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The Canadian Engineer.

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CONTENTS OF THIS NUMBER.

Air, Mechanical Transport of..	73	Machine Shop Notes from the States	97
Association of Ontario Land Surveyors	66	Marine News	72
Canadian Mining Institute	70	Metric System of Measures	94
Canadian Niagara Power Co.'s Plant, Construction of	82	Mining Matters	68
Catalogues Received	67	Motor-Starting Panels with Circuit Breakers	92
Coolgardie Pumping System	74	Motor Boats	94
Dams, Essential Elements in the Design of	89	Municipal Telephone Plant at Neepawa, Man.	93
Electrical Thawing of Pipes	80	Municipal Works, etc.	71
Harbor and River Works in Canada	77	Peat, Progress in	92
Heating the Human Body	89	Personal	71
Independent Air Pump and Jet Condenser	77	Railway Notes	69
Incorporations, New	67	Reform, A Chance for Real	66
Industrial Notes	68	Steel Hardening Metals	96
Light, Heat, Power, etc.	88	Telephone and Telegraph	71
		Transformer Outfits for Thawing Pipes	73
		Vested Rights and Vested Wrongs	65

VESTED RIGHTS AND VESTED WRONGS.

If there were just a few more members of the Canadian Parliament with the moral courage and prescience of W. F. Maclean, member for South York, the telephone problem of this country would be settled in short order and with substantial justice to all interests. When the question came up in Parliament last month Sir Wilfrid Laurier expressed a sympathetic concern for the disabilities under which municipalities and the public labor by reason of the present state of legislation regarding telephones, and at the same time he evinced an equally tender concern for the "vested rights."

No one should wish to deprive any company of goods it has bought and paid for, but let us examine the sophism, which if Sir Wilfrid Laurier is correctly reported, he has dignified with the name of "rights" in the case of the company in question. Is not the principle of local self-control in matters of local concern a settled principle in the government of this country? If this is so then what right has the Dominion Government to grant to a private corporation privileges which invade the "vested rights" of every municipality in the country. When the Bell Telephone Co. applied for power to enter a city or town, tear up its streets and injure or destroy its property, why was not Parliament a little more solicitous about the "vested rights" of these municipalities? The fact is that the Dominion Parliament gave the Bell Telephone Co. a right to rob, and having given away what never was morally its own to give, the Government now holds up the Bell Company as the injured one, when the municipalities wish the depredations stopped.

Sir Wilfrid Laurier has always professed great reverence for British constitutional usages, and the British notion of law and order.

We may point out that the rights claimed by the Bell Telephone Company in regard to the placing of poles on public property, exceed those possessed by any telephone company, or even the Government telephone department in Great Britain or on the Continent of Europe. The British Postal Telegraph Department itself has to obtain the consent of the municipalities to the placing of poles on the public highways, and there are cases on record where circuitous routes have had to be taken in consequence of the refusal of this privilege by the local authorities. We quote these facts in order to demonstrate that British law recognizes the principle which gives the municipalities the same right to control the public roads or streets, which the private owner has over his own property. If the Government of Canada has hitherto ignored this principle, the sooner it remedies the wrongs created by itself the better it will be for the public whose natural rights are over-ridden. Perhaps when the Premier reflects on the ill-liberal and confiscatory tendencies of his own legislation as compared with the respect which British legislators pay to local and private rights of property he will form a new and better conception of whose "rights" were invaded by the various pieces of legislation that have created the Bell Telephone Co.

The "vested rights" of the combined municipalities of the Dominion have an infinitely greater claim for recognition than those of a monopoly which today has the gratuitous use of the ratepayers' property whereby they are enabled to earn an 8 per cent. dividend on stock, a large part of which is water, and nearly 50 per cent. of which is held by a United States corporation for patent rights long since expired and now valueless.

There is another feature of this question which has hitherto been overlooked. We refer to the charters granted by Parliament to other telephone companies to the number of at least sixty, doing one-third of the telephone business of the country. These companies have also "vested rights," yet we do not find them to be the same "spoiled children of fortune" as the Bell monopoly, in regard to the right to defy municipal authority. Indeed, many of these undertakings are seriously handicapped because they have to compete with the "Bell" under unequal conditions. This is not only inconsistent but unjust. The duty of the Government in this matter is clear. They should either amend the law in regard to the Bell Telephone Company, or they should pass a general act giving all telephone companies equal rights in regard to the use of municipal property, and so make competition possible under equal conditions.

The "vested rights" of the Bell Telephone Company do not differ from those of any other corporation operating under a Dominion charter. No other charter, that we are aware of, carries with it the right to make use of other people's property without compensation. Even railway companies have to buy the land necessary for their operations within all municipalities, therefore we fail to see why the Premier should betray such timidity in dealing with the telephone monopoly.

However solicitous the Government may be for the "vested rights" of the Bell Telephone Company, that corporation cares little for the interests of the telephone users of Canada, and of the many thousands of people who are debarred from telephone communication by reason of the exorbitant rates charged, albeit the company obtained its charter on the ground of being "for the general advantage of Canada." According to the last report of the Dominion Statistician there were 81,500 telephones in use in Canada, of which 57,172 are operated by the "Bell," and it is a significant fact that if the whole of Canada had as many telephones in proportion to the population as British Columbia, which is furthest removed from "Bell" influence, the total would exceed 275,000.

The telephone is the greatest distributor of intelligence yet invented, and should be cheaply at the service of every inhabitant, but so long as this modern means of communication is used in Canada "for the general advantage" of the Bell Telephone Company, so long will it remain a luxury for the few instead of a boon to the many.

A CHANCE FOR A REAL REFORM.

The advent of a new cabinet into power in Ontario and the reorganization of the Temiskaming Railway Commission lead to the hope that a reform will be made in the character of railway commissions and other official organizations for the control or regulation of public works. In Great Britain and most other countries government commissions for the control or investigation of public utilities are composed chiefly of engineers and other practical men. Here in Canada of late years, both in Dominion and Provincial affairs, the controlling element in railway, canal, and other commissions has been political and not technical, and where engineers have been attached to such commissions they have been called in a consultative and not an executive capacity. As a consequence the decisions of these commissions have been governed by political party considerations and not by strictly business considerations, and thus hundreds of thousands of dollars of the people's money are squandered and made to serve the corrupt purposes of partyism instead of being directed to the most efficient and economical methods of constructing and maintaining the public works of the country.

A commission such as that of the Temiskaming Railway, for instance, should be composed wholly of engineers and other practical railway men, and there is no doubt, whatever, that if the new Ontario Government rise to the demands of common sense and honest administration in such matters, by eliminating the politician from works that call for technical skill and special business knowledge, it will fortify itself strongly in the public confidence at the outset. Will it rise at the call?

—The Engineering Review, of London, is severely censuring the British Post-Office for its failure to reduce the postage on magazines coming to Canada. In its January number, which was a special export number, the Review referred to the disadvantage to which the British trader was put in competition with the United States dealer for the Canadian market, by reason of the high postal tariff on technical and other journals. In its next number the Review points out that the act limiting the application of newspaper rates was passed in 1870 when high-class technical magazines were unknown, and the Post-Office continues to pass voluminous papers weighing as much as 2 or 3 pounds, for a halfpenny, while charging nine or ten times as much for magazines of far less weight. "In Canada," the article continues, "there is a growing feeling that political and commercial relations with the home country should be extended, and that the spread of this sentiment is greatly retarded by the handicap imposed on high-class monthly reviews. Such publications are carried at almost nominal rates in the United States and the Dominion, with the unfortunate result that anti-British literature is disseminated throughout the latter country with the most regrettable results. Canada is the most loyal of all British possessions. She stands with open arms offering postal concessions and most valuable privileges in the way of customs regulations, but our own government entirely misrepresenting the feeling of the nation continue to reject all overtures as if they were a bureaucracy acknowledging no duty to the people whose servants they are." It is evident from this and many other expressions of opinion in the daily and technical press that the British Post-Office must soon yield to popular sentiment and grant lower rates between the Motherland and the colonies. When this shall have been achieved, it will be a matter of some pride to Canada to reflect that it was she who first raised the standard of reform in this regard.

ASSOCIATION OF ONTARIO LAND SURVEYORS.

The annual meeting of the Association of Ontario Land Surveyors was held in Toronto beginning Tuesday, February 28th. The president, C. A. Jones, of Petrolia, occupied the chair, and an attendance of over fifty members was recorded. Otto J. Klotz, of Ottawa, read a paper on Transpacific Longitudes, which was especially interesting, as showing the extremely accurate work done in this kind of surveying. He told of two astronomers who independently measured the circumference of the earth, one working eastward, and the other westward, whose results agreed within one hundred feet. On Tuesday evening, Mr. Klotz gave a lecture on the South Seas, in which he described his work for the Canadian Government in connection with the all-British cable. He dealt in a popular way with ethnological, social, botanical and other aspects of Hawaii, Fiji, Samoa, New Zealand, and other lands visited, and illustrated his talk with views. W. E. McMullen, in a paper entitled "What is Our Future?" suggested that the private practice of surveying should be abolished in Ontario, and that there should be organized a Survey Department, the head of which should be the Surveyor-General, a Minister of the Crown. The deputy Surveyor-General should have complete control of all work going on, and in case of dispute his decision should be final, except in extraordinary cases. Further details of the proposed organization were outlined. This suggestion, though not acted on formally by the Association, seemed to meet with approval.

Other papers presented at the convention were: The Status of Ontario Land Surveyors, by P. S. Gibson. Personal Supervision of Surveys, by J. F. Whitson. Notes on the Cost of Constructing Pipe Sewers, by J. Hutcheon. On Assessments, by Angus Smith. A Few Stray Observations about Instruments, by D. D. James. Faulty Descriptions, by E. C. Steele. Topographical Survey by Stadia Measurements, by L. B. Stuart, of the School of Practical Science. Rambling Notes on an Exploration Survey on the Athabasca and Churchill Rivers in 1888, by T. Fawcett.

