrument.

For setting out railway curves, the maker combines a graduated horizontal circle with the gradient limb or cam at a small additional cost, thus adding to the instrument's efficiency. For setting out distances the subtense method is used, based on the following rule:

If any two integers whatever be taken and used as divisors into the distance required, the result will be a gradient pair, which, being applied as any ordinary pair, will give on the rod a subtense in feet that is equal to the difference between the two selected integers.

* From a Paper read before the Canadian Society of Civil Engineers, by R. W. Macintyre, A.M. Can. Soc. C.E.

Example (selected integers 2 and 9)

Distance 150 feet $\div$ 2 = 75 } Gradient pair.
Distance 150 feet $\div$ 9 = 16⅔ }

Difference 7 giving subtense 7 feet.

The gradient pair is 75 and 16⅔; set up and send out rodman in direction of required line; move index to 75 on gradient limb and take reading which assume to be 10.42 feet, unclamp and set index at 16⅔ and take second reading, which should be 3.42 feet, if the rod is exactly 150 feet from instrument; but as this is most important in ordinary work, it will be found necessary to move the rodman nearer or further until the subtense representing distance required is read on rod. Where distance to be set out is a constant one, a table of subtenses, with integers and resultant gradient pairs, can be easily prepared beforehand. The greater the subtense the more accurate the setting out will be.

Regarding the accuracy of telemeter levels, the writer's experience is that the checking in is not usually so close as with an ordinary level, but that there is a certain amount of give and take, which limits the difference to within 1 foot in any distance of consequence, such as 75 to 100 miles. The rodman is a most important factor in obtaining satisfactory results, and should be selected with careful judgment. A rod-level should always be attached to the rod in the field, as a truly vertical position at right angles to the line of sight is absolutely necessary, or, in other words, a plumb-line suspended at the side of rod should strike the centre from top to bottom. This rule, however, does not apply to the face of rod, which must always be slanted over either to the right or left, so that the vertical hair in diaphragm will intersect the centre of rod-face throughout its length. The reason for that is, that when the telescope is tilted up or down, by being moved around the gradient limb to the pair numbers selected, the diaphragm (in common with the telescope) leans over to one side or the other, so that the cross-hairs are only truly vertical and horizontal respectively when the index is at zero on the gradient limb, and the instrument leveled up.

A valuable property of the telemeter not generally known is, that distance can always be measured by using any pair, whether the instrument has been levelled up at zero or not. For example, assume a 16-foot rod to be 1,000 feet from the instrument and a level reading of 8 feet is obtained as foresight. The instrument man cannot get the distance (by tilting either up or down) at the corresponding pair number of 100, for in the first case he strikes 2 feet above the top, and in the alternative case 2 feet below the foot of rod. However, after booking his level reading, he can depress or raise the line of sight by using the levelling screws, and then, having the whole rod to work upon, can obtain the distance by moving index to the pair number. Gradient pairs which do not include a level (or zero) reading can also be calculated from by this method, but the result will only be approximate, and such readings should only be used for intermediate sights.

The telemeter gives very satisfactory results in the strongest winds, and will stand a good deal of travelling in rigs, extremes of temperature, etc., without getting out of adjustment. It is not designed for particularly accurate work in cities, etc., but for preliminary and even final location, contour work and exploration, it is a very decided success.

CHICOUTIMI.

Its New Dam—Its Waterworks and Electric Light—Its Pulp Works—Its City Improvements.

BY CHAS. BAILLAIRGE, C.E., QUEBEC.

On the occasion of my second visit to Chicoutimi, at the request of the municipal council, to report on its waterworks, etc., a few words, now that these works are more advanced, will not be uninstructive to readers of The Canadian Engineer. I had about two years ago to describe to you—with a diagram of the occurrence—how the destruction of the Chicoutimi dam was brought about, by the pressure of the water impounded causing a tiny leakage around the foot of the dam at its western end, which then abutted against a cliff of clayey and sandy material, while the eastern end thereof closed in upon a solid promontory of rock. This tiny leakage was not long, however, in wearing away a passage for itself, increasing soon to the dimensions of a drain, then to those of a sewer, a culvert, and soon to the size of a veritable tunnel, the roof of which fell in, when 100 feet in width of the cliff, several hundred feet of it in length, and its height 60 to 70 feet, was in a very few hours washed away—some 300,000 cubic yards of it—into the Chicoutimi river (the outlet of great lake Kinogami), and thence into the Saguenay of which the waters were rendered undrinkable for a whole week after the occurrence.

The dam has now been rebuilt with sluice gates as before to let off the freshets as required, while the 100 ft. extension of it westward to meet the new line of cliff, has been constructed as a core-wall, some 4 ft. thick at top, 7 to 8 ft. at base, and over 30 ft. in height, of hydraulic cement, rubble or mosaic work; and this core is now flanked on each side by earthwork to a slope of 1½ or 2 to 1; while on the up-stream side the foot of the embankment is protected by heavy stone-filled crib-work, extending up stream so far as to preclude all danger of future rupture; or substantially on the lines prediated by the writer in his description of the occurrence at the time.

The total length of the dam is say 300 feet—head above Racine street, level 270 feet, or more than 300 feet above the waters of the Saguenay river. The depth of the water impounded is 30 feet; the penstock, 13 ft. in diameter, with inlet splayed to 14-ft., and mouth of recess thereof, in dam wall, extended with flanks or sides further splayed to a size of say 20 ft.; while the shutting off of the water from the penstock, as may be required, is to be accomplished by the closing of three sluice gates, working vertically in frames of the stoutest timbering, lined with steel rubbing surfaces.

The general features of the power plant have been designed by Wallace C. Johnson, of Montreal, a member of our Canadian Society of Civil Engineers, and a Mr. DeGeer, a Swede, is on the ground as resident engineer, charged with seeing that Mr. Johnson's ideas are faithfully interpreted and carefully carried out.

The penstock, which, as already stated, is not less than 13 feet in diameter, is 800 ft. in length, and while starting at the fountain head, where the pressure is that due to a height of 17 ft. of water over roof of flume, with a thickness of steel plate of but ¼ to 5-16 of an inch, increases with the pressure of a fall of some 70 ft. towards the power house, to nearly an inch in thickness, where it enters it. It is built in rings, in sections of four sheets, each of some 10 ft. by 5 or 6 ft., the whole thoroughly double riveted. This tube is a splendid piece of work, prepared ready for putting together in Pittsburg, whence it has been sent with a Mr. McDermot, of that city, to superintend its erection on the premises, and a Mr. Wilson in charge of the aerial or cable railway erected by that gentleman to move the sections to destination, and save the expense and delay of transportation over the very rough and rocky bottom of the locality. Throughout the 800 feet between the dam and power house, this gigantic tube or water tunnel is supported at 10 ft centres on stone pedestals or pillar blocks of substantial build, with iron cradles to each, shaped to curve of tube, and each of a length of about 10 ft. or one-quarter the circumference of pipe. Nor need this be wondered at, when we find on calculation that each foot in length of such a conduit, with its contained water, comes to close upon 9,000 pounds, while its total length reaches three and a half million pounds or 3,529 tons.

Emile Cote, of Quebec, is contractor for all the masonry, including dam, power house and pulp mills, while Berlinguet and Lemay have been entrusted with the architectural features of the installation. Mr. Winsler, a Norwegian engineer, is the designer of the pulp work machinery, and will be retained by the company as managing engineer of the power works and pulp mills.

There are two mills: the first or smaller built some few years ago on the opposite side of the Chicoutimi river, and now worked by a separate flume from the fountain head, but which will hereafter be connected with the new and larger works, and worked by the tail water from the new structure, being as it is at a level some 80ft. lower than said structure. The output of both mills, it is expected, will be not less than 300 tons per diem. All the aforesaid works are under the general superintendence of Mr. Dubuc, one of the directors of the company, of which Gaspard Lemoine, of Quebec, Nemèse Garneau, and others are members, and the works in the aggregate will not cost less than one million dollars.

The city has a very efficient system of waterworks. The principal water main through Racine street is six inches in diameter, being an inch or two larger than those of several other places where the population is not greater than that of Chicoutimi--some 4,000 to 5,000. Again, the intake through the new dam has been made of not less than 24 inches diam., or of 16 times the capacity of the present main running through the city, so as to allow for any future extension or increase of population up to 50,000 souls.

The town is, moreover telephoned and thoroughly electro lighted with 3,000 16-c.p. lamps, with provision for electric tramways, all of which last works, and the aqueduct are managed by Engineer Casgrain, a brother of Senator Casgrain, of Montreal, also an engineer, and a brother of Mr. Casgrain, assistant engineer of the Quebec Waterworks Department.

Chicoutimi under its present progressive city council, headed by Mayor Savard, a gentleman of the medical profession, has lately had its roadways graveled, its thoroughfares flanked with double sidewalks, while its public buildings are of quite a monumental kind and architecturally stylish, to wit: its magnificent cathedral, its bishop's palace, its seminary, convent, hospital, its new city hall, the upper portion of which is to be used as a theatre and concert hall, etc. And last, but not least, the city is liberally provided with hotels, that of Nero—possibly a descendant of the Roman emperor—being of the Canadian type of true comfort; while its more pretentious sister the "Chateau Saguenay" puts on that style which is dear to our wealthy tourists of Canada, the United States and Europe.

Nor can I close this sketch without mention of Chicoutimi's well provided and efficient fire brigade, nor without mentioning that when the works in progress are completed, which they will be by the forthcoming spring, and the grounds and approaches leveled and trimmed off: the pulp works at about a mile and a half from the steamboat landing at Racine street, and the hotels, will be well worth seeing in all their picturesque surrounding frame work of forest bedecked rocks and cataracts, lovelier, if anything, than those we already know of at Grand Mere, and Shawinigan, and thence to Kinogami, where the company has erected an extensive barrage to store freshet waters, and let them out by sluices when continued drought may require it to supplement the then diminished flow of the Chicoutimi river.

DUTIES AND AUTHORITY OF AN ENGINEER FROM A LEGAL STANDPOINT.*

The public profession of an art is a representation to all the world that the person holding himself out as possessed of certain qualifications does, as a matter of fact, possess them, and that he can and will properly perform and complete any work that he may undertake with requisite skill and ability. There is consequently on the part of an engineer, employed to do certain work, a warranty that he is reasonably competent for the task he undertakes, and furthermore, he is responsible for those whom he may employ under him. It is also to be remembered that it is a general principal of law and equity that an agent is not allowed to make any profit out of his agency beyond his proper remuneration, and any sum of money so obtained must be accounted for to his principal. Where, therefore, an engineer entered into a sub-contract with a contractor without the knowledge of the employer, it was held that the employer could have such contract rescinded and that he could refuse to proceed with it in any shape. On the other hand, an engineer cannot without the knowledge of the builder or contractor, enter into a secret contract or engagement with his employer. For instance, if besides the contract between the employer and the contractor, there is an agreement between the employer and the engineer, of which the contractor knows nothing, that the outlay shall not exceed a certain sum, and the contractor is by his contract subject to the orders of the engineer as to what work he shall do, this agreement between the employer and engineer is not binding upon the contractor, and this restriction of the engineer's authority cannot in any respect prejudice the contractor's rights.