The question of personal supervision of surveys was one that was discussed at some length by the convention. It was held that in carrying on any work surveyors should not appoint unauthorized persons as assistants, and that when they used their pupils as assistants they should be careful to superintend the work themselves from time to time. The matter was referred to the council, who will at their next meeting pass a bylaw defining accurately what is meant by personal supervision.

The financial report of the secretary showed the Association to be in a flourishing condition.

On Wednesday evening the annual dinner was held, which was pronounced a success by the forty-two persons who sat down.

Officers for the ensuing year were elected as follows: President; J. W. Tyrrell; vice-president, Dr. Otto J. Klotz; sec.-treasurer, Capt. Killaly Gamble; auditors, W. A. McLean, L. V. Rorke.

NEW INCORPORATIONS.

Canada.—Dominion Cement Block Machine Co., Ottawa; $100,000. C. A. Irvin, H. P. Fleming, C. H. Hutchings, Ottawa; C. E. B. Adams and J. H. Hall, Toronto.

The Hill Crest Coal and Coke Co., Montreal; $500,000. R. H. Pope, Cookshire; W. Farewell, Sherbrooke, Que.; G. W. Fowler, Sussex, N.B.; M. P. Davis, Ottawa; R. B. Pringle, Cornwall, Ont., and C. P. Hill, Frank, Alta., N.W.T.

Canadian Appraisal Co., Montreal; $50,000. F. Paul, W. M. Doull, P. C. Ryan, L. Guest, H. Seymour, and E. Dowson, Montreal, Que. To supervise the construction of building machinery and industrial plants, and to act as average adjusters, etc.

Monterey Electric and Gas Co., Toronto; $3,000,000. W. Mackenzie, W. Laidlaw, Z. A. Lash, A. W. Mackenzie, Toronto, and S. H. Holt, Montreal.

W. J. McGuire & Co., Montreal; $50,000. W. J. McGuire, G. F. McGuire, Toronto; R. J. McCauley, W. L. Horn, and H. C. Stone, Quebec. To manufacture and deal in automatic sprinklers and other fire-extinguishing apparatus.

New Brunswick.—The Richibucto-Rexton Telephone Co.; $20,000. W. J. Brait, A. B. Carson, T. C. Burns, F. W. Tozer, M. Tanigan, and others, of Montreal. To operate a telephone system in the counties of Kent, Northumberland and Westmoreland.

Ontario.—Francis Gold Mines, Limited, Sault Ste. Marie; $1,000,000. E. M. Stenabaugh, J. Gostanian, R. H. Taylor, H. F. Reid, Sault Ste. Marie, Mich.; and E. A. Head, Sault Ste. Marie, Ont.

The Scarboro' Telephone Co., Toronto; $40,000. A. Neilson, J. Neilson, D. Brown, Scarboro'; T. A. Young, Markham, and W. Mulock, Toronto. To carry on the business of a telephone company in the counties of York and Ontario.

The Bessemer Iron Mines, Sault Ste. Marie; $200,000. R. Henry, Sault Ste. Marie, Ont.; E. S. B. Sutton, C. W. Baldwin, A. B. Standish, and T. Bailey, Sault Ste. Marie, Mich.

The Markham and Pickering Telephone Co., Whitevale; $40,000. A. Hoover, W. Hoover, D. R. Beaton, W. A. Fuller, Pickering, and A. C. Reesor, Markham. To carry on business of a telephone company in York, Ontario, and Durham.

The Ontario and Minnesota Power Co., Toronto; $3,000,000. E. W. Backus, Minneapolis, U.S.; A. Mackenzie, W. H. W. Templeton, G. F. McFarland, and R. A. Grant, Toronto.

Archer Light, Heat and Power Co., Toronto; $100,000. R. B. Younghusband, I. F. Moore, J. M. Sinclair, C. B. Murray, and A. W. Holmestead, Toronto.

The Huntsville Foundry and Machine Co., Huntsville; $20,000. J. H. Johnson, F. H. Tool, A. C. Suttaby, T. D. Moase, and D. M. Grant, Huntsville. To carry on the business of foundrymen and machinists in all its branches.

The Connor-Woods Machinery Co., Sarnia; $40,000. G. F. Connor, F. W. Woods, D. E. Purdy, F. C. Godley, Port Huron, Mich., and A. S. Burnham, Sarnia, Ont. To manufacture and deal in agricultural and wood-saving machinery.

The Curtis & Neff Screw Co., Ingersoll; $30,000. F. O. Curtis, F. D. Curtis, M. Neff, J. A. Neff, and E. A. Neff, Ingersoll. To manufacture screw machines, machine screws, nuts, and bolts.

Blind River Light, Heat and Power Co., Blind River Tp.; $40,000. D. I. Millar, Sault Ste. Marie, Ont.; F. R. Price, D. S. Pindell, Sault Ste. Marie, Mich.; E. F. Bradley, Toronto, and G. A. McArthur, Blind River Tp., Algoma.

Thompson & Livock, Limited, Ottawa; $40,000. L. H. Thompson, J. Livock, F. X. Laderoute, K. H. D. Thompson and A. Livock, Ottawa. To carry on the business of plumbers, steam and gas fitters, electricians and manufacturers of engines, machines, etc.

Thomas Lawson & Sons, Ottawa; $50,000. T. Lawson, C. T. Lawson, A. T. Lawson, R. Mitchell and J. Lawson, Ottawa. To carry on the business of nickel and electro-platers, machinists, pattern makers, etc.

John Hillock & Co., Toronto; $40,000. F. Hillock, J. S. Hillock, M. C. Hillock, J. F. Hillock, and C. W. Hillock, Toronto. To carry on the business of carpenters, joiners, contractors, and to manufacture and deal in refrigerators, builders' supplies, etc.

The Close Brick Co., Stratford; $25,000. G. Close, W. Miller, F. J. Scarff, J. L. Youngs, D. H. Farrow, and J. H. Kenner, Stratford. To manufacture brick and tile.

Keystone Engineering Co., Toronto; $40,000. A. W. Kirvan, F. B. Johnson, S. Johnson, R. H. Parmeter, and A. J. Thomas, Toronto. To carry on the business of general contractors of construction and engineering works.

The Campbell Milling Co., incorporated under the laws of the Dominion of Canada, has also received a charter from the Ontario Government, and has appointed D. A. Campbell, Toronto Junction, attorney.

Lumen Bearing Co., New York, U.S.A., has been licensed to operate in Ontario, provided it does not use more than $60,000 capital. To manufacture and sell metals, alloys, castings, etc. W. K. B. Patch, Toronto, attorney.

Dain Manufacturing Co., Iowa, U.S.A., has been licensed to operate in Ontario, provided it does not use more than $40,000 capital. To manufacture and sell implements and to operate machine shops. L. R. Shantz, Waterloo, attorney.

British Columbia.—British Columbia Wire and Nail Co.; $50,000.

The Western Power Co.; $25,000.

American and British Columbia Hydraulic Placer Co.; $50,000.

The Dease Creek Hydraulic and Development Co.; $50,000.
Enderby Coal Mines, Limited; $250,000.
Spokane Boundary Mining Co.; $100,000.
International Telephone Co.; $50,000.
The Whatshan Lake Power Co.; $250,000.
South Yale Copper Co.; $450,000.
Spokane Boundary Mining Co.; $100,000.

N.W.T.—Calgary Lime and Cement Co.

CATALOGUES RECEIVED.

The following catalogues may be obtained on mentioning the Canadian Engineer:

Brown & Sharpe Mfg. Co., Providence, R.I.: Catalogue of Machinery and Tools, 1905. Regular pocket edition, 3½ by 5¾, nearly 500 pages.

Canadian Rand Drill Co., Montreal: Catalogue C, Air and Gas Compressors. 100 pages, 7 by 9, illustrated, with useful information and tables.

Westcott Chuck Co., Oneida, N.Y.; Catalogue of Lathe and Drill Chucks. 32 pages, 7 by 9, illustrated.

Allis-Chalmers-Bullock, Limited, Montreal: Catalogue of Ingersoll-Sergeant Air Compressors. 64 pages, 7 by 10, illustrated.

Westinghouse Electric and Manufacturing Co., Pittsburg: Circular 1,097, Type K Motors, for crane, hoisting and similar service; descriptions and curves. Also Circular 1,099, Bi-polar Motors, Type R.

The Hayward Co., 97-103 Cedar St., New York: Catalogue No. 25 of Digging Machinery, Buckets, Cranes, Derricks, Dredges, etc. 104 pages, 10 by 12, with embossed cover.

John Birch & Co., Limited, 3 London Wall Buildings, London, E.C.: Motor Cars, being Appendix B to Machinery Catalogue. Illustrates and briefly describes the prominent makes of automobiles sold in Great Britain. 80 pages, 8½ by 11.

Westinghouse Machine Co., East Pittsburg. Westinghouse-Parsons Steam Turbine, a neat, 35-page booklet describing and illustrating this power unit.

Sterling Lubricator Co., Rochester: Illustrated catalogue of force-feed lubricators, 1905 edition. 20 pages, 4 by 6½.

INDUSTRIAL NOTES.

Three concrete piers and one abutment will be built at Battleford, N.W.T.

The Gutta Percha and Rubber Co. of Toronto is opening a branch at Vancouver.

The Horseshoe Stone Quarry Co., of St. Mary's, Ont., propose to instal a new 125-h.p. engine.

The Ontario-Slocan Lumber Co. have decided to build a sawmill at Slocan, B.C., to be completed by next spring.

The Dodge Mfg. Co., of Toronto Junction, are building a new power house in which a large engine and boiler will be installed.

The Borland Carriage Co., now of Stratford, Ont., and formerly of Tillsonburg, Ont., will start up their new factory this month.

The Standard Windmill and Manufacturing Company of Michigan will erect a factory at Whitby, and begin business in the near future.

Canada Furniture Manufacturers will remove their Stratford factory to Seaforth, and the building and equipment in Stratford will be sold by auction.

The Macdonald Engineering Co., of Chicago, has just completed a 500,000-bushel steel elevator at Fort William for the Ogilvie Flour Mills.

D. R. Dingwall, Limited, have been awarded the contract for installing two tower clocks, one for the new C.P.R. Hotel, and the other in the new depot, at Winnipeg, Man.

On July 1st the Canadian Government will assume control of the fortifications at Halifax and Esquimalt. The cost to the Government will be about $2,000,000.

The Kamloops Lumber Company, B.C., have commenced the rebuilding of their sawmill, which will be up-to-date in every respect. The main building will be 136 x 30 feet, with a planer shed 60 x 50 feet.

The Dominion Iron and Steel Co., of Sydney, N.S., is about to install new electrical appliances in various departments of its works. The latest devices calculated to facilitate production and reduce expenditure will be adopted.

The Dominion Iron and Steel Co., Sydney, N.S., have awarded the contract for the extension to their steam power plant to Goldie & McCulloch, of Galt, Ont. The contract for the extension of the electric power has been awarded to the Canadian General Electric Company, of Toronto.

In the notice last month of the new works of the Canada Car Co., the name of G. F. Johnson was omitted. Mr. Johnson, a Swedish engineer of Pittsburg, Pa., supervised the designing of the structures. The contract for the foundation was carried out by D. G. Loomis & Sons, of Montreal.

It is stated that the C.P.R. contemplate building a smelter on the west coast of Vancouver Island. This will be in the centre of the iron fields, and within reach of a large number of copper properties, which show immense deposits of low-grade ore. Coal and coke are within easy reach at Comox and Nanaimo.

The estimates for Dominion public works, under consideration by Parliament, include $263,194 for a Canadian mint building, the contract for which has been let to Messrs. Sullivan & Langdon, Kingston. It will be built of stone, 220 by 164 ft., at a total cost of $375,000. In view of the annual production of $20,000,000 worth of gold in this country, it has been considered advisable to provide a market for this gold which has now to go to the United States. The mint will make Canadian $1, $5, $10, and $20 pieces, as well as British gold coins.

Installation of the postal pneumatic service in Toronto and Montreal will begin the coming season. It is expected that the system in Montreal will be constructed and in operation first, although the construction of street work will go on simultaneously in both cities. There is still annoying delay occasioned in Toronto, due to the impossibility of locating the Central Station building on Front St., until the railway expropriation of the burnt district has been settled. Mr. Galt, the chief engineer for the Government, informs us that the contract for the pneumatic mains was awarded to Robert McLaren & Co., of Glasgow, Scotland, and that delivery will begin during May.

MINING MATTERS.

It is said that a mountain of asbestos has recently been discovered in the vicinity of Rainy Lake.

The silver-lead mines of British Columbia have paid dividends amounting to $3,500,000 since 1892.

The Saskatchewan Mining and Development Company have bought dredging machinery costing $60,000.

The output of gold from the Atlin, B.C., mining district, is estimated at $600,000 for the current year.

R. Mackay has received the contract to enlarge the concentrator at the Iron Mask Mine, Kamloops, B.C., at a cost of $80,000.

The diamond yield of South Africa, which began with $2,500, in 1867, and reached $18,000,000, in 1888, was $24,500,000 last year.

Six thousand dollars a day is the amount of gold being taken off the plates of the Nickel Plate mine, at 20-Mile, or Headley, in the Similkameen.

At Medicine Hat, Assa., a good flow of natural gas has been struck at a depth of 950 feet. Advantage will be taken of the strike to greatly enlarge the local works.

Last year Canada shipped to the United States 68,048 tons of coke valued at $260,507, besides over one and a half million tons of coal valued at over four million three hundred thousand dollars.

The Regina gold mine, Lake of the Woods, which was formerly in active operation, is to be re-opened. A considerable quantity of machinery has been purchased, and operations will commence shortly.

A well shot last month near Leamington flowed 350 barrels in the first fifteen hours, and is the best well yet struck in the neighborhood. It is expected that an oil refinery will soon be started at Leamington.

The first iron mine in the vicinity of Sault Ste. Marie to recommence operations is shipping ore to the Algoma Steel Works at the rate of 35 tons a day. The output will be increased shortly.

The mineral production of Southeast Kootenay in the year 1904 reached the highest total value of any year in the history of mining in the district. The value of minerals produced in this district was $4,813,800.

Mackenzie & Mann have just completed the formation of a million dollar concern, known as the Atikokan Iron Company, for the purpose of mining iron ore, and manufacturing pig iron and other products of iron and steel at Port Arthur.

Active prospecting operations are being carried on in the region at Torbrook and Nietaux, N.S., by the Nova Scotia Steel and Coal Co., and the Londonderry Iron Co., both of which have obtained options covering considerable areas.

The British Columbia Copper Company's plant at Greenwood, B.C., in 1904, treated 211,864 tons of ore. The total production was as follows: Gold, 35,911 ounces; silver, 11,668 ounces; copper, 5,201,073 pounds. The value of this at New York market prices was about $1,700,000.

The report of the Crow's Nest Pass Coal Company for the year 1904, submitted to the annual meeting of the shareholders, showed net profits of $406,049, as compared with $310,492 in 1903, an increase of $95,557. The company mined 81,000 more tons of coal and exported 78,000 more tons of coke in 1904 than in 1903.

The owners of the Princess Royal gold mine, situated on the island of that name, 450 miles north of Vancouver, B.C., have decided to install electric or compressed air drills and other mining equipment this spring. The power will be derived from a water fall, capable of developing 2,000 horse-power, about six miles distant from the mines.

Orders have definitely been placed for the two new furnaces at the Granby smelter. Each of these furnaces will have seventy square feet, as against fifty feet in those now in use, and when completed will give the smelter a daily capacity of 2,700 tons of ore. This addition will also be made, owing to an ingenious arrangement of Supt. Hodges, without enlarging the furnace building itself.

It is reported that while working their claim, situated on No. 7, Big Skookum Gulch, Yukon Territory, Robert Evans and Pete Domisky unearthed a lump of platinum weighing 35 pounds. This rare mineral is seldom found in such a large quantity, and this 35 pounds constitutes a large perecentage of the annual product of Canada or the United States. It is estimated that if the platinum proves to be nearly pure it will bring its owners about $15,000.

"The gold output of the Yukon during the current year ending June 30th will total ten million dollars," asserted ex-Governor Congdon, of the Yukon. "In a few years," he continued, "the output will be larger. It is only a question of getting in machinery for the purpose of decreasing the cost of mining. That is now being introduced, and it will soon make itself apparent. There is no doubt that the country continues to be as rich as ever in its gold-bearing properties."

There has been considerable renewal of activity in mining operations in central Ontario recently, and many of the companies have made large increases in their plants. The Kingston Felspar Mining Co., at Bedford, purchased from Allis-Chalmers-Bullock, Limited, Montreal, a hoisting plant, including a 30 h.p. double cylinder Lidgerwood engine; James Richardson & Sons, zine miners, Mountain Grove, purchased an Ingersoll-Sergeant air-compressing plant, and the Madoc Mining Co., at Tweed, purchased a complete mining plant, consisting of a horizontal return tubular boiler, Ingersoll-Sergeant air-compressor, Lidgerwood hoisting engine, etc., both from Allis-Chalmers-Bullock, Limited, Montreal.

RAILWAY NOTES.

Guelph will ask the Legislature for powers to extend its electric railway line from Guelph to Puslinch Lake and Berlin.

The Toronto Railway Company has decided to equip every car on its system with air brakes at a cost of approximately $150,000.

Close upon one hundred men have been laid off by the C.P.R. at their Angus and Hochelaga shops owing to the falling off in repair work.

H. J. McDonald, New Glasgow, N.S., has been awarded the contract to double track the Intercolonial Railway from New Glasgow to Stellarton, N.S.

The Grand Trunk Railway will not, as was reported, remove the Canada Atlantic Railway shops from Ottawa when that railway is taken over by the G.T.R.

During the coming season the C.P.R. will spend on improvements on the Atlantic division, from St. John to Megantic, and branch lines, not less than $275,000.

Survey parties for the G.T.P. have found nine new passes through the Rocky Mountains, all of which afford good gradients for a railway, and some of them are capable of carrying a double track.

The White Pass and Yukon Railway has placed orders for steel for three additional bridges, and will replace all their wooden bridges with steel as quickly as practicable.

It is now confidently expected that 1905 will witness the completion of the Kootenay Central Railway from Jaffray on the Crow's Nest line to the Windermere mining district.

The Grand Trunk Railway Company has placed an order for six electric locomotives with the Westinghouse Company for handling trains through the tunnel at Port Huron, Mich.

The new power house of the Berlin and Waterloo Street Railway is now running. The new 250-h.p. engine purchased from John Inglis & Sons, Toronto, is giving excellent satisfaction.

Work on the Guelph and Goderich Railway is now in abeyance until spring. This work, it is expected, will be completed early in the summer, when traffic between the two points will commence.

The Facer Car Wheel Company, of Perth, has applied to the Government for an extension of its charter for one year. The ground for the request is that the company has not yet been enabled to manufacture the patented articles in the Dominion.

Ross & McRae have just been awarded the contract for the last piece of double tracking of the Grand Trunk Railway between Montreal and Chicago. The contract extends from London to Kingscourt, some forty miles, and is to be graded by August.

The Canada Atlantic Railway Company has petitioned to be allowed to increase its bonding powers, and to issue bonds, debentures, or other securities to the extent of $16,000,000, and to secure such bonds or debentures upon the property of the company.

Joseph Critelli & Sons, Niagara Falls South, Ont., have established a business for supplyng railway contractors, mine operators or quarrymen with laborers, either skilled or unskilled. They have a branch at Thorold, Ont., and at Sault Ste. Marie, Mich.