*Notes of a paper read before the Engineers' Club of Toronto.

No particular form of agreement appointing an engineer is necessary. The retainer, so to speak, may with two exceptions, be verbal or implied, from the acts of the parties or the circumstances of the case. This general rule has two exceptions. If the agreement is one which is not to be performed within the space of one year, that is to say, if in its nature it is such an agreement that the parties must have contemplated a continuation of the employment after one year, then such a contract to be binding must be in writing. This is governed by an old statute, known as the Statute of Frauds. The other exception is in the case of a corporation. A corporation, whether municipal or otherwise, can only express its intention, or make a contract, by deed or writing under its common seal. There are some every-day acts of necessity for which it would be absurd and unreasonable to require the corporate seal, for instance, cheques or promissory notes, but any transaction of any importance, not in the ordinary daily round of business, in order to be enforceable against a corporation, must be executed under its seal, and a number of cases have been decided in England and in our own courts, holding that contracts by corporations with engineers and architects not under seal are not bindig on the corporation, and this notwithstanding the fact that the architect or engineer may have performed considerable work on the supposition that the contract was valid. Do not, therefore, be content with a mere resolution or by-law of the company or corporation for whom you undertake to do work. There seems to prevail among engineers the impression that a resolution of a municipal corporation is all they require before proceeding with their work. This is a mistake. See that you get your contract on each occasion under the corporation seal.

There is no fixed rule in this country regarding the payment of engineers. In England there is some sort of tariff recognized by the Society of Engineers. The usual remuneration is by way of commission on the total cost of the work, and this remuneration should be defined by a written agreement. The local municipalities in Ontario are very chary about spending municipal moneys and are not disposed to pay professional men anything like a proper remuneration. Engineers in England are paid for similar work much higher fees than are obtained here. This results from the fact that engineers undervalue their own services, and they have themselves to blame for the inadequate fees that they receive. Preliminary plans are either made subject to a special contract for that purpose, or in the case of public competitions, to the terms of the advertisement. In the latter event the employer cannot make use of the plans if the competition is not proceeded with. In a Scotch case the architect prepared detailed plans. The buildings were not proceeded with but the proprietor used the plans to his advantage in dealing with the purchasers of the ground. The proprietor denied liability on the ground that the plans had been furnished on the understanding of there being a competition. The court, however, considered that it lay upon the proprietor to prove that the employment was gratuitous, and as he failed to do so, ordered payment to the architect of a fair sum. If an engineer agree to prepare such probationary plans as an employer should approve of, and fail to obtain such approval, he will have no cause of action, but if no time is fixed within which the plans are to be finished, the presumption will be that a reasonable time was intended. In the case of probationary drawings, all agreements should clearly set out the terms on which they are to be provided. If it is intended that the engineer should make a charge for such preliminary work under any circumstances or in any event for work actually done, a special clause should be inserted to that effect, and it is also advisable that a special provision should be inserted as to the ownership of the plans. Generally, it is laid down that an engineer or architect is to be paid for the use of his plans only, the documents remaining his property. There is really no law on this point, and a prevailing custom, if reasonable, would govern.

No question of the nature or extent of the engineer's authority arises where he is merely employed to prepare and sell his plans for a certain sum. It is where he is engaged to superintend the erection or completion of certain works that he becomes the agent of his employer generally, and a question which very frequently arises in litigation as to the extent of the architect's authority, is answered very unsatisfactorily by the broad statement that he is the general agent of the employer within the contract connected with the erection of the works. The usual contract between employer and contractor, as you are aware, states that the work must be done to the satisfaction of the architect or engineer and provides for his certificates, etc. The authority of the engineer is usually expressly given. Sometimes, however, it can only be inferred from the acts of his employer, and in this case the general rule is that the extent of the engineer's authority is as between the employer and contractor to be measured by the extent of the engineer's usual employment. As a general agent, therefore, the engineer has the apparent authority due to his position, and the employer is bound by his acts within that authority, notwithstanding specific instructions restricting that authority which are not known to the builder. The engineer is only the agent for his employer to see that the work contemplated by the contract is carried out properly. He cannot unless he has authority to do so, bind his employer to pay for additional work. Where therefore extra work is done by order of the engineer, the contractor must show authority in the engineer to give directions for extra work. Where the limits of the engineer's authority are clearly set out by express terms in the agreement between the employer and the contractor, the authority must be strictly followed, as the employer will not be liable for the acts of his engineer unless the authority be duly followed by him. At the same time, the courts are so far liberal in construing the authority given to agents that they held it to include permission to use all necessary, or even usual means of carrying out the main intention of the agreement in the best manner.

It is another general principal of the law of agency, which applies to engineers, that an agent cannot delegate his authority. Delegata potestas non potest delegari. For where a man employs another to do work for him he relies upon his ability, and it is not competent to that person to get another to do his work; but this must not be construed as a prohibition to the engineer to employ necessary people under him. For instance, the engineer might be justified, and ordinarily would be justified, in employing a surveyor to take out quantities. The rule simply means that an employer has a right to rely on the personal qualifications of the engineer and not to have the qualifications of some other persons substituted for them.

It would be well for you to bear in mind that an engineer, who orders materials or does some act professing to act for his employer, impliedly warrants to the other contracting party that he possesses the authority that he presumes to exercise, and he becomes liable to an action for breach of such warranty; so where an engineer represented to a contractor that he had authority to order certain building materials, and he had no such authority from his employer, he was held to be liable to the builder for their value, and it was also held that it did not make any difference whether his representation was fraudulently or bona fide made. To heap up the misery of the engineer, it was held that the builder could recover against him as damages the costs of the action which he had brought against the supposed employer, which action he had lost, it being held in that action that the engineer had no authority to bind the builder, Consequently, the builder had no action against the corporation, but the expense and damages and costs that he had suffered were held to be a proper charge against the warranting engineer.

As a general rule in building contracts it is usually a condition precedent to payment that the work shall be completed to the satisfaction of the engineer. In this case the right of approval must be exercised in a reasonable and not in an arbitrary or capricious manner. Such cases receive reasonable construction, and a jury would in case of dispute be asked to settle whether the employer ought reasonably to be satisfied with the work, and if so, payment would follow. Of course it is possible to provide by the use of proper and specific words that the architect's approval shall be quite arbitrary, and then no matter how unreasonable and oppressive the stipulation may be, the only restriction upon the right is that it must be exercised in good faith and not merely for the purpose of defeating the contract. In one case a clause provided that if the works did not proceed as rapidly as the engineer required, the engineer would have power to enter upon the works, pay off whatever number of men should be left unpaid by the contractor, and set other men to work, the amount so paid to be deducted from any moneys which might be due to the contractor, and it was held that the intention of the parties was to enable the employers, if dissatisfied, whether with or without sufficient reason, but so long as they were acting under a bona fide sense of dissatisfaction, to avail themselves of the terms of this proviso.

It is customary in building agreements to provide for certificates in writing of the engineer. When the agreement contains the usual provisions, these certificates are conditions precedent to the right of the contractor to payment, and the court cannot dispense with them unless there is some conduct on the part of the engineer or employer which would make it inequitable to insist on them. Therefore work which has been done under the supervision of an engineer, but not to his satisfaction, cannot be charged for by the contractor where there is the usual agreement calling for certificates and the engineer sees fit to withhold same. On the other hand, when the engineer has given a certificate, it is conclusive upon the employer, and the engineer cannot vary or repeal it.

There is a distinction between progress certificates and final certificates. Certificates given during the progress of the work merely control payments made by way of advance to the builder. These certificates are simply statements of a matter of fact, such as the weight and the contract price, and the materials actually delivered from time to time upon the ground. The payments made under these certificates are altogether provisional and are subject to adjustment or readjustment at the end of the contract. Final certificates are those which are given when the whole contract has been carried out to the satisfaction of the engineer. By virtue of these certificates the balance of the contract price is ascertained and becomes payable.

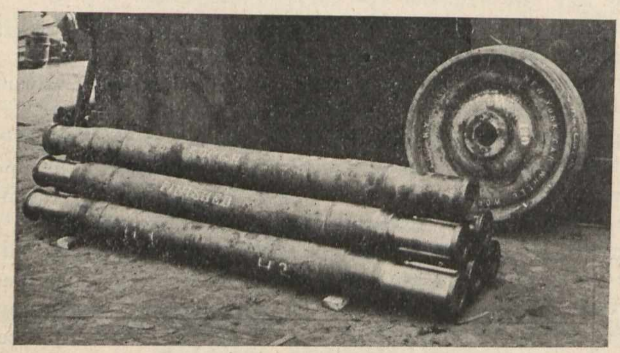
The principles governing the duty and authority of an engineer, as to extras, may be broadly stated as follows: First, it should be noted that where a contract provides that no extra work should be charged for, unless it has been previously authorized in a particular manner, such a provision, unless legally waived by the employer, must be strictly followed in order to enable the builder or contractor to maintain an action for extra work. For instance, if it is stipulated that no extra work shall be paid for unless the contractor previously obtains an order in writing, a verbal order will not be sufficient. Again, if the clause stipulated that for all extra work written instructions shall be given by the engineer, mere oral directions of the employer cannot sustain a demand for extra work unless the order amounts to an altogether new contract. And if the contract provides that all extras or additions shall be paid for at such price as may be fixed by the engineer, then the engineer's certificate is conclusive, not only upon the question whether these matters are extras, but also upon the question of price to be paid for them. The mere provision, however, that any dispute, difference or question relating to the contract should be settled by the engineer, would not give him power to adjudicate on claims for extras, for extras are matters without the contract, unless specifically provided for therein. Second, where there is no provision in the contract for extras, then the question simply is this, was there another contract for the extra work? And if there was another contract, had the engineer authority to enter into it? Generally speaking, if the written contract does not contemplate extras, the engineer would have no authority to order them, and it would be necessary for the contractor to show that the employer had either expressly, or by the general course of his conduct, given the engineer such wide authority, as would include the ordering of any extra work that he required. The engineer's duty is usually to see that the works contemplated by the contract are carried out in accordance with its terms, and he cannot bind his employer to pay for additional work unless he has been authorized to order it.

HOLLOW PRESSED AXLES.*

BY CAMILLE MERCADER, PITTSBURGH.

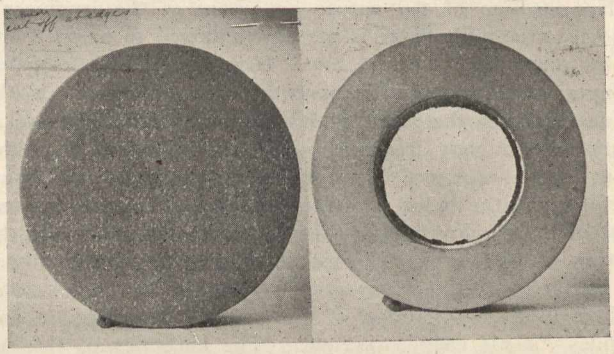
The axle is one of the most important elements used in rolling stock. Upon its strength depends the safety of the whole car superstructure, and upon its freedom from friction the economy in draft. While improved forms of construction have been devised in every branch of the railway equipment, the axles for tenders and cars have been rather neglected, and this portion of the equipment has only kept pace with the other improvements by increasing its size and weight to gain the strength necessary for supporting the greatly increased loads which are now considered standard. A few years past, who would have thought of 110-pound rails, 125-ton engines, 110,000-pound steel cars, and the many other improvements now considered necessary for the economical operation of our great railway systems ?

It is a well recognized fact that steel articles manufactured by pressing are, as a rule, superior to articles made by any other method, and the present tendency is to develop this method in every branch of the iron and steel trade, especially as it insures the most economical production of articles needed in considerable quantities and makes them



Mercader Hollow Pressed Axle.

perfectly true and uniform to the templet, permitting interchange of parts or the making of standard sizes. In order to produce, by pressing, an axle having varying diameters, the following method was proposed by the writer: A rolled round steel blank, uniformly heated, is inserted into a two-part die, having a matrix cavity in the form of a rough turned axle. The diameter of the journals is made equal to the smallest diameter of the axle in the centre, which corresponds to the diameter of the round blank. After the dies are clamped about the heated round the latter is axially perforated simultaneously at both ends by two cylindrical punches, which force the metal of the blank to conform to the shape of the matrix die and fill out the same. The round is heated up to about 1,000 degrees C. and the total hydraulic pressure required for penetration with a punch of 3 inches diameter amounts to about 50 tons. During the last end of the stroke a total hydraulic pressure of about 150 tons is required because the blank loses its initial heat through contact with the dies, and because the end collars upset, at which time the metal may flow back against the punch. Considering the small diameter to be pierced, and the length of the punch, this pressure required to penetrate the blank is, apparently, very small, and it will be conceded by all familiar with the work that a prerequisite to entering the blank lies in allowing the metal to flow freely in the direction of the forward movement of the punch. The presence of the an-



Centre and Journal Hollow Pressed Axle.

nular spaces between the blank and the die fulfills this condition, the metal flowing radially in the direction of the least resistance; the only back flow against the punch is at the end of the stroke. It is obvious that if this back flow existed initially the punch would bend and buckle before entering any great distance. The punch, being tapered, acts as a wedge and the pressure that can be exerted upon the axle blank is consequently enormous. In one of the experiments the heated blank happened to be smaller in diameter than the gripping portions of the dies, and hence was not clamped by them. In this case the punch pushed the metal endwise and upset the blank into the matrix die. The inability of the metal to flow against the punch caused the upper die head, a steel casting weighing 25,000 pounds, to spread, and under a pressure of 200 tons upon the punch the die and the die head broke in the centre.

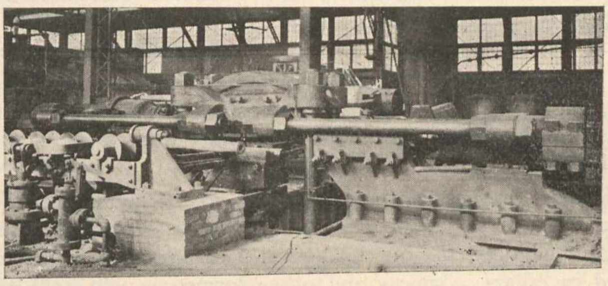
The strength of the cast steel die head was determined upon the basis of ultimate tensile tests of its material, and it was found that a total lateral pressure of 2,600 tons must have been exerted by the wedge action of the punch in order to break this casting. This occurrence shows that the metal blank, in being punched, can be subjected to an extraordinary pressure. This pressure is exerted throughout the entire length of the axle blank, for it is found that the central part of the axle, where the punch does not penetrate, conforms to the shape of the dies. It cannot be disputed that this great compression improves the quality of the steel in the central part of the axle by destroying the injurious effects of segregation and piping usually found in ingot steel. Regarding the temperature of the heated blank, it may be mentioned that it is absolutely necessary to have the greatest uniformity throughout the body of the blank, the temperature determining the resistance which the punch must overcome.

[Then follows the result of a number of experiments made at the Homestead works.]

Many experiments have been made regarding the material for the punches. Water cooled tool steel punches with cast iron points removably secured were first tried. Such a punch afforded the necessary stiffness, and the cast iron nose withstood heat to a great degree, being self lubricating and not liable to become welded within the blank. The securing of the cast iron nose to the punch was found, however, to be too weak, owing partly to the small diameter of the punch and partly to the fact that having at that time no cross rolls, the blank was not straight, and the punch followed the course of the blank and hence fractured, the nose breaking and remaining in the axle. Solid crucible steel punches were then tried, but it was found that by the great pressure exerted the point of the punch welded to the axle blank, requiring great power to extract it. The

* Extracts from a paper read at the May meeting of the Iron and Steel Institute.

point of the punch was covered with steel from the blank and was ragged, and therefore unfit for a second operation. To avoid the welding the punch was entered first for only six inches, then removed, the cavity filled with hard coal, and the punching operation finished. The punch being sufficiently lubricated by the gases from the coal, did not weld, but was caused to deviate on account of the coal not being evenly distributed around the punch. Solid charcoal iron punches were thereupon tested, but under the great pressure required for penetration they bent before entering the blank, deviating accordingly. If the temperature of the blank was high enough the deviation amounted to only about 1-16 inch, but if the steel was too cold, the punches broke in the outer part, the broken end remaining in the axle. In figuring the strength of these punches 35 tons are required to make them deviate 1-16 inch, showing again the small pressure required for punching. On the other hand, this deviation necessarily followed from the fact that the length of the punch was eight times its diameter, whereas it should not be over five times, according to accepted authority for cast iron. It may be twelve times the diameter for steel, or even more, according to percentage of carbon and treatment. As a result of these experiments high carbon Bessemer steel containing 0.9 to 1 per cent. carbon was adopted and the



Mercader Hydraulic Axle Press.

punch was found to be very stiff. To overcome the difficulty of the welding the ends of the punches were provided with drop forged steel caps. These caps rest on the point of the punch, fitting the same neatly, and are a little larger in external diameter than the punch, in order to avoid friction between punch and the blank, resulting in a minimum of pressure required for penetration. By the pressure the caps are welded to the blank. The punch, being protected from injury, is very easily withdrawn, and, after cooling, it is ready to receive a new cap for the next operation. This arrangement proved to be very satisfactory and practical. The caps can be made very cheaply, drop forging same from steel plates or skelpt, preferably made of axle steel. In order to avoid heating up of the punches the same are preferably black leaded, this being carried deep into the blank, the pierced hole having a greater diameter than the punch, owing to the slightly larger size of the cap.

The material employed for the matrix dies is best machine cast iron, water cooled to prevent a change in the shape and dimensions of the cavities. The dies show very little signs of wear and tear, and it appears that they will withstand the punching of a great number of axles, since the slight wear only smooths the inner surfaces of the dies. Further experiments in this direction might lead to the adoption of cast steel dies. To remove the axle readily all corners of the die are tapered and to prevent sticking the cavities are preferably black leaded.

In order to cover all possible conditions and emergencies in the manufacture of these car axles the press should be designed for about 350 to 400 tons, total pressure being about 1,500 pounds hydraulic pressure per square inch. To lengthen the life of the punches and avoid liability to their injury by the heat, the piercing should be carried out very rapidly. This can be accomplished in four to five seconds by connecting the hydraulic cylinders and the accumulator with a correspondingly large pipe line, and by using specially designed four-way operating valves. The auxiliary parts of the press require for their operation a hydraulic pressure of 500 pounds per square inch. The quantity of water needed is comparatively small.

With the experimental plant erected at Homestead, the time required to make one axle, all operations included, did not exceed two minutes. Allowing two minutes for cleaning and black leading the dies and for cooling and capping the punches, the capacity of one press will be 15 axles per hour, or 300 axles, 5½ by 10-inch journal, per 20 hours, which is fully three times the quantity accomplished with one hammer by the best American practice. The number of men required to operate the press remains the same as needed at the hammer to forge five 5½ by 10-inch journal axles per hour. The machine produces a strong and light axle which contains the cardinal combination desired—namely, minimum weight and maximum strength. The axles made have more resiliency than the present type, and are not liable to fracture from sudden strains. Their use in railway car construction results in material economy, not only over solid axles, but over any other species of hollow axles.

Broadly speaking, hollow axles are old, but such axles have been made either by casting them the shape desired or pressing them hollow throughout and then forging on a mandrel or by boring out solid metal. These methods are each objectionable, because they either fail to produce axles of sufficient strength and lightness or are too expensive for general adoption. The end portions of this axle are, of course, hollow, the cavities extending beyond the wheel seat, but this is an advantage because the forging action which is produced by the entrance of the punches greatly compacts and strengthens the metal and renders the axle less liable to break. The combination of hollow ends with solid centre has the advantage over hollow axles that all requirements for the drop tests and for torsion, produced in curves, are fully covered. It is obvious that a hollow axle will soon deform in the centre under the drop test, rendering the test uncertain.

It will be understood that heretofore, in the finishing of an axle, it has been greatly weakened by cutting away the outer skin, which has been compacted by the forging operation; but in the use of the present system a tough dense skin is produced on the interior of the axle by the forging action of the punches, and this skin is not cut away, but remains a permanent element of strength, and the tough external skin is cut away only at the end portions. It is unnecessary, as heretofore, to machine the axle throughout its entire length, for by the dies it is compressed to exact length and made so true that it is sufficient if only the journals and wheel seat portions are turned or machined.

The advantages of a hollow pressed axle may be summarized as follows:

1. The axle has a perfect form; its shape can be best adapted to resist the strain to which it is subjected with the least amount of metal, combining minimum weight with maximum strength.

2. The forging effect being carried out throughout the material, both internally and externally, the material is found to be far more homogeneous than solid axles made in the usual manner, segregation is destroyed and, consequently, the axle is much more reliable.

3. The journals, being highly compressed, will in finishing attain a more highly polished surface, thereby minimizing the friction, resulting in economy of draft.

4. The journals, being hollow, will remain cooler and permit the storage of a considerable quantity of oil, removing herewith the chief cause of hot journals, also economizing materially in the expenditure for lubrication.

5. No straightening after punching is required, the axle being as straight as the die, thereby eliminating entirely the injurious effects of the gagging operation.

6. No centreing, no cutting of the ends, no rough turning is required, thereby saving considerable in finishing labor and increasing the finishing capacity of existing plants.

7. The punching of treble the amount of axles as compared with forging with an equal number of hands, resulting in saving of forging labor.