The G.T.R. is buying land at Battle Creek, Mich., with a view to establishing largely increased terminal facilities and freight yards. The company has already obtained a site for a $100,000 station, and land has been secured for big workshops, which will cost $1,500,000.

Survey parties have been sent out by the C.P.R. to select the route of two one hundred mile branches from the Calgary and Edmonton branch. The new lines will be extensions of the twenty-five mile branches already begun from Lacombe and Wetaskiwin last season.

The contract for supplying 150 tons of electrical equipment in connection with the operation of the railway line to Lulu Island by the British Columbia Electric Railway Company has been awarded to the Canadian General Electric Company. The contract price is about $80,000.

President Hays is credited with the statement that the grades on the Grand Trunk Pacific will be much easier than at first calculated, not exceeding one and one-half per cent. in the mountain section, about half of one per cent. west of the mountains, and about twenty feet to the mile east of the mountains.

By the close of the present year, the electric railway from Toronto to Oakville, 21½ miles, and that from Toronto to Whitby, 26 miles will be completed. The Metropolitan line will also be extended this year from Newmarket to Jackson's Point, thus giving a line 50 miles from Toronto to the shore of Lake Simcoe.

The Michigan Central, with the co-operation of the Grand Trunk, the Pere Marquette, and the Wabash, will build a tunnel under the Detroit river from Detroit to Windsor. The Pere Marquette had made ararngements to spend about two million dollars in ferries and docks, but will abandon this plan in favor of the tunnel.

The Kingston Street Railway has passed into the hands of the bondholders, who hold a mortgage amounting to about $200,000. The bondholders appointed a trustee in the person of Dr. R. V. Rogers, K.C., who will assume control for the present until matters are wound up. The road has not been paying, hence the interest could not be met. It is understood that there are also many outstanding debts. Hugh C. Nickle, present superintendent, will be general manager of the road.

Among the improvements on the lines of the C.P.R. will be a course of instruction for train hands and all those engaged in train handling. The intention is to educate all train men to the highest possible point of efficiency so that great efficiency, speed and safety may be attained. Under the new regulations each man is supposed to be able to take charge of a train, and to be able to understand all signals or rules of the road under all conditions.

J. G. G. Kerry, of Montreal, is preparing a report on the cost of extending the Hamilton, Grimsby and Beamsville Electric Railway to St. Catharines, with an extension to the Niagara river. The line to St. Catharines will be the only proposition immediately considered. It is reported that a working arrangement will be made between this company and the Hamilton, Ancaster and Brantford electric line, which is now being financed by capitalists from the United States, and construction upon which will probably be commenced early in the spring.

The progressive railway manager of the present day seeks success in his motive power department by driving his engines to the limit, and permitting them to remain out of service for the least possible time. During the winter months the time required for melting snow and ice from the running gear and putting the engine in shape for another run has been very materially reduced by modern methods of heating and ventilating the round-house. A thoroughly up-to-date example is that of the Blair furnace round-house of the Pennsylvania railroad at Altoona, Pa. Here a large steam hot blast apparatus, constructed by the B. F. Sturtevant Co., of Boston, Mass., is employed to distribute heated air throughout the building, and also to force it in large quantities into the pits beneath the locomotives. The time required for cleaning and repairs is thereby reduced by 60 or 70 per cent.

CANADIAN MINING INSTITUTE.

The annual general meeting of the Canadian Mining Institute opened at the Windsor Hotel, Montreal, March 1st, with a diminished attendance, compared with recent years. Eugene Coste, of Toronto, president, occupied the chair.

The following is a synopsis of the programme of papers and addresses:

Wednesday.

Presidential Address. By Eugene Coste, E.M., Toronto, Ont.

The Goldfield District, Nevada. By E. P. Jennings, M.E., Salt Lake City, Utah.

Wrought Pipe-threading and Relative Durability of Steel and Iron. By Frank N. Speller, B. Sc., Pittsburg, Pa.

The Advantages of Combining Topographical and Geological Surveying in New Regions. By Dr. Robt. Bell, Ottawa, Ont.

Crude Oil Fuel. By J. N. S. Williams, C. and M.E., Puunene, Maui, T.H.

On the Bordos Silver Mines, near Copiapo, Chili. By George Fergie, M.E., Copiapo, Chili.

On the Need of a Provincial Museum in Ontario. By Dr. W. A. Parks, Toronto, Ont.

On the Carboniferous of New Brunswick. By Dr. Henry M. Ami, Ottawa, Ont.

On Canadian Mica Mines. By E. T. Corkill, Toronto, Ont.

The Artesian and Other Deep Wells on the Island of Montreal. By Dr. F. D. Adams, Montreal, Quebec.

On Concrete. By R. W. Leonard, C.E., St. Catharines, Ont.

On the Value of Undeveloped Mining Claims. By Prof. G. R. Mickle, Toronto, Ont.

The New Plant at Copper Cliff, Ontario. By A. P. Turner, Copper Cliff, Ont.

On Electric Furnace Construction. By F. T. Snyder, Oak Park, Ill.

On Electric Smelting. By Eugene Haanel, Ottawa, Ont.

The Possibilities of Steel Manufacture in British Columbia. By Wm. Blakemore, M.E., Nelson, B.C.

On Canadian Metallurgical Products for the Far East. By F. Hobart, M.E., New York, N.Y.

The forenoon of Thursday, 2nd, was devoted to students' essays, the principal of which were:

Prospecting in Western Canada. By D. D. Cairns, Queen's University, Kingston, Ont.

Mine Surveying Methods used in the Centre Star Mine, Rossland, B.C. By L. H. Cole, McGill University, Montreal, Que.

Notes on the Centre Star and War Eagle Mines, Rossland, B.C. By G. C. Bateman, Queen's University, Kingston, Ont.

Drilling for Oil in the Petrolia Field, Ont. By G. P. Stirrett, School of Practical Science, Toronto.

Properties of Nickel Chloride. By N. F. Rutherford, School of Practical Science, Toronto.

Notes on Graphite: Its Occurrence, Uses and Production. By G. C. Bateman, Queen's University, Kingston, Ont.

Notes on Recent Reverberatory Smelting Practice at Anaconda, Montana. By A. McL. Hamilton, McGill University, Montreal, Que.

Notes on Mining in the Slocan, B.C. By D. Sloan, Queen's University, Kingston, Ont.

Solubility of Cobalt and Nickel Arsenides in Ammonia. By G. S. Hanes, School of Practical Science, Toronto.

Thursday afternoon and evening were set apart for the following papers:

On Mining Statistics. By F. Hobart, M.E., New York, N.Y.

On Uniform Mining Statistics in Canada. By Eugene Coste, M.E., Toronto, Ont.

On Mining Laws. By J. M. Clarke, K.C., Toronto, Ont.

The Bornite Ores of the Pacific Coast, in British Columbia and the Yukon. By Wm. M. Brewer, M.E. Victoria, B.C.

A Correction in the Classification of our Gold-rock Formation. By F. Hille, M.E., Port Arthur, Ont.

On Bankhead Coal Mines. By C. M. Henretta, M.E., Fernie, B.C.

The Stratigraphy of the Cascade Coal Basin. By D. B. Dowling, Geologist, Ottawa, Ont.

Notes on the Life History of Coal Seams. By Prof. J. C. Gwillim, Kingston, Ont.

Cheap Production of Pigments Direct from Sulphide Ores. By C. B. Jackes, Toronto, Ont.

The Bed-rock of the Gilbert River Gold Fields, Quebec. By John A. Dresser, M.A., St. Henri de Montreal, Que.

A Note on Varieties of Serpentine in South-eastern Quebec. By John A. Dresser, M.A., St. Henri de Montreal, Que.

A New Mining District in the North of the Province of Quebec. By J. Obalski, M.E., Quebec, Que.

The Cobalt-Silver-Nickel-Arsenic Ores near Lake Temiskaming, Ont. By W. G. Miller, Provincial Geologist, Toronto, Ont.

Los Reyes Gold Mines, Mexico. By Alex. Smith, Oaxaca, Mexico.

On the Mining Possibilities of Arctic Canada, Illustrated by Lantern Slides. By A. P. Low, B.A., Sc., Ottawa, Ont.

On Meteorites. By Dr. Borgstrom, Kingston, Ont.

Notes on Some Hoisting Machinery. By F. Cirkel, M.E., Montreal, Que.

Methods of Time and Cost-keeping of Copper Cliff Mine, Ont. By E. A. Collins, Kingston, Ont.

Application of Electricity to Mining Operations. By Prof. L. W. Gill, Kingston, Ont.

On the Occurrence of Hematite North of Little Current, Georgian Bay. By S. Dillon Mills, Toronto, Ont.

Indicator Cards. By W. D. L. Hardie, M.E., Lethbridge, Alta.

A Canadian Dellwik-Fleischer Water Gas Plant. By E. A. Sjostedt, Sault Ste. Marie, Ont.

On Iron Pyrites in Eastern Ontario. By E. L. Fraleck, M. E., Belleville, Ont.

International and Interprovincial Boundaries of Canada. By James White, Geographer, Ottawa, Ont.

The annual dinner of the members was held at the Windsor Hotel on Friday evening, 3rd.

TELEPHONE AND TELEGRAPH.

A new telephone exchange will be erected in Kingston, Ont., at a cost of about $30,000.

The Bell Telephone Co. will build and equip ten to fifteen new telephone exchanges in the smaller towns and villages in the vicinity of Winnipeg.

The telephone war at Fernie, B.C., has been settled, the C.N.P. Coal Co. having purchased at cost the British Columbia Telephone Company's partially built plant.

The Bell Telephone Co. will install a new switchboard in the Manitoba central office with a capacity for 10,000 subscribers. The present one is large enough for only about 4,300.

Some of the farmers around Berlin are having telephones installed by the Bell Co. The cost is $15 per year among themselves and ten cents a call to Berlin, or $25 per year unrestricted.

The Board of Trade, of Vernon, B.C., has under consideration a proposal from Geo. Williamson to put in a long-distance telephone system connecting Enderby, Armstrong, Vernon and Kelowna.

Frederic Nicholls, general manager of the Canadian General Electric Co., has made a gift of a considerable quantity of electrical machinery to assist in equipping the physics department of the University of Manitoba.

The Guernsey State Telephone Service has issued its seventh annual report for the year 1904, which shows a profit of $1,400 after allowing for interest, depreciation and sinking fund. The total number of telephones is 1,044, an increase of 107 during the year. The rates are: Tariff A, $7.31 per annum and two cents per call; Tariff B, $10.96 per annum and one cent per call; Tariff C, $24.35 per annum and unlimited calls up to 3,200. Nine hundred and eighty-five subscribers use Tariff A, 82 Tariff B, and 95 Tariff C.

PERSONAL.

E. T. Corkill, B.Sc., has been appointed by the Ontario Government inspector of mines, to take the place of W. E. H. Carter, resigned.

Charles O. Granberg has been added to the staff of engineers of the Canadian Casualty and Boiler Insurance Co., of Toronto. Mr. Granberg is regarded in engineering and insurance circles as one of the best in his class.

The Philip Carey Mfg. Co., of Lockland, O., makers of roofing and pipe coverings, is opening a branch in Montreal, with G. H. Langridge as agent. Mr. Langridge has for the past fifteen years been with Alex. Bremner, of Montreal.

William H. Baush formerly of the Baush Machine Tool Co., of Brightwood, Mass., has opened up a new concern in Springfield called the Baush Machinery and Supply Co. The New England Roller Grate Co. is also run by this firm.

John M. Dixon, formerly engineer of the City Hall, Toronto, has been appointed organizer for the Amalgamated Society of Engineers for the Dominion of Canada, and reports good success in organizing branches in Ontario, where his campaign has begun.

James Sykes, mentioned in the January issue as one of the builders of the first Canadian-built locomotive, the "Toronto," died at his home in Toronto last month, at the age of 76. He leaves two sons, W. J. Sykes, of Toronto, and Dr. F. H. Sykes, of Columbia University, New York.

A. A. Dion, of Ottawa, the efficient editor of the Question Box of the Canadian Electrical Association, has been at work for some time on the Question Box to be published next June. Last year's publication proved a valuable work of reference, and with the co-operation of the Association members, we have no doubt Mr. Dion will produce a book of equal value this year.

G. C. Mooring, who has been engineer and machinist for the Methodist Book and Publishing House, Toronto, for the past fifteen years, is leaving that establishment, having bought out the Boiler Compound business of the late Wm. Sutton, together with machinery and plant. His specialties will be the making of printing and book-binding machinery, repairing, etc. His many friends wish him every success in his new venture. He will assume charge this month of the "Modern Machine Shop," which is located at 82 Adelaide St. West, Toronto.

Timothy Jento, the first steamboat engineer in Canada to whom a life certificate was granted, died last month at Brockville, aged 75 years. He was born at Chambly, Que., and came to Upper Canada when 18 years of age, and located at Bedford Mills as a steamboat engineer for Chaffey Bros., and when that firm settled in Brockville he moved there also. He afterwards lived in Morrisburg and Ottawa, returning to Brockville in 1870. He built and operated several small steamers plying the St. Lawrence. Five years since he retired from active life. He is survived by three sons, one of whom is Dr. C. P. Jento, of London, Ont.

MUNICIPAL WORKS, ETC.

Wetaskiwin, Alta., is now lighted by a municipal electric light plant.

Victoria, B.C., will spend $11,000 in improving its electric light system.

At Moosomin, N.W.T., fire did $30,000 damage in the business part of the town. Insurance, $15,000.

The McNab, Ont., township council has decided to build a steel bridge over the Madawaska river, to cost about $18,000.

The civic administration of Calgary has asked tenders for the erection of a lighting plant, to be completed by October 1st.

The town council of Goderich, Ont., are considering making improvements to the electric light plant there at a cost of about $10,000.

North Vancouver, B.C., has awarded the contract for the completion of its water works system to J. C. Williams, of Vancouver.

Brandon's city engineer is preparing plans and estimates for the installation of an electric light system for the streets and public buildings of the city.

The Lieut.-Governor will be asked to sanction the raising of $7,000 by debentures for the completion of the waterworks system at Burk's Falls, Ont.

Medicine Hat, Assa., will probably soon begin the construction of a sewerage system. Plans are being prepared by John Galt, C.E., of Toronto.

The new electric lighting and power plant at Fenelon Falls, Ont., built by the town at a cost of $30,000, is now in running order, the preliminary test having been entirely successful.

Fort William last year derived from its water, light and telephone service a revenue of $37,000, being a surplus of $900 after defraying all expenses and providing interest and sinking fund on the debt.

The City of Vancouver, B.C., desires to receive applications for the position of City Engineer. Address A. B. Cather, Acting City Clerk, stating fully qualifications, age, experience, etc., and salary required.

A contract for cement for Hamilton for 1905 to the extent of about 15,000 barrels has been awarded to a United States firm, whose quotation was 2½ cents per barrel lower than that of the lowest Canadian tender.

The vote taken at Charlottetown, P.E.I., February 19th, on the question of municipal ownership of the electric light plant resulted in a large majority in favor of the move. The council will proceed at once to erect a plant.

Banff, Alberta, is to have an up-to-date water supply and sewerage system. John Galt, C.E., at the request of the Department of the Interior, has made investigation and prepared plans on the subject, and his report with estimates of cost, etc., has been submitted for consideration.

Surveys have been made and plans prepared for a complete working system of water supply, sewerage and electric lighting for Indian Head by John Galt, C.E., the cost of which will run about $150,000. The water supply will be taken from springs at the foot of the Squirrel Hills, a distance of seven miles from town at an elevation of 160 ft., so that natural gravitation will produce a most economical result for all domestic service, and a fire pressure pump only used as an auxiliary in case of necessity.

The Donnelly Wrecking Company of Kingston have contracted with the town of North Bay to put 1,300 feet of submerged sewer pipe into Lake Nipissing, and to lay 330 feet of intake pipe for the new waterworks system into Trout Lake, three miles from the town.

Allan Hagen, sanitary expert, advises water supply extension in Winnipeg to a capacity of 18,000,000 gallons per day. He declares that an ample water supply need not be expected from the extension of the present artesian system, but states that the Red and Assiniboine river water can be filtered and made potable.

The contract has just been awarded by the City of Winnipeg to Babcock & Wilcox, Limited, Montreal, for the installation of two of their 250-H.P. forged steel, patent water-tube boilers, fitted with B. & W. patent steam superheaters and chain grate automatic stokers. This is in addition to the power plant of the city water-works system, in which five of the same type of boiler were installed some five years ago, and it speaks well for the general satisfaction they have given.

The result of municipal ownership of light and power in Kingston, Ont., is that it has been decided to reduce the price of gas from $2 to $1.50 per thousand, and of electricity from 14 cents to 12 cents per kilowatt. The reduced rates will come into force on Dominion Day. The question of the rate for power supplied to the street railway company will come up on the 6th March, when the present agreement expires. The city is now supplying the company with power below cost.

Regina, the capital of the new Province of Saskatchewan, is actively pushing municipal improvements. The water works system, which furnishes a plentiful supply of pure spring water, is now completed and in use. Construction began in June last, and, although the system is a large and extensive one, bringing water by natural gravitation a distance of fully seven miles to the city. it was vigorously pushed and completed ready for use on New Year's Day. Several domestic services have already been installed and in use, and the coming year very many additions will be made. A power house has been built, about 75 feet square, containing two Babcock & Wilcox water tube steam boilers, each 250 horse-power; also a 450 h.p. high-duty Corliss engine, coupled direct to a 350 k.w. alternating Westinghouse generator at 150 revolutions per minute, for supplying light and power. The sewerage system is now under construction, and will be completed during the coming season. The entire works have been designed and are being carried out under the supervision of John Galt, C.E.

MARINE NEWS.

It is expected that by the end of the present year about 130 miles of the Trent Valley Canal will be navigable.

The contract for repairing the British ship, "Haddon Hall," has been awarded to the Victoria Machinery Depot. The cost is about $7,000.

The Government has granted the Interprovincial Navigation Co. fifty feet adjoining the railway wharf for the purpose of building a new wharf at Campbellton, N.B.

The Manly Co., of Toronto, Ont., have been awarded the contract for construction of breakwaters at Port Stanley and Rondeau, to cost in each case about $100,000.

The Allan liner Victorian will sail from Liverpool on her first trip to St. John and Halifax on March 23rd. The Virginian will sail for Montreal about April 8th.

Engineer Cunningham, last year of the Garden City, will be engineer of the Arabian this year, changing positions with James Brown, who was last year engineer of the Arabian.

The Montreal and Lake Superior Line boats, the Wacondah and Neepawah, wintering at Hamilton and Port Arthur, respectively, are being equipped with friction hoisting gear.

The National Marine Engineers of Canada held their annual convention in Collingwood last month. It was decided to send a special committee to Ottawa to urge the passage of the bill compelling the engineers of all large tugs to have certificates.

Engineer Norman, formerly assistant engineer of the steamer Ames, will be chief engineer of the steamer Strathcona for the coming season. Engineer Smeaton, of the Strathcona, will go to the Neepawah, one of the Montreal and Lake Superior line, now lying at Port Arthur.

Particulars of the contract between the Minister of Marine and the Submarine Signal Co., of Boston, for signal protection of the St. Lawrence and Atlantic Coast have been laid before Parliament. Each installation will cost in the neighborhood of $2,500 for vessels of 5,000 tons, decreasing to $100 for ships of small tonnage. The Government will pay the charges for installation and incidental expenses, plus 25 per cent. There is to be a royalty of $2,000 per annum until $100,000 shall have been paid, when further charges or royalties shall cease. If more favorable terms are granted to any other Government, Canada is to be granted a corresponding reduction in the charges paid. At least thirty submarine signal stations will be required on the St. Lawrence and the Atlantic Coast, and the company will install the signals on a like number of steamers making Canadian ports.