8. Considerable saving in steam consumption and fuel.

9. The detection of a defective axle without performing

any extra work—that is, without the necessity of rough turning it over all, which provision is now included in the latest M.C.B. specifications.

10. Approximately uniform fibre stresses throughout the body of the axle, due to the straight and uniform taper between the wheel seats.

11. A saving of .33 per cent. of steel in the manufacture.

12. Present drop test specifications need not be changed.

13. The possibility of supplying uniform axles, limiting the weights and dimensions to a minimum.

14. The weight of a 100,000 pounds capacity steel car is decreased by 1.7 per cent., permitting this load, which amounts to 24,000 pounds in a train of 40 steel cars, to be carried without any additional expenditure of energy. Converting this advantage into other channels, there would be a corresponding saving in coal consumption or tractive power.

Industrial Notes.

Aluminum works in New Brunswick are projected.

Leitch & Adamson will build a flour mill at Weyburn, Man.

The Elmira Co-operative Furniture Co. is asking Elmira to loan them $10,000.

Getty & Scott, manufacturers of children's shoes, Galt, will double their plant.

The Perrin Plough works at Smith's Falls expect to turn out 3,000 sulky ploughs this summer.

A pork packing company has been organized at Belleville with Sir Mackenzie Bowell as president.

The Wm. Buck Stove Co., Brantford, has let the contract to Shultz Bros. to enlarge their works.

Perth is negotiating for bolt works, which will employ 100 men. John Dittrick's works will be taken over and enlarged.

Mr. Burrows is placing at Grand View, Man., the largest sawmill in the province. It has a capacity of 80,000 feet a day.

Dundas has voted a loan to the Valley City Seating Co., of $15,000, repayable at the rate of $1,000 a year without interest.

Building operations will be commenced at once on the Meaford canning factory, of which Mr. Smith, of Oshawa, is manager.

The name of the Toronto Portable Oven and Manufacturing Co. has been changed to the Warren Manufacturing Company.

By the use of electrical appliances three men now do the charging of 24 furnaces at Homestead, which formerly required 200 men.

The Lambe Wire Fence Co., a Michigan concern, has bought a site at London East, and will shortly commence the erection of a factory.

The Portland rolling mills, which were proposing to move to North Sydney, have decided to remain in St. John, N.B., in consideration of certain concessions.

The works of the Steel Corporation of Canada will be near the Welland Canal, and promise to be one of the largest and most important industries in Canada.

The Mechanics' Supply Co., of Quebec, intend opening an upper town show room at 101 and 103 St. John street, in that city, where they will carry a full line of samples of their various specialties in the plumbing, heating and electrical trades. They intend making this show room a credit to the ancient capital.

The Niagara Machine and Foundry Co., of Niagara Falls, Ont., is asking leave to increase its capital from $10,000 to $45,000. This firm started about a year ago making heavy iron machines and castings such as are used by the power companies in the development of electric energy at Niagara Falls.

An order for lasts has been received at the Granby last factory from New Zealand.

A large plant is to be established at St. John, N.B., to make mill refuse into wood board.

The Canadian Steel Company is applying for an act reviving and extending its charter and reducing the capital.

The old Moore and Macdowall sawmill at Prince Albert, N.W.T., is being fitted up by the Telford Lumber Co.

The Northern Elevator Co. has increased its capital from $500,000 to $1,000,000, and the Gorham Co., from $50,000 to $100,000.

Preston will vote on a bonus, by way of loan, to the Canadian Office & School Furniture Co., to enable them to enlarge their works.

A company of Vancouver capitalists, the Alberta Lumber Co., with a capital of $65,000, is about to build a new saw and shingle mill on False Creek.

By the bursting of an emery wheel at the Viau foundry, St. Jerome, Que., Joseph Leblanc was killed, and Thomas McCabe had his leg broken.

It is rumored that the dynamite company will install a plant in their old works at Tweed for the purpose of manufacturing fuse and detonating caps.

The Hamilton branch of the Canadian Association of Stationary Engineers held its sixteenth annual banquet on Good Friday. About 75 members and guests were present.

The Whitman & Barnes Manufacturing Co. at St. Catharines, manufacturers of reaping and mowing knives, knife sections and hardware specialties, are putting in a lot of new machinery.

Ernest Caron, mechanical engineer, and manufacturer of shoe machinery, Quebec, is the promotor of a factory for making artificial marble. All shades of marble can be imitated in pillars, cornices and other forms.

Delahey & Co.'s foundry at Pembroke is turning out about thirty sets of scales a day, for making which 7 tons of iron are melted. All the buildings, which are well equipped, are heated by steam and lighted by electricity.

Work is to be commenced at once on the plant of the Dominion Tar and Chemical Co. at Sydney. They will manufacture pitch, creosote oil, carbolic acid and other chemicals. They will start with six distillers. John Craven is manager.

The Deering Harvester Co. has let contracts for additional buildings at Hamilton to cost $250,000, and may spend a quarter of a million more. M. A. Pigott has the contract for all but the structural iron work, which goes to the Hamilton Bridge Co.

The building of two cribs in the lake at Peterboro at a cost of $2,000 was avoided by drilling holes in large rocks and sinking them where required. Boom chains were passed through the holes and a secure anchorage for the booms thus obtained.

The Dominion Iron and Steel Company are making considerable enlargements to their works at Sydney. These will include mills for making rods, plates and structural steel, 250 more coke ovens, a lime kiln, a mixer for holding molten pig iron and labor saving devices in almost every department.

Mr. McGibbon, of Lachute, Que., is said to be contemplating the establishment in Montreal of a new steel industry, a chief feature of which will be the adoption of the Hunter process, by which cast iron can be tempered like high carbon steel, and made available for axes, and other edged tools. The company will manufacture all kinds of machinery and railway castings, horseshoes, wagon hardware and steel castings.

An experiment has been made at the Valley Iron Works, St. Paul, Minn., which may revolutionize the iron industry. Titanic iron ore, of which there is a large quantity in Northern Minnesota, was smelted in an ordinary cupola and turned out pig iron which polished up like steel, and which, according to those interested in the experiment, is better than the finest Bessemer steel.

Wilson & Wilson, millers, Indian Head, Assa., are enlarging their mill.

The Ogilvie Flour Mills Co. is increasing its capacity at Montreal to 6,000 barrels a day.

Two of the Rathbun Co.'s dams near Bancroft have been swept away, involving a loss of $3,000.

A boiler in Petit Bros. mill near Comber exploded recently, and of three employees near at the time only one was injured.

The Oshawa wireworks have installed a Sylvester gasoline engine which they find to be a great improvement over the old steam engine.

The Malted Cream Crisp Co., of Detroit, manufacturers of pure food made from wheat, is looking for a place to establish a Canadian branch.

Beauharnois town council has decided to grant a bonus of $10,000 to Kilgour Bros. for rebuilding and enlargement of their factory recently destroyed by fire.

The E. Long Manufacturing Co., of Orillia, is asking for tenders for a brick foundry, 74 by 57 feet. It will be fitted with a 10-ton electric crane. The present foundry will be added to the machine shop.

The Carberry Machine and Manufacturing Co. has been formed, with a capital of $100,000, to acquire the business of the Jones Stacker Co., and the local machine works, and build a large modern factory.

The Berlin, Ont., Rubber Co., is about to erect a building of cement for offices and warehouse. It will be 100 by 50 feet, four stories high. They are going to make a two story addition to their boiler house.

J. W. Doherty, of Mount Pleasant, B.C., and Mr. Walker, of Moodyville, are about to establish a shingle mill on the Capilano, near Vancouver. A flume is being built to float timber from the upper reaches of the stream.

The A. F. of L., at Toronto, has settled the dispute between the electrical workers and plumbers and steamfitters as to who should do conduit work, in favor of the electricians. The question arose in connection with the new King Edward Hotel.

A boiler in Angus MacKinnon's sawmill at Coleman, P.E.I., exploded, killing Fred. Profit, fatally injuring John MacKay and a man named MacKinnon. The building was destroyed, the railway station shattered, and many houses in the vicinity damaged.

The cement works to be established, probably at Kingston, by Messrs. Gillies, to work up the marl deposits at Loughboro Lake, will have a capacity of 400 tons a day. Application is being made for leave to construct a railway between Kingston and the lake.

An exhibit will be made at this year's Toronto Industrial by the Clergue Company, showing the iron in the crude state and through the various processes, until it is turned out a finished steel bar. They will also show the process by which paper is made from the spruce tree.

The output of pig iron at the Dominion Iron and Steel Co.'s works at Sydney is being steadily increased. Under contracts that have been made a profit of a little over $5 a ton is being realized. A meeting is to be held on May 6 to decide upon the future policy of the company.

The McDonnell Rolling Mills, Toronto, have been purchased by the Toronto Bolt and Forging Co., the price paid being about $90,000. The latter has also purchased some twenty acres of land near the mouth of the Humber, upon which the erection of a factory is contemplated.

Vancouver lumbermen, it is said, are forming a company to erect a large sawmill near Melbourne, Victoria, for the manufacture of Australian hardwoods. The scheme includes the operation of a lumber fleet between British Columbia ports and Melbourne. The vessels could carry British Columbia woods which are in demand in Australia, and bring return cargoes of the rare Australian hardwoods. A concession of 50 square miles has been secured.

A great many strikes have taken place in industrial works in Canada during the last month. One of the most serious was at the Walkerville bridge works where 300 hands struck because asked to work 10 hours a day to fill orders during the busy season.

The Imperial Elevator Company, capitalized at $500,000, backed by Minneapolis capital, will enter western Canada. Contracts have been let for twenty of the seventy-five elevators which the company plans to build. There is a rumor that Minneapolis capital is being solicited for terminal elevators of large capacity at Port Arthur or Fort William.

The stove founders of the Maritime Provinces recently held their annual meeting at St. John, N.B. No business was done beyond electing officers. There will be no change in prices. The following are the officers elected: President, James Hillis, Halifax; vice-president, F. H. Wilson, Yarmouth; secretary, W. S. Fisher, St. John.

The Electro-Manganese Co., having a capital of $1,500,000, with power to increase to $10,000,000, is asking the New Brunswick Government for the use of the immense power at Grand Falls on the St. John river, to establish works for the electric treatment of wad or bog iron ores, which abound in New Brunswick, and from them get ferro-manganese with the ultimate object of establishing a large steel plant. The company is composed of United States capitalists.

The new mill of the Dowd Milling Company at Pakenham, Ont., is now in operation. It is arranged in two independent working divisions, the smaller with a capacity of 150 barrels, the larger 350 barrels. An addition accommodates the packers and provision grinders, which does away with dust in the mill. The lighting is effected by a 250 light generator, the surplus of which supplies the motive power to the 50,000 bushel elevator a half mile distant at the C.P.R., in connection with a large storehouse.

Within three months a plant will be established either in Montreal or at Shawinigan for the conversion of crude black copper into refined copper, to be followed by extensive works for the manufacture of the free copper into sheets and tubes. This method of copper treatment is quite new. The copper is separated from other minerals contained in anodes by a method not dissimilar to that by which lead is freed from other components in the matte at Trail. The machinery is being built in Glasgow. C. K. Milbourne, a British capitalist, is the promoter.