A number of Manchester capitalists, represented in Toronto by W. M. Barber, 92 Langley Avenue, have taken steps to secure a charter for a company to manufacture tin plate.

Ross & Holgate, of Montreal, have been appointed to carry out a field engineering enquiry for the Niagara Power Commission, to ascertain the amount of power needed by the manufacturers.

It is reported that the Canadian Shipbuilding Co., of Bridgeburg, Ont., have secured a contract for the building of a large part of the rolling stock for the new electric railway from Toronto to Niagara Falls.

H. C. Kennedy, of Wiarton, has secured an option on the Lake on the Mountain, Prince Edward County, which is a body of water 200 feet higher than the Bay of Quinte and situated about five miles from Picton. It has been impossible to locate any bottom in some parts, and the lake appears to be fed from below. Mr. Kennedy proposes to develop the water power to supply electric energy to the nearby towns and cities. For this purpose he will organize a company with a capital of $500,000.

A water power at Deux Rivieres, on the Ottawa River, has been leased to H. H. Dewart, K.C.; Joseph Kilgour, and Charles Mitchell, of Toronto, and W. Woodruff, of St. Catharines, for a period of ten years. The lessees must within two years develop not less than 2,000-h.p. The rights of lumbermen and others to drive logs down the river are reserved, and it is provided that the Ontario or the Dominion Government may at any time take part of the land leased for use in connection with the proposed Georgian Bay Canal. Andrew McCallum reports that the development of 2,000-h.p. will cost $63,000.

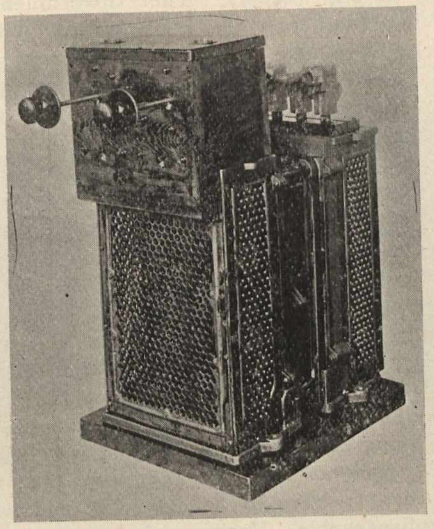
Sir William C. Macdonald has donated $2,000 to McGill University for experimental work carried on in the physics building. The Canadian General Electric Co. has given $400 for a scholarship in the faculty of applied science. James Morgan, G. A. Grier, A. Kingman, A. E. Childs, H. G. Nicholls, and F. Nicholls have given bursaries in aid of needy students in the faculty of applied science. A friend in the United States has renewed his donation of $400 for a fellowship in the electric department.

C. W. Purington, of the United States Geological Survey, has prepared a report on road building in Alaska. So far, Congress has done nothing towards building or maintaining roads in that territory, and mining journals are urging that some immediate action should be taken. "As all roads led to Rome," remarks the Mining World, "so the need of modern Alaska is that all roads should lead to Nome." The same paper remarks that the condition of affairs in Alaska is especially deplorable, as it is in such sharp contrast with the state of things in the Yukon. Much of the data from which Mr. Purington made his estimates was obtained from the Canadian Government officers, who have constructed admirable wagon roads on this side of the line.

TRANSFORMER OUTFITS FOR THAWING PIPES.

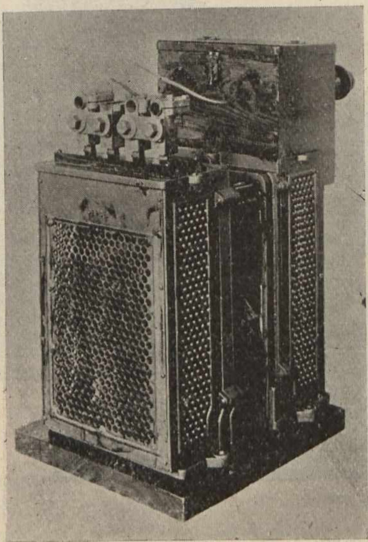
The manifest superiority of electricity as a thermal agent in thawing frozen pipes and the field for this service that awaits development has attracted a considerable amount of attention on the part of central station managers, many of whom have improvised outfits for this purpose. There has arisen a very general demand for thawing outfits that shall have a range in capacity to cover all ordinary requirements; shall be portable, easy to connect and moderate in price, and to meet this demand the Westinghouse Electric and Manufacturing Company has designed the two transformers herein described.

The larger of the two outfits (Style No. 40810, shown in the illustrations) weighs, complete with transformer, switchboard and base, 750 pounds. It occupies a floor space 2 feet 4 inches by 1 foot 10 inches, and is 1 foot 7 inches in height.



A link in the top of the transformer case affords a means of lifting the outfit, and if desired truck wheels may be attached to the wooden base. It will be seen that it is of small size, and is lighter in weight than any other outfit for the same purpose, giving it a superior portability.

The transformer may be operated satisfactorily on circuits varying from 1,800 to 2,500 volts. The low tension is arranged to deliver approximately 500 amperes for several hours at an E. M. F. from 15 to 50 volts. By a simple



change in connections the windings may be arranged to deliver about 1,000 amperes at voltages from 8 to 16 for thawing large mains whose resistance is generally low. It is suitable for thawing anything from a one-half inch pipe to a one-foot main. The transformer is generously designed, and will deliver large overloads for short periods of time. The windings are air cooled. The insulation is not injured by rain, snow or ordinary abrasion. There are no moving parts to get out of order, and the entire outfit is contained in a single unit. A light but substantial switchboard is mounted upon the high-tension end of the transformer. The switches are of the enclosed plug type, such as are used upon high-tension arc light circuits, and permit a variation of the low-tension voltage, and consequently the current supplied to the pipes. The switches are so arranged that it is impossible to make a wrong connection.

The other outfit is smaller, and is adapted for thawing service piping about dwelling houses. It is light, of such proportions as to make it easy to handle, and is mounted in a wooden box provided with a handle and shoulder strap. It has a capacity of 200 amperes at potentials up to 25 volts for one hour. It is arranged for operation off a nominal 2,000 volt circuit, but can be supplied for any other primary voltage to as low as 200 volts. The voltage regulation and current control are obtained through plug switches in the high-tension circuit. When desired, these outfits are furnished with a current measuring device, so that the operator may know the amount of current that is being used.

MECHANICAL TRANSPORT OF AIR.

In the Engineering Magazine, Walter B. Snow, of Boston, who has made a special study of heating and ventilating questions, points out that wholesale transportation of fluids such as air, is rarely accomplished by actual carrying, but rather by the process of flowing, as a result of creating a pressure difference between the two ends of a conduit.

"The simplest of all methods of creating such a difference is by heating the air within a vertical conduit, of which the chimney is a familiar illustration; thereby reducing its density and inducing at the bottom an inflow of the cold and heavier outside air. Because of its simplicity it was but natural that this method should have preceded the application of mechanical devices for the production of artificial ventilation. But simplicity and efficiency do not here go hand in hand. The bellows appears to have been the first mechanical contrivance utilized for the purpose of ventilation. The date of its invention is, however, buried in the dim past, although as early as 1556, Agricola in his elaborately illustrated work, *De Re Metallica*, shows this simple device, as well as a crude form of rotary blower applied for the ventilation of mines. The fan or centrifugal blower has, however, long been accepted as the only effective mechanism for creating wholesale air movement. The air compressor, producing pressures up to 100 pounds or over, the blowing engine operating within the usual range of 10 to 20 pounds per square inch, and the positive or rotary blower seldom exceeding 5 pounds in the pressure created, are not primarily designed for mere movement of air, but more essentially for the creation of pressure and transmission of the same through the medium of the air. The propeller or disc fan on the other hand is efficient only under very low resistances, and is incapable of economically forcing the air through conduits of very great length. The maximum economical working pressure for the fan blower is well established at about one pound per square inch, but for the purposes of ventilation its rotative speed seldom exceeds that necessary to create a pressure of one ounce per square inch and a corresponding velocity of somewhat over 5,000 feet per minute which, in general practice, is reduced to about 3,500 feet in the conduits, corresponding to about one inch head of water.

"The province of a fan wheel when in motion is to create such a pressure difference between the inner and outer diameters of the blades or floats as to cause a flow of air from the centre of the circumference. The resulting action is well exemplified by rotating a tube about an axis established at right angles to its own and midway of its length. By centrifugal force the air is thrown outward from its open ends and a partial vacuum created at the axis about which revolution occurs. If an opening be made at this axis, air will rush in to supply the vacuum and a constant flow will be established. Much thought has been expended upon fan design with many resulting arrangements of the fan blades and casings. Some blades are radial, some curved forward and some backward, while others combine these forms; some fans are relatively wide and of small diameter, others of almost excessive diameter, but of minimum width; some run free in the atmosphere, while others are equipped with casings of varied design. In all these forms the effort has ever been to improve the efficiency; but frequently greater volume or pressure has been secured only by increased expenditure of power. In fact, the simpler still remains not far behind the more elaborate in economy of operation.

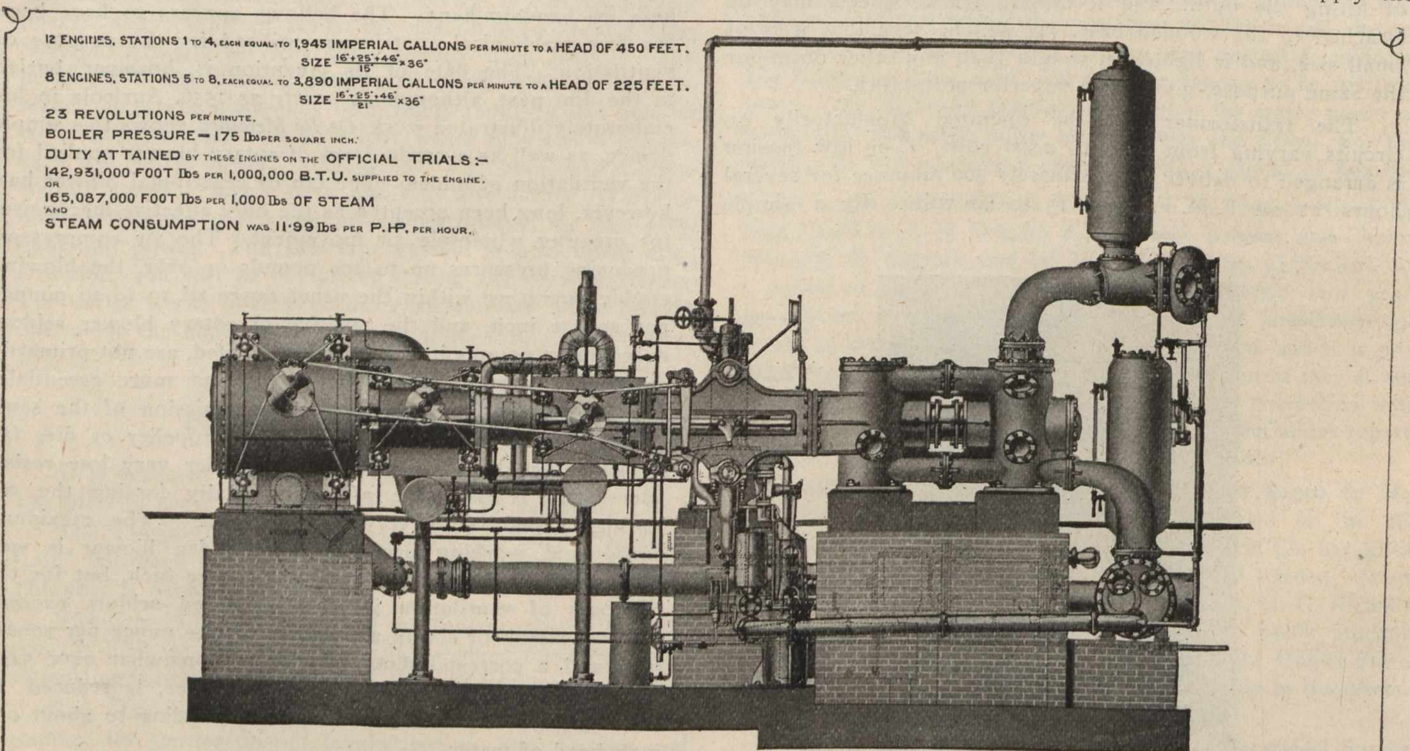
"The effect of high velocities is clearly shown by the fan in which doubling the rotative speed simply doubles the volume discharged, while producing four times the pressure and requiring eight times the power. That is to say, the volume varies directly as the number of revolutions; the pressure varies as the square and the power required as the cube of the revolutions. It is, therefore, evident that a fan which is half large enough to move the desired volume at the required pressure will have to run at double the speed and will absorb eight times the power necessary to operate a fan of proper proportions. In a word, a fan should be so proportioned to its work as to make possible the delivery of the necessary quantity without exceeding the minimum permissible pressure."

THE COOLGARDIE PUMPING SYSTEM.

The Coolgardie Goldfields, which is a common name for the great groups of mines at Kalgoorlie and Coolgardie and the immediate neighborhood, is some 363 miles in a direct line from the Port of Fremantle on the West Coast of Australia. The first 100 miles crosses a series of granite ranges averaging 1,200 feet high, covered with gum trees, etc. The country then becomes a series of broken rolling plains gradually rising towards Coolgardie. The soil, with the exception of a few patches, is sandy, and covered with scrub, gum trees, etc. It is to all intents and purposes waterless (the average rainfall being 7.14 inches, and the evaporation 82.6, with a temperature often over 100 degrees Fahr. in summer), there being in the old days only a few soaks and native wells available for the supply of water.

In 1892 the first discovery of gold in paying quantities was made near the site of the present town of Coolgardie. Until the discovery of gold, this desolate and waterless country had been crossed several times by bands of intrepid explorers, the earliest of which was under the leadership of Mr. Forrest, now the Rt. Hon. Sir John Forrest, P.C., G.C.M.G.* When the great rush of 1893 set in, the want of water caused indescribable suffering and loss of life, largely due to typhoid, and, as the railway ran only to Southern Cross, some twenty-five miles from the coast, the remainder of the distance had to be done in stage coaches or any other vehicle that could be made available. As the gold area increased, and the various gold-bearing reefs and formations showed signs of being permanent, the Government did all that was possible to minimize the suffering due to the shortness of water. When it is stated that inferior water, hardly fit for human consumption, was worth 2s. 6d. per gallon, and very scarce at that, some idea of the condition of affairs is conveyed to our readers. The Government excavated tanks and built dams on the roads to the fields. As the mines developed, at the lower levels salt water was found, which was distilled and sold at 70s. per 1,000 gals. In this way some sort of a provision was made, but the water supply was still a danger point in connection with the fields. Typhoid fever raged, and owing to the extreme saltness of the water (there being 30 ozs. of saline matter to the gallon), a quantity of fine gold was lost.

In 1894 the railway had been extended to the Goldfields, i.e, Coolgardie and Kalgoorlie. The difficulties and cost of working the traffic were enormously increased, owing to the trouble in obtaining fresh water at almost any price. For example, the cost of water alone to the Railway Department was £1,000 per day during the summer. Such a state of affairs could not last, as it meant an immense increase in the cost of living on the fields. As gold was being found at other places, such as Menziers, Leonora, etc., the railway would of necessity have to be extended, and water, therefore, was indispensable. Various schemes were propounded, and several offers were made to the Government by groups of capitalists to build and work waterworks to supply the fields if a concession was granted them. An attempt was made to obtain water by boring, but after going down 3,000 feet through granite the attempt was given up. At the latter end of 1895 Sir John Forrest announced during a visit to Coolgardie that the Government intended to carry out a scheme for the supply of fresh water to the Goldfields by



COOLGARDIE WATER SUPPLY.
WESTERN AUSTRALIA.
Triple Expansion Surface Condensing High Duty
Worthington Pumping Engine.

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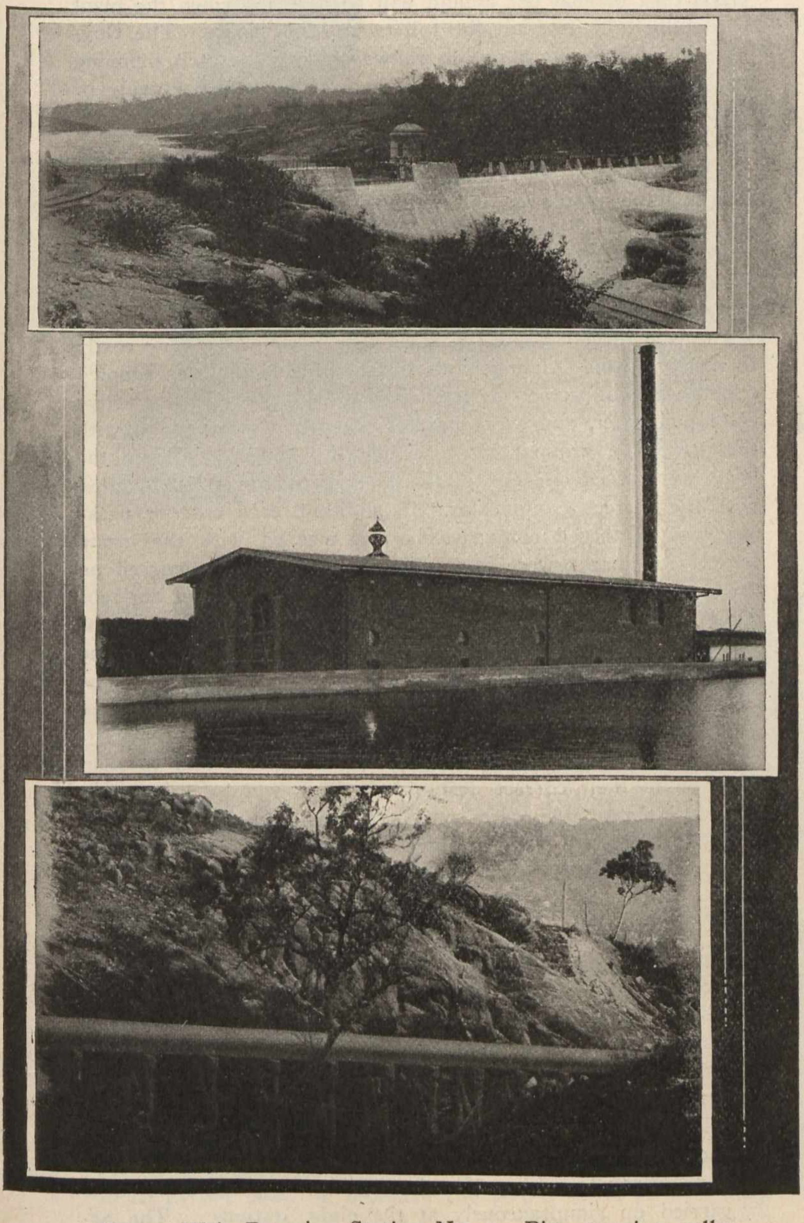
*High Commissioner of the Commonwealth of Australia in London.

means of pumping from the coast. This was received at the time with a good deal of scepticism. But Sir John Forrest was in earnest. He believed in the future of the colony and the permanency of the Goldfields, at that time producing 231,513 ozs. of gold per annum.