Plans have been approved ot by the American Sault Paper Company for pulp and paper mills at Sault Ste. Marie. The plans call for a wood pulp mill of 100 tons capacity, a sulphite mill of 50 tons capacity, and a news and fibre paper mill of 125 tons daily capacity; also water-power and electrical power development in connection with the Chandler-Dunbar water-power privilege and Edison Sault Electric Company. The cost of the plant will approximate $1,250,000. This is probably the mill spoken of in the Canadian Engineer when the new power canal on the United States side was opened.

The following fires have occurred: D. W. Carpenter's sawmill at North Augusta, burned.——C.P.R. wharves, sheds, etc., including about 20 C.P.R. and I.C.R. cars loaded with freight at St. John (North), N.B., burned, entailing a loss of about a quarter of a million dollars.——Woodworking building of Mayor Underwood at Calgary, burned.——Canadian Drug Co.'s warehouse at St. John, N.B., and G. F. Stephens & Co.'s paint and oil warehouse at Winnipeg, burned.——Herald office, St. John's, Nfld., badly damaged by escape of gas which took fire from the sparks caused by picks striking stones when workmen were making excavation to reach leak, and explosion of the gas.——Windsor cannery, Skeena river, B.C., burned.——Northern Elevator Co.'s elevator at Morden, Man., burned; engine room and gasoline engine saved.——Mill of Nelson, B.C., Saw and Planing Mill Co., burned; engine room saved.——Dominion Iron and Steel Co.'s warehouse at George's river, N.S., burned with 40,000 barrels of kerosene, gasoline and naphtha; fire caused by a lamp exploding.——Swan River Lumber Co.'s mill near Dauphin, Man., burned; the mill had just been equipped with new machinery.

Light, Heat, Power, Etc.

Chilliwack, B.C., is considering electric light and waterworks.

A local private telephone exchange is to be established at Westport, Ont.

The Bryan Mfg. Co., Collingwood, have installed their own electric light.

There is very little of the Montmorenci Falls power now remaining unutilized.

Three parties of engineers are at work laying out the course of the power transmission line from Niagara Falls to Toronto.

The Cataract Power Company, Hamilton, will erect a new transformer building near the Deering Works, to cost $6,000.

Among the patents recently granted in Canada is one to Harry Shoemaker, of Philadelphia, Penn., for a system of wireless telegraphy.

A telephone line is to be built from either Perth or Smith's Falls to Port Elmsley, where plumbago works have been established.

The sound made by a Marconi transmitter is said to be so great that it is necessary to put cotton wool in the ears to protect the ear drums.

Winnipeg has five or six proposals before it to furnish electricity from water powers outside the city. It may be taken up as a municipal work.

The American Cereal Co. and the Otonabee Power Co. are both after the contract for lighting Peterboro, and the former offers to extend and run the street railway as well.

By-laws have been passed at St. Mary's, Ont., to raise $20,000 for roads, to extend the waterworks and electric light service, and to place them under the management of commissioners.

The electrical development at the Soulanges Canal by the Light, Heat and Power Co., of Montreal, will involve the making of a channel about two miles long from the canal to the Ottawa river.

The fruit growers of the Niagara peninsula want a telephone system. They have been negotiating with the Bell Co. A committee, consisting of E. D. Smith, A. H. Pettit and others, have the matter in hand.

The Jenison plan for power development at Fort William, from the Kakabeka Falls, has cropped up again. An English engineer is to look over the ground for a new company, in which Winnipeg capitalists are interested.

Goldie & McCulloch, of Galt, have contracted with Fort William to supply the power plant for the new municipal system of electric lighting. The plant includes a 500 horsepower cross-compound condensing Wheelock engine, boilers, pumps, etc., and will cost $21,000.

Legislation will be asked from the Ontario Legislature providing that neither Port Arthur nor Fort William shall sell, lease, impair or part with the operation of its municipal telephone system, without consent of the ratepayers of both towns; that each town shall have right of free exchange over the other's system, and that the rates on each system shall be the same and be altered only on joint consent of both councils.

A plan to furnish electric light, power and communication over the same circuit has been patented by Alexander M. Stark, superintendent in Toronto, for the Bell Telephone Company. He uses a power current distributed at each subscriber's station to the subscriber's main circuit to furnish him continuously with power for his lamps, motors and communication instruments, and maintain the power current at constant tension by a storage battery bridged across the main power circuit between the generator and subscriber.

The Government will probably extend its telegraph lines in Cape Breton to the Marconi station at Glace Bay.

Brantford is giving the Imperial Natural Gas Co. a franchise to lay pipes under the streets and supply gas.

In adjusting the loss on the Fort William town hall recently burned, the insurance companies deducted 25 per cent. on account of increased risk from the municipal telephone plant.

The DeForest Wireless Telegraph Co. has presented to Toronto University a complete set of instruments suitable for short distance work, up to half a mile, and for laboratory experiments.

The two 1,000 K.W. Westinghouse steam turbine generating units for the De Beers mines at Kimberly, South Africa, have recently been shipped. These are the largest steam turbines that have yet been exported from the United States.

Jas. Ross, President of the Dominion Iron & Steel Company and the Dominion Coal Company, has completed in England a purchase of the City of Mexico Electric Light Company, for the Mexican Power Company. It has an exclusive franchise.

Berlin, Ont., town council and the Berlin Gas Co. have entered into an agreement whereby the town will pay $90,000 for all the latter's property, except the new building in course of erection, and take over the new building with its plant at actual cost price.

La Compagnie de Telephone du Canton Patton, with a capital of $2,000, headquarters at Saint Paul du Buton, has been incorporated in Quebec, to build, or acquire, and operate an electric telephone line, through the counties of Montmagny, Bellechasse and L'Islet.

The Peterboro town council is wrestling with the lighting question. The Otonabee Power Co. has put in a tender and the American Cereal Co. has also made an offer, the latter including the re-opening and operation of the street railway. The Peterboro Light & Power Co. is also in the field, and there is talk of the various companies amalgamating.

The Dominion Gas Improvement Co. is asking for a charter to build gas works, etc., to distribute gas and other agents for illuminating, heating, etc., and to acquire and use any inventions, franchises and business of any other person or municipality. It is believed this relates to the amalgamation of Quebec's two electric companies, the Quebec Railway, Light and Power Co., and the Quebec Jacques Cartier Electric Co.

A minister, living at Madison, Mo., finding that he could not reach an appointment to preach in time on account of the bad roads, remembered that almost every family could be reached by telephone, arranged with the manager of the system, and addressed his prayers and sermon to a battery of transmitters, from which it was conveyed over some 300 miles of wire to 326 receivers. An organ and choir gathered in the central office furnished the musical part of the service.

The suit between P. H. Patriarche and the town of Orillia has been decided in favor of the town. The plaintiff contracted in December, 1899, to build a municipal plant for transmitting electrical power and light from Ragged Rapids on the Severn River. The contract price was $71,000, with allowances for extras due to future changes in plans. In December, 1900, another agreement was entered into, and in August, 1900, an important change was made in specifications relating to the dam. For this Patriarche claimed $212,000, and alleged that there had been so many changes, additions and variations in the original plans that the works constructed are not the works contemplated and covered by the contract and specifications originally agreed upon. H. H. Strathy, to whom the case was referred, found that there was a contract for the sum named, and dismissed plaintiff's claim, but was willing to allow $44,673.39, if claimed as balance due on original contract and for extras, because of changes in the original specifications. This brings the total cost of the work up to $99,275.75. The town had offered to pay $100,000. Peter Ryan also appeared as a plaintiff, having a lien on the works.

The high price of coal in Greece has induced the promoters of a light and power enterprise at Tripolis to instal gas power. The fuel to be used will consist entirely of native lignite, which has been found to yield a gas of good quality, and quite suitable for power work. The plant will have a present capacity of about 125-h.p. and Westinghouse three-cylinder vertical-producer gas engines will be used. There will be two of these engines, each belted to a generator, which will supply the present demand for current. The engines will be supplied with fuel gas from Taylor gas producers, furnished by R. D. Wood & Co.

Extensive works are in progress by which Lakes Coquitlam and Beautiful will be connected by a tunnel over two miles long to supply Vancouver and New Westminster with a permanent source of electrical production. The tunnel is through solid granite for much of the way. The difference in level between the lakes is 32 feet. A dam is to be built 405 feet above the sea level, 300 feet long, 50 feet high, 35 feet at base, and tapering to eight feet on top. In seeking for a solid rock foundation, several preliminary shafts were sunk. When the proper locality was found, tunnels were run under the stream, and the site prospected over the bedrock. In doing this 500 feet of tunnel were run. At present, a temporary dam is being put in, so as to carry off the water by flume while the permanent dam is in course of construction. The power house will be so situated that even if the big dam did give way, the rush of water would not affect it. The lake, which will be formed by the dam, will cover 500 acres. The intention is to keep the water 20 feet above the outlet pipe from the big dam. From the dam to the power house is a drop of 400 feet in 1,600. The transmission line will cross Burrard Inlet by steel cable. The distance across is nearly half a mile.

Municipal Works, Etc.

Bithulitic is the name now given to tar macadam roads.

Vankleek Hill and Marmora are preparing to put down cement sidewalks.

Tenders have been let in Toronto for 74 concrete sidewalks, 23 of them to the city engineer.

The county of Wentworth has bought two road graders and is negotiating for a roller.

Sydney, C.B., has now a water system sufficient to supply a city of 25,000. A number of new mains are to be laid.

The Canadian Wheelmen's Association will petition the Ontario Government to construct and maintain cinder paths.

The ratepayers of Glace Bay, C.B., have decided to borrow money for extensive street improvements and a system of sewers.

The town of Galt and the Bell Telephone Co. are negotiating for a renewal of the franchise, which expired four years ago.

A drain in Lindsay became blocked and investigation showed that for about 12 feet it was filled with the fine roots of a maple which grew near.

Winnipeg city council has awarded the contract to John McDougall, of Montreal, for the supply of pumping machinery for extending the waterworks.

Lindsay has decided to purchase a 15-ton steam roller, and has appointed J. B. McWilliams town commissioner, to supervise the making of good roads.

Extensive improvements, including roads, sidewalks, drains, plumbing, sanitary improvements, etc., are to be made in the Industrial Exhibition grounds, Toronto.

A proposed system of waterworks at Port Arthur provides for pumping from Thunder Bay to a reservoir on the hill 250 feet high, from which the water would be distributed by gravitation.

The salary of C. H. Rust, Toronto city engineer, has been increased to $4,000. W. Jones, city commissioner, will get $2,650; W. E. Evans, his assistant, $1,300, and J. Bannen, engineer at the city hall, $1,200.

The ratepayers of Sydney Mines are considering the advisability of borrowing $15,000 for sewers. The Nova Scotia Steel Co. will instal a system of waterworks for the town, the source of supply being Pottle's Lake.

City Engineer Kerr, of Ottawa, is taking steps to put a stop to the needless waste of water. The amount of water pumped between 3 and 6 a.m., is as great as in the day time, due, the engineer alleges, to the practice of leaving taps open.

The dispute between the village of Eganville and the county of Renfrew over the new bridge has been settled. The village will pay the county $3,000, and the latter will finish the bridge and approaches with concrete sidewalks and iron railings.

The contract for sewer pipe at Brantford for 1903 has been awarded to John Mann & Sons as follows: 4-in., 6.75 per foot; 6-in., 10; 9-in., 19.60; 12-in. 33; 15-in., 45; 18-in., 57; 24-in., 1.10; and for cement to Thos. Ramsay, of Hamilton, brand Cayuga Lake, $2.34 per bbl. of 350 lbs. f.o.b. at Brantford.

The suspension bridge at St. John, N.B., is having a new flooring. The new steel bridge which the Government has constructed across the St. John river from Andover to Perth is now in use. It is 800 feet long. The contractor for the substructure was Albert Brewer and for the superstructure, the Montreal Bridge Company.

The cases against the town of Berlin for nuisance in connection with sewage disposal have been settled out of court on the basis of an injunction being issued, not to take effect for twelve months, no damages to be assessed until the expiration of the year, and then by the County Judge. In the meantime the town will seek to overcome the difficulty in their septic tank system.

The new bridge across the St. Francis, between Richmond and Melbourne, has the longest spans of any municipal highway bridge in Canada. It has two spans of 375 ft. each, is 40 feet high, 25 feet above high-water mark, and has three ice breakers, one above and two below, paid for by the Federal Government. The bridge itself cost $51,000. It takes the place of one carried away by ice in 1901.

A unique law suit is looming up by the town of Dunnville against the City of Brantford, for damages for having deprived it of an important industry. For several years the Buffalo Ice Company of Buffalo, has been getting its supply of ice from the Grand River, at Dunnville, where it stores immense quantities and employs a hundred men. The Buffalo Health Department condemned the ice, and this winter none could be harvested. The reason alleged is that Brantford discharges its sewage into the Grand River.

A leak in the Massena Canal threatened to develop into a break and allow the water to escape into the Grasse River. Men worked night and day and thousands of loads of stone, pressed hay, bags of sand, etc., were thrown into the break, which was along the spillway, and special trains run to Gouveneur for quarry waste. The earth kept caving until there was a hole 50 feet long by 12 feet wide and 40 feet deep, through which the water poured. A man was standing near the break when the earth crumbled beneath his feet and he was swept away. The break was finally repaired.

Bracebridge has water, light and power plants operated by the municipality with great success. Until two years ago the water and light service paid the town about $2,000 a year. Of late the town has installed a plant which by utilizing the local waterpower has enabled it to offer electrical energy to manufacturers at $12.50 per year per horsepower for a ten hours' service. At present the yearly expenditure is $8,000, and the cash receipts are over $7,500. Estimating the street lighting and fire protection at slightly under $2,000 a year, the plant yields a profit of $1,500 a year. In addition the town has cheap power for sale.

Railway Matters.

The Yarmouth, N.S., street railway is to be reopened.

The C.P.R. will this year build an extensive addition to the shops at Moose Jaw.

The C.P.R. extension to Kirkella, Man., has been located, and construction will shortly be commenced.

Engineers are at work at Belleville laying out improvements on the G.T.R. to accommodate the increasing grain traffic from Midland.

British Columbia is agitating to have the Dominion Government build a railway to open up the lower Okanagan and Similkameen Valleys.

Plans have been made for the elevation of the G.T.R. tracks in Montreal from St. Henri to Bonaventure station, which will cost $2,500,000.

The C.P.R. will build a cut off west of the bridge at Galt, which will give an easier grade. It will cost over $100,000, but will save a large amount of fuel in operating trains.

The Canadian Northern Railway Co. is adding to its equipment over 1,000 box cars, 3 sleeping cars (the first owned by them) and a number of baggage and stock cars.

The Canadian Northern expects to lay more track this season than has ever been laid in one year in the West, and to beat the record of the C.P.R., which was 446 miles in 1882.

Reports are coming in from the Trans-Canada survey parties in the field, and they all agree as to the great resources of the country through which it will pass, and its favorable character for railway construction.

A. J. DeB. Corriveau, of Montreal, has interested a number of United States capitalists in a scheme to build an electric railway through the Eastern Townships. The first line projected is to run between Montreal and Valleyfield and St. John's.

A party of Pere Marquette engineers have been making a survey for a line crossing the Welland canal between Allanburg and Port Robinson, thence through Stamford township to Niagara Falls, where a bridge will be built.

The Montreal Street Railway Co. will expend nearly $100,000 in repairs this season. New track will be laid with 96-lb rails on steel ties, embedded in concrete, with granite blocks between the rails and for 18 inches on each side. Twenty-five new cars are being built, with 28 foot bodies and removable windows.

The Galt, Preston & Hespeler electric railway is to be double tracked between Galt and Preston, half way this year, the remainder next. A cut off will be built in Preston to shorten the distance to Hespeler and to avoid the heavy grades at the crossing of the Speed. A more level connection will also be made with the C.P.R. at Galt.

The C.P.R. has ordered 242 iron bridges to replace the wooden ones on their lines. The companies that have secured contracts are: Canada Foundry Company, 69; Dominion Bridge Company, 160; Hamilton Bridge Company, 11, and the King Bridge Company, 2. They are all to be delivered this year. C. N. Monsarrat is engineer of bridges.

Mr. Lancaster, M.P., has reintroduced his cattle guards bill at Ottawa, but in view of the forthcoming report of the cattle guards commission it has been referred to the Railway Committee. The question of guards came up recently in the Utah State Legislature under a bill compelling railways to pay for animals killed on the tracks, whether due to accident or not. It was contended that such an act would encourage carelessness on the part of farmers, to which reply was made that railways never paid for animals killed until compelled by the courts, that all such legislation was controlled by the railways, and that "the railways ought not to have more rights than the people." Further consideration was postponed.

The terminus of the Temiskaming Railway has been fixed at North Bay, satisfactory arrangements having been reached with the C. P. R. An additional order for 1,500 tons of steel rails has been placed with the Cammell Company, thus bringing the total order up to 9,700 tons. There is every prospect that 72 miles of the road will be finished this year.

W. T. Jennings, C.E., of Toronto, has three gangs of surveyors working on a high voltage pole line between Toronto and Niagara Falls, crossing Hamilton Beach, but it is supposed they are also making surveys for an electric railway, probably the Electric Railway and Power Company between Toronto, Hamilton and the Falls, for which a charter was recently obtained.

An application by L. T. Barclay, of Whitby, and others for authority to construct a railway or tramway from a point at South Bay, on Lake Nipissing, in a general southwesterly and southerly direction, to some point on the Georgian Bay, thence to Lake Simcoe, and a point on the C.P.R. in the Counties of Dufferin, Peel or York; also from the Georgian Bay to a point on the C.P.R. between Myrtle and Peterborough; also from South Bay, via Callendar, to North Bay, is supposed to indicate a desire on the part of the C.P.R. to obtain a line between Toronto and North Bay independent of the Grand Trunk.

On the 24th of April, 1851, the directors of the Bytown and Prescott Railway met at Gilham's hotel, Prescott, to receive the report of the engineer employed to survey the lines and decide the route. Mr. Shanley made his report and produced the chart of four lines. The eastern terminus, it was stated, would in all probability be at the lower end of the town, almost in front of the Fort, and the line will thence take a northern direction to Spencerville or near it, and from there to Kemptville. From Kemptville it will pass up the east side of the Rideau river, entering Bytown in the Lower Town. The distance will be 52 miles and the cost, when completed, about £180,000. This road, one of the earliest built in Canada, is now part of the C.P.R.

The Grand Trunk report for the half year ending 31st December, 1902, has just been received. The following items relate to engineering features: The line worked by the company has been decreased 3 miles by the taking up of the remaining rails on the Chemong branch; the doubling of the track between Hamilton and Niagara Falls has been completed with the exception of a short distance between St. Catharines and the Welland canal; 9 miles of double track east of Whitby have been completed, and the remaining 24 miles to Port Hope will probably be done this season, which will complete the double track between Toronto and Montreal; 33 freight engines, 25 passenger cars, 1,000 box cars and 687 platform cars have been built in the company's shops and 355 box cars purchased; 14 new stations have been built. Work on improvements has been retarded by the difficulty in obtaining labor. Working expenses have been considerably increased by the high price of fuel arising from the coal strike. The gross receipts show an increase of 9.42 per cent., and the working expenses an increase of 12.39 per cent. On the whole the report is optimistic.

QUEBEC LAND SURVEYORS.

The land surveyors of the province of Quebec met in the Parliament Buildings, Quebec, on April 17th. A number of matters affecting the profession were discussed, and the following elected officers of the association: J. N. Gastonguay, president; Hon. J. P. B. Casgrain, and P. C. Talbot, vice-presidents; C. E. Gauvin, treasurer; F. X. Fafard, syndic. These, with J. E. Sirois, Ste. Anne, Kamouraska; Thomas Breen, Quebec; G. K. Addie, Sherbrooke; H. B. Tourigny, Pte. Julie; McLea Walbank and H. Irwine, Montreal, constitute the board of directors.

Hon. W. Pugsley, Attorney-General of New Brunswick, and other capitalists, have, it is said, bought ten gold quartz claims on Princess Royal island, off British Columbia, which an expert opinion thinks will run $100 to the ton.

Mining Matters.

A combine to control the mica mines of Canada is talked of

A geological survey of the county of Gaspe is being made.

A customs copper smelter is projected at Sherbrooke, Quebec.

A large find of copper is reported from Grand Manan, New Brunswick.

Gold to the amount of $80,000,000 has been taken out of the mines in the Yukon.

Mining in the vicinity of Vernon, B.C., promises to be unusually brisk the coming summer.

Sir Wm. Macdonald has given $500 to purchase radium for research work at McGill College.

A battery of coke ovens will be erected near Midway, B.C., in connection with the Ashnola smelter.

A new coal and petroleum field has been opened up on the Flat Head River, southeast of Kootenay, B.C.

Vast deposits of platinum are said to have been discovered in Siberia, where there is enough to supply the world.

A shipment of molybdenite is being tested at the Kingston School of Mines in concentrating, by J. Walter Wells.

Zinc ore is being shipped to Swansea from the Richardson mine on the K. & P. Railway. One lot of 700 tons recently went forward.

The Dominion Coal Company is about to acquire extensive coal areas at Port Morien, a large portion of which are underneath the sea.

Some $20,000 worth of mining machinery is being made by the Vancouver Engineering Works for the Cariboo Goldfields Company at Barkerville.

The output of arsenic by the Canadian goldfields was as follows: In 1899, 113,477 lbs.; in 1900, 522,400 lbs.; in 1901, 1,346,983 lbs.; in 1902, 1,600,000 lbs.

The National Corundum Wheel Company, of Clayville, N.Y., is mining corundum at Maberly, Ont. They expect to ship three or four cars a week.

United States capitalists are pumping the water out of the old Hollandia lead mine at Bannockburn, Ont., to make an investigation with a view to purchase.

H. C. Le May, of Pittsburg, Pa., a petroleum expert, has gone to Alberta to take charge of prospecting work for the Rocky Mountain Development Company.

The Elizabeth mine, belonging to the Anglo-Canadian Gold Estates, in Northwestern Ontario, has completed its plant and is beginning to turn out gold bricks.

The Deering Harvester Co. has purchased the John Armstrong corundum property in Hastings, and will use the material in their own business. The quality is very superior.

A method of lead smelting without fuel is said to have been successfully tried at Clichy, France. The production of white lead direct from ore is said to have been accomplished.

John Johnston, resident manager at Sydney Mines, for the Nova Scotia Steel Company, has been appointed general manager of the Dominion Coal Company, under G. H. Duggan.

The Canadian Corundum Company is about to put in at its mines, at Craigmont, what is said to be the largest concentration plant in Canada. The demand for corundum is increasing rapidly.

The Granby smelter, B.C., which has had two furnaces in operation has blown in a third, and will probably add a fourth, which will bring its capacity up to 1,600 tons of copper gold ore every 24 hours.

To flood the Dominion mine in Cape Breton and extinguish the fire, it was estimated 896,000,000 gallons of water would be required, which represents a lake 2¼ miles long, 1¼ miles wide and 6 feet deep.

Dominion No. 3 has the largest single rope of any colliery, and hauls more coal, it is said, for one rope than any colliery in Cape Breton. The rope is over three miles long. The output is 1,600 to 1,700 tons a day.

An immense area of coal land is said to have been discovered on the Flat Head river, East Kootenay, B.C., in the same belt as the Crow's Nest Pass. A large number of claims have been staked by Americans from Spokane.

The Denoro Mines, B.C., having been placed in funds will proceed with development work under the superintendence of R. H. Anderson of the neighboring British Columbia mine. With copper at 15 cents the outlook for Oro Denoro is considered bright.

The departments of mining and metallurgy at McGill College, Montreal, will be separate in future. Professor Stanfield will have charge of the metallurgical department, and Dr. Porter of mining engineering. By this arrangement more research work can be done.

An action is brought by the Log Cabin Gold and Copper Company against Frederick C. Fisk, Bertha C. Fisk and Charles Slack, at Buffalo, over the purchase of seven hundred acres of land in Ontario, the land being represented as mining property. Fisk is alleged to have salted the mine.

The mining rights on the Magdalen islands, Gulf of St. Lawrence, were recently sold for $32,000, and the islands for $70,000. They had belonged to the Coffin family ever since they were granted by the Crown, and have now passed into the hands of a syndicate composed of New Brunswick and Nova Scotia capitalists.

Copper mines are long lived. One of the oldest in the world is at Fahlun, Sweden, which has been worked 700 years, and has produced 500,000 tons of copper, fifteen tons of silver and one and a quarter tons of gold, representing a value of $277,500,000. In 1900 a single mine in the United States yielded 60,000 tons of copper. At that rate it will produce more copper in ten years than the Swedish mine has in 700 years.

Science and Invention.

A tidal wave visited Gore Bay, Manitoulin. It came in with tremendous force and smashed and piled up the ice in all directions. One man reports that the water went up 40 feet through a hole cut in the ice to procure water. A large number of fish were thrown up by the wave.

A Russian engineer has, it is said, discovered a deposit of natural radium. As gold is dirt cheap compared with radium the importance of such a discovery is obvious. Wonderful properties are ascribed to this new mineral, which has the power to project electrons through the atmosphere at the velocity of 120,000 miles a second.

In an iron refinery at Yon, Russia, is a machine to separate the iron from phosphorus and all other foreign matter without the intermixing of lime. Not only is the quality of the iron considerably improved, but the cost of refining and the use of other ingredients will be considerably lessened. The machine works entirely independent of heat or blast.

Artificial clay is receiving increased attention. It is used for the manufacture of artificial stone, tiles, gutters, etc., is composed of sand, chalk, cement, liquid glue and petroleum. The substances are mixed in certain quantities and a clay-like mass results, which can be formed at pleasure, and acquires an excellent degree of hardness by being subjected to heat.

The steam turbine has lately been used in the reverse direction for compressing air, an ordinary steam turbine being coupled direct to the air turbine. This air turbine is like the steam turbine, consisting of alternate rows of moving blades and guide blades, and is driven at a high speed, each row of blades increasing the pressure, and giving a steady blast.

According to a French contemporary, a good simple test for the poles of an electric apparatus is a slip of ferro-prussiate paper moistened and held on the pole. The negative pole makes a white mark on the paper, which, by the way, is the same as that used for making copies of engineering designs, where the lines appear on a blue ground. Old blue diagrams of this kind cut into slips will serve as test papers.

Gold mining in Egypt under British auspices is certainly a return to abandoned workings. Egypt was the gold country of the ancients. A papyrus has been found describing the mines of Akita, which were reached from the Nile at a point near the modern Dakka. A great mining people lived in the mountains between the Nile and the Red Sea in the days before the Ptolemies.

Emery is quarried in the island of Naxos, in the Eastern Mediterranean, whence it has been exported for the last two centuries. The material is much too hard to be dug out, or even blasted. The method of working is as follows: Great fires are lighted round the blocks till the natural cracks expand with the heat, and levers are then inserted to pry them apart. This system is continued until the blocks are reduced in size to masses of a cubic foot or less, and they are then shipped as if they were coal. There are said to be 20,000,000 tons of emery yet available at Naxos.

Acetylene lamps for a penny are now sold in London. The apparatus consists of a glass tube about 2-in. long and ½-in. in diameter, pinched in at the top to form a neck and burner and plugged with a cork at the bottom. The installation includes a piece of calico and a pill-box full of carbide particles. Gas is generated by dipping the rag in water, squeezing out part of the moisture and replacing it in the tube with a tiny piece of carbide. Acetylene immediately issues from the top, and when lighted gives a flame which at first is about an inch long, and then gradually dies down till the carbide is spent. A piece of carbide about the size of a pea will give a light for several minutes.

Marine News.

The C.P.R. has added the Elder-Dempster steamer Monmouth to their fleet.

A bad land slide occurred on J. J. Fallon's contract on the Cornwall canal. One man was killed.

It is proposed to spend $12,500,000 in deepening the Thames and providing docks and warehouses at London.

The St. Lawrence and Chicago Steam Navigation Co. has been authorized to increase its capital from $500,000 to $1,000,000.

The canal tug Hector, built by R. Abbey, at Port Colborne, for Hogan and MacDonnell, contractors, has been launched.

Owing to the increased traffic on the C.P.R., a daily steamship service will soon be established between Owen Sound and Fort William.

The harbor commissioners of Montreal have a plan for ice breakers to open navigation some weeks earlier than usual. It will be submitted to the Minister of Marine.

The Cunard Steamship Co. has commenced running certain of its vessels for second and third class passengers only. The Aurania and Carpathia will be used for this service.

The Esquimalt Marine Railway have secured the contract for the repairs to the British ship Belkneigh, injured by collision with the steamer City of Seattle. Their tender was $15,950.

The Great Northern Railway has made arrangements for shipping connections at Quebec. Ten large freight steamers, from 7,000 to 8,000 tons each, will ply between Quebec and London, Liverpool and Manchester.

It is probable a large new passenger steamer will be placed on Rainy river this year to ply between Warroad and Fort Frances. A steamer is also to be placed on the Saskatchewan between Edmonton and Battleford, by Capt. H. H. Ross, of Medicine Hat.

The new C.P.R. steamer Princess Victoria made the trip from England to Victoria via Cape Horn in 58 days. She ran at an economic speed of 13 knots but can do 19¼ knots.

A bottle containing a message from the crew of the steamer John Hall, which foundered in December off the Main Ducks, Lake Ontario, has been found on Stoney Island near Oswego.

The International Steamship Co. hope, with their new steamer Calvin W. Austin, to cut down the time between St. John and Boston to 14 hours, one hour better than by rail. Another similar boat will be built for next year.

A derelict buoy, marked Department of Marine, Canada, with bronze bell weighing 200 lbs., has been washed ashore on the coast of France. It is supposed to have drifted from Nova Scotia. When new these buoys are worth $1,000.

Michael Connolly has purchased a steamer in England for the Dalhousie-Gaspe service to replace the old Admiral. She has been in the Channel service between England and France and has cabin accommodation for 50 passengers. She is 250 feet in length, 31-ft. 6-in. beam, and a speed of 12 to 13 knots. She is a first class ship, being fitted with steam winches, steam derricks, steam steering gear and electric lights.

The A. E. Ames was launched by the Northumberland Shipbuilding Co., on March 31, and the J. H. Plummer, by Armstrong, Whitworth & Co., on March 28, and a third is building on the Clyde, for the Canadian Lake & Ocean Navigation Co. These steamers are 245 feet long, 37 feet beam, 24 feet deep, with lofty between decks arranged with eight large double side ports, and five large hatches for the grain elevators, so that they may be loaded or discharged in two hours.

PERSONAL.

Captain Andrew Miller, one of the best known and most popular steamboat men among the Thousand Islands, is dead.

Richard Martin, of Galt, has been made foreman of the finishing department of the Maple Leaf Harvest Tool Works at Tillsonburg.

H. J. Bowman, of Berlin, Ont., has gone to the Northwest to survey townships for the Government. L. T. Bray has also gone on the same business.

F. B. Polson, of Toronto, has been elected a member of the board of councillors of the National Metal Trades Association, which met at Buffalo in April.

Geo. Hancock, jr., is to take an interest with J. E. Westcott in the Grand River Metal Works at Galt. They will make barn door fastenings, gate hasps, shelf brackets, carpet stretchers, etc.

Archibald Naughton, the well-known railway contractor, who built a considerable portion of the Parry Sound division of the Canadian Atlantic and also the Ottawa and New York Railway, is dead.

Captain Wm. Leslie, a graduate of the Royal Military College, and son of a Kingstonian, is in command of the Royal Engineer Corps sent out with the British expedition to run down the Mad Mullah in Somaliland.

F. Brass, who was Master of Bridges and Buildings for the Middle division of the G.T.R., has been promoted to the position of general foreman, and C. H. Mitchell, who had charge of the bridges in the western division, succeeds him. G. F. Bishop succeeds Mr. Mitchell.

S. F. Parrish, M.E., recently appointed general manager of the Le Roi mine at Rossland, is an engineer of wide experience and ability. He was engaged in mining in Colorado for many years, and before his appointment to Le Roi had charge of the British Columbia Chartered Co.'s mine at Eholt.

W. J. Clark has been appointed superintendent of the Bell Telephone Co. at Toronto, in place of A. M. Stark, resigned. Mr. Clark has lately had charge of the long distance department, but will now have full control under the general manager. He has been in the employ of the company for 22 years, and has learned every department.

THE PERPETUAL MOTION WHEEL.

Editor Canadian Engineer:

Sir,—Re the pretty diagram of gravity motor in April number, it seems as if the inventor had overlooked the real centre of gravity of the movable balls which are to produce by their position movement or rotation. The point at C, where the track swung from the spoke, corresponds to the suspension point of the pan of a pair of scales or balances and the ball on the right exerts no more effect on the wheel than the one on the left. Further, the track cannot be level, as the pendent weights B will swing to right or left until compensation for ball J is reached. The main defect is that the inventor has overlooked the point that all the apparatus on the end of each spoke is only as efficient as its total weight. This being equal on the four spokes, the point of balance is obtained and the wheel will stand still. Were the wheel to be revolved by some external power the weights B would fly out by centrifugal force and the movable weights would not be of any effect whatever. Looking a little longer at the diagram it may be seen that there is no necessity for the automatic track, as the balls J would, if fixed, occupy the best positions for exertion of force, on the upper spoke and on the lower spoke, the centre, thus inactive, on the right hand spoke farthest from the centre (not of gravity) of the wheel on the left nearest to the centre of the wheel. In the diagram the automatic track has really put the ball J on the lowest spoke on the wrong side of the spoke. The design is pretty but it does not seem to bear analysis well.

J. M. Williams.

Hamilton, Ont., 20th April, 1903.

WEIGHT OF ICE ON WIRES.

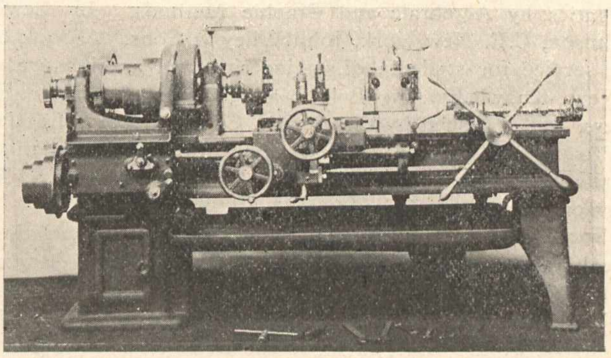
Editor Canadian Engineer:

Sir,—In your last issue, under the heading "Ice-laden Wires," C. Baillairge asks for information re the weight of ice on wires. A few years ago Hamilton experienced a snowfall that covered trees and wires with wet snow until they reached the breaking point referred to by your correspondent. The amount of the accumulation was so great that over a mile of posts with their wires broke down. Before the posts broke the wires sagged to a distance, in cases, of five feet from the plane of the insulators. This must have been great stretch in the wires. A corner post which had received, owing to a street draught, an extra deposit of snow, and also having an extra number of wires at an angle turn, parted its guy wires and went down, and a quarter of a mile of posts cracked off one after another until a point was reached where the wires were fewer and the posts stood. The strain reached several ways. On the absence of the pull of these wires being felt, lines of breaking started in different directions, and many posts went down. The point which Mr. Baillairge asks for, is how much snow was on these wires. I weighed a section of wire six inches long, which had retained its coating of frozen snow after it fell. It weighed, approximately, 8 ounces, and the calculation I made at the time gave six tons of snow between two poles. This would hold for about two-thirds of the total poles that went down. The very great sag astonished me at the time, and it seemed impossible for wire to stretch so far and not break. The facts fit in with the approximation of weight here recorded. Poles eighteen inches in diameter were snapped off at the ground.

J. M. Williams.

CAPSTAN LATHE WITH CHASING SADDLE.

The following is a description of a Capstan lathe with patent chasing saddle, as made by Alfred Herbert, Ltd., of Coventry, England. While designed mainly for chuck work in cast-iron, steel or brass, the machine tool is well adapted for work from the bar, particularly where the chasing of square threads or of fine and accurate threads, either internally or externally, is required. The bed is of unusually deep and massive section, and is strongly ribbed internally. It is fitted with an oil pan of ample size, and provided with cabinet and cupboard for holding tools, etc. The headstock has friction back gearing, enabling the machine to be instantly changed from single speed to back gear without stopping the spindle. This arrangement in conjunction with the two speed countershaft, enables four different spindle speeds



Herbert Capstan Lathe.

to be instantly obtained without shifting a belt. By changing the belt on the cone-pulley, 12 spindle speeds are obtainable. The spindle is hollow, admitting bars up to 2-in. in diameter, and the gearing is enclosed by neat cast iron guards. The chasing saddle is provided with our patented arrangement for chasing from a leader. Four different pitches, either right or left hand, can be cut by each leader, the change being made by levers. A special saddle can be fitted when required for taper-turning, boring and chasing. Adjustable dead stops are provided for both the longitudinal and transverse movements. The capstan slide is fitted with automatic feed, having six changes, ranging from 21 to 160 revolutions per inch of traverse. Six automatic and dead stops are provided, by which each of the six tools is automatically stopped at exactly the position desired, entirely independent of the other five tools.

NEW WESTERN BRANCH OF FAIRBANKS.

The Fairbanks Company, of Montreal, have opened up a branch in Winnipeg, where they are now having erected a six-story warehouse, which will have a front of 54-ft., and will be 100-ft. deep, extending from Prince and Arthur streets, and fronting on both of these streets. The site is in the heart of the Winnipeg business district and will afford their customers great convenience in doing business with them. The branch will be in charge of F. Ross Newman, formerly with the Fairbanks Company, Montreal, and previous to that purchasing agent of the Laurentide Pulp Company. E. R. Whitehead will be cashier and J. J. Jessup will look after the Gas and Gasoline Engine Department. John Aiken also goes from Montreal to look after the shipping department. Until this warehouse is constructed the Fairbanks Company have temporary quarters which will enable them to look after this season's business. Henry J. Fuller, general manager for the company for Canada, has just returned from completing arrangements in Winnipeg, and is very enthusiastic about the prospects of the Northwest, and especially those of the company with which he is associated. The Fairbanks' scales have been used for many years in the grain elevators in the Northwest, and the increasing volume of business made it absolutely necessary that a stock should be kept in Winnipeg. In addition to this leading line the usual lines carried by the Fairbanks Company will also be handled in Winnipeg, including Fairbanks' valves, gas and gasoline engines, full line of steamfitters' and plumbers' supplies. The Vancouver branch of the company, which was started only about a year ago, is meeting with great success, and with the three warehouses in full operation the Fairbanks Company will be in position to meet the requirements of their customers to better advantage than ever.

—United States financiers, including the Standard Oil Co., which recently bought the volcano of Popocatepetl, Mexico, for $5,000,000, are about to build a cog-wheel railway up the mountain and excavate for sulphur.

NEW BOOKS.

The following new books have been received:

A New System of Heavy Goods Transport on Common Roads. By B. J. Diplock. Longmans, Greene & Co., London. A very good work on traction engines.

Statics by Algebraic and Graphic Methods. By Lewis J. Johnson, C.E. New York, John Wiley & Sons. A book of great service for students of engineering and architecture.

New Knowledge on Belt Management. By John E. Powers, M.A. Issued by the Buffalo Cling-Surface Mfg. Co.

Proceedings of 12th Annual Convention of Association of Railway Superintendents of Bridges and Buildings. S. F. Patterson, secretary, Concord, N.H.

Proceedings of 17th Annual Meeting of the Association of Health Officers of Ontario held at Berlin. Dr. P. H. Bryce, secretary, Toronto.

Technical Education and the Higher Industrial Life. Address by H. F. J. Porter, M.E., of the Bethlehem Steel Co.

NEW CATALOGUES.

Copies of these new catalogues and booklets will be sent to parties interested by mentioning The Canadian Engineer:

Dodge Mfg. Co., Toronto, power transmission machinery.

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

The Fairbanks Co., Montreal and Vancouver, Yale & Towne chain blocks.

Brown & Sharpe Mfg. Co., Providence, R.I., machinery and tools.

Westinghouse Electric & Mfg. Co., Pittsburg, fan motors; also fifty-four car loads (meters).

Stromberg-Carlson Telephone Mfg. Co., Rochester and Chicago, bridging telephones.

Arthur Koppel, New York, narrow gauge railway materials

Johnson & Phillips, Old Charlton, Kent, and 14 Union Court, Old Broad street, London; price list of Arc lamps.

Farr Telephone & Construction Supply Co., Chicago, telephones and telephone supplies.

J. Stevens Arms and Tool Co., Chicopee Falls, Mass., Stevens rifle telescopes.

Sylvester Mfg. Co., Lindsay, Ont., gasoline engines and launches.

Arlington Mfg. Co., Canton, Ohio, Arlington vegetable boiler composition.

Mica Boiler Covering Co., 86-92 Ann street, Montreal, mica covering.

Pittsburg Meter Co., Pittsburg, Penn., Meter System vs. Flat Rate System.

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The Garvin Machine Co., New York, second-hand machine tools.

Joseph Dixon Crucible Co., Jersey City, N.Y., Silica graphite roof paint; also Graphite for March and April.

Manual of Electrical Undertakings, Mowbray House, Norfolk street, London. Extracts from Seventh Annual Volume.

Canadian General Electric Co., Toronto. Card re Lightning Arresters.

ENGINEERS' CLUB OF TORONTO.

The Engineers' Club, of Toronto, held two meetings during April. On the 7th, J. H. Chewitt, C.E., read a paper on Recent Developments in Acetylene Lighting, which he illustrated by means of the Siche gas machine, of which he is one of the manufacturers. On the 23rd, R. B. Rogers, C.E., Peterboro, read a paper on the Waterways of Canada, more especially the Trent Valley Canal, of which he is chief engineer. He described in some detail the hydraulic lock now under construction at Peterboro. This canal and lock were described in the February number of The Engineer. The paper was illustrated by a large number of lantern views.

The club has been invited by Cecil Smith, chief engineer of the Canadian Power Co., to pay a visit to the works at Niagara Falls. It is expected the trip will be made on May 30th.

—The contract for the Quebec and Lake Huron Railway has been signed, and construction will shortly be commenced at the Quebec terminus. The railway will run from Quebec to French River. New York capitalists are at the back of the enterprise and the three Canadian directors are; Hon. C. Langelier, Hon. A. Turgeon and Hon. H. G. Carrol.

—Referring to the paragraph in another part of this issue, mentioning the transfer of the franchise and plant of the Merchants' Telephone Co. of Montreal, Dr. J. N. Culburtson, of New York, has been elected president and general manager, and Joseph Maison is appointed secretary, with offices at 83 St. James street. It is expected that in a few days the new company will announce its plans for extending its present exchange or putting in a new system. The company has at present about 1,000 phones, and its rates are $35 for business phones and $25 for private houses. Dr. Culburtson was formerly with the Bell Company in the United States, and for some years a manager of the International Bell Company in Europe.