The late C. Y. O'Connor, Engineer-in-Chief, reported in favor of a scheme which consisted of a reservoir to be built on the Helena river, near Mundaring, in the Darling Ranges, about twenty miles from Perth, the water to be then pumped through a main to Coolgardie. In the first place only 1,000,000 gallons was estimated as the probable requirement; this quantity was, however, increased to 5,600,000 gallons per twenty-four hours, and the estimated cost was set down at £2,500,000, exclusive of the reticulation of the towns en route.

In the scheme the main supply reservoir is situated in the Darling Ranges, about thirty miles from Perth, 320 feet above sea level, where two great arms of granite jut out



Helena Weir Pumping Station No. 5. Pipe crossing gully.

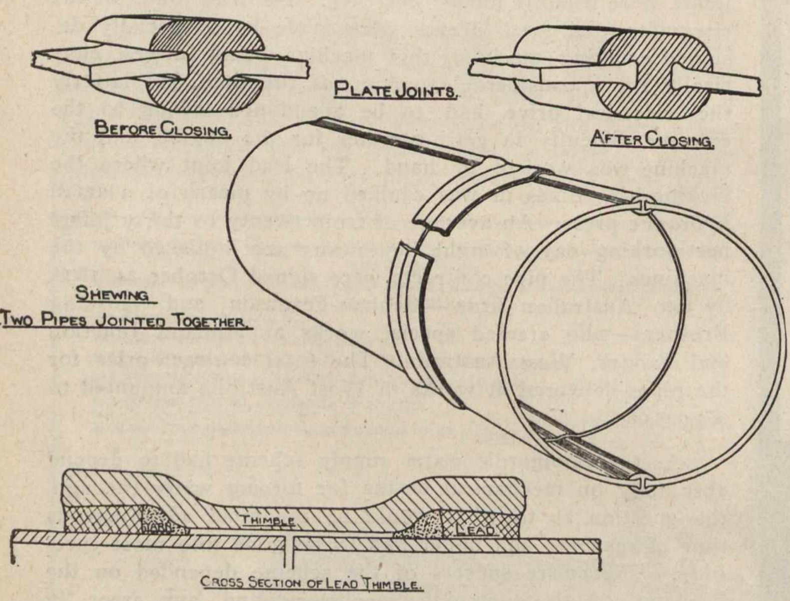
across the narrow valley, at the bottom of which flows the Helena river. A gigantic dam of concrete is placed like a huge wedge between these two granite arms, thus closing up one end of the valley. It is 760 feet long, and 100 feet high in the deepest part, and the foundations were carried down nearly 100 feet below the level of the river. At the base of the foundations the thickness of the dam varies from 85 to 120 feet, tapering to a width of 15 feet on the top. Sixty-nine thousand cubic yards of concrete were used in the construction. The surplus water flows over the crest of the dam. The reservoir or lake thus formed is eight miles long, and contains, when full, 4,600,000,000 gallons of water. The catchment area comprises 850,000 acres, and consists chiefly of granite hills. The water is exceptionally good. At a trifling cost it would be possible to divert other streams into the reservoir, and so largely increase its capacity. Suitable valve towers are provided to regulate the flow to the first pumping station.

After a series of tests, the Government, acting on Mr. O'Connor's advice, decided to use a new and novel form of pipe. All the best known pipes were passed by, and the decision to use what is known as Mephan-Ferguson's patent locking-bar pipe was arrived at. This pipe consists of two steel plates rolled into semi-circular form, the edges being upset by special machinery and a locking-bar forced on. The joint is then finally clamped or closed by means of hydraulic machinery. The diameter of the Coolgardie pumping mains is 30 in., each pipe being about 28 ft. in length, made of plates ¼ in. thick, and weighing about 1¼ tons. In some sections, where extra pressure existed, the pipes were made of plates 5-16 in. thick. The total number of pipes required was about 60,000 for the main to Coolgardie, and the total estimated weight of steel plate about 76,000 tons. Each pipe was subjected to a hydraulic pressure test of 400 lbs. to the square inch, and was then immersed in a bath of hot Trinidad asphalt, and kept there until the steel rose to the same temperature as the bath itself; this coating acts as a preservative against rust, etc. The circumferential joint consisted of a forged steel sleeve with lead-caulked joint. The pipe was laid partly in a trench, and then covered to a uniform thickness of two feet with soil, except where it ran through salt country, where, in order to avoid corrosion, the pipe was laid on trestles and protected from the sun by suitable coverings. No expansion joints were used or found necessary. The lead joints of the circumferential steel sleeves were made by a specially designed caulking machine, this machine being driven elecrically for a considerable portion of the time, but latterly the electrical drive had to be abandoned owing to the extreme difficulty in getting water for the engine, and the machine was worked by hand. The lead joint where the locking-bar comes in was caulked up by means of a small hydraulic press. An average of from twenty to thirty joints per working day of eight hours was accomplished by the machines. The pipe contracts were signed October 24, 1898, by two Australian firms—Mephan-Ferguson and Hosking Brothers—who erected special works at Midland Junction and Falkirk, West Australia. The total contract price for the pipes delivered at works in West Australia amounted to £1,025,000.

As the Coolgardie water supply scheme had to depend absolutely on mechanical means for forcing water through, the question as to what would be the most advantageous type of machine and boiler had to be gone into most carefully. The entire success of the scheme depended on the working of the pumping machinery, and any error in selecting the type would lead to disastrous financial results. Briefly, the problem was to pump 5,600,000 gallons per twenty-four hours against a total estimated head, including friction, of 2,700 feet, through a pipe 30 in. in diameter, and roughly, 330 miles, the speed of the water through the pipe being taken at about two feet per second.

From Stations 1 to 4, in each station there are three complete sets of pumping machinery and boilers, any one of which is capable of pumping 2,800,000 gallons per twenty-four hours against a head of 450 feet, so that to get the full quantity of water two sets of engines and pumps are always pumping together into the main, and one set is "spare." From Stations 5 to 8 inclusive, there are at each station two sets of machinery, each set of machinery being capable of pumping 5,600,000 gallons per twenty-four hours against a head of 225 feet, so that while one set is pumping the other set is "spare." Station No. 1 is situated close to the foot of the great dam on the Helena river. The water is elevated 421 feet in daily work into an open concrete tank of a capacity of 468,000 gallons, situated at No. 2 Station, the total distance from No. 1 being about 1½ miles. From Station No. 2 the water is pumped up about 360 feet through twenty-three miles of main to the first regulating tank at Baker's Hill, about 1,080 feet above sea-level. This tank is of concrete, with a capacity of 500,000 gallons. The water runs from Baker's Hill by gravity to a second regulating 500,000 gallon concrete tank at Northam, eighteen miles further on, the Northam tank being 94 feet lower than Baker's Hill. Still falling, the water reaches the great tank at Cunderin, which holds 10,000,0000 gallons, and is seventy-eight miles from the Helena reservoir. Stations 3 to 7 pump the water against a steady rise to the 8th station at Dedari, a distance of 217 miles from Cunderin, and situated at an elevation of 1,457 feet. Each station is provided with concrete tanks of 1,000,000 gallons capacity, which act as combined receiving and suction tanks. From Dedari the water is pumped a distance of twelve miles to the main service reservoir at Bulla Bulling. This reservoir is of concrete, reinforced with barbed wire strands, and holds 12,000,000 gallons. Bulla Bulling supplies a small reservoir of 1,000,000 gallons on Toorak Hill, overlooking the town of Coolgardie, the mean elevation being 1,525 feet. The total head pumped against in daily working at Stations Nos. 1 to 4 varies from 360 feet to 410 feet, depending on whether one or two engines are working. At Stations Nos. 5 to 8 the head is from 180 to 210 feet. From Toorak tank the water runs by gravity to a reservoir on Mount Charlotte, which is to supply the town of Kalgoorlie. This brief description of the work to be done clearly shows how absolutely the financial success of the scheme depended on the pumping machinery.

MEPHAN-FERGUSON'S
PATENT RIVETLESS OR LOCKING BAR STEEL PIPE.



In October, 1899, tenders for the machinery were called for by the Government. Mr. O'Connor decided that it was useless for him to attempt to say which design should be used; he simply specified what the work to be done consisted of, laid down stringent tests of materials and workmanship, and left to the various firms of manufacturers the onus of submitting plans and proposals as to how they would tackle this proposition. The Government accepted the tender of James Simpson & Co., Limited, of London, a special clause being inserted in the contract giving them permission to have half of the manufacturing done by the Worthington Company. The size and type of engine selected was as follows for Stations Nos. 1 to 4 inclusive: Twelve triple-expansion high-duty Worthington pumping engines, each having two high-pressure cylinders, 16-in.; each having two intermediate pressure cylinders, 25-in.; each having two low-pressure cylinders, 46-in.; each having two double-acting plungers, 15-in.; all of a common stroke of 36-in. And for Stations Nos. 5 to 8, inclusive, eight engines of similar type; each having two high-pressure cylinders, 16-in.; each having two intermediate pressure cylinders, 25-in.; each having two low-pressure cylinders, 46-in.; each having two double acting plungers, 21-in.; all of a common stroke of 36-in.

From these sizes it will be seen that the only difference in the whole of the engines is that eight of them had 21-in. water plungers and twelve had 15-in. The whole of the steam ends are standard to one size. The gain in economy is at once apparent, as it means the whole of the twenty boilers, accessories, etc., could be made standard, and the number of spare parts required to be held in store is greatly reduced. The boilers are Babcock & Wilcox, with single drums, and are equipped with superheaters, and to secure the highest possible economy, feed water heaters and economizers, with all necessary accessories, are provided in the boiler-house; one boiler being provided for each engine.

The contract provided that each of the pumping engines should be capable of attaining throughout a twelve-hour trial a duty of 135,000,000 foot pounds of effective work per 1,000,000 British thermal units supplied to the engine, which would not be returned to the boiler in the ordinary course of working.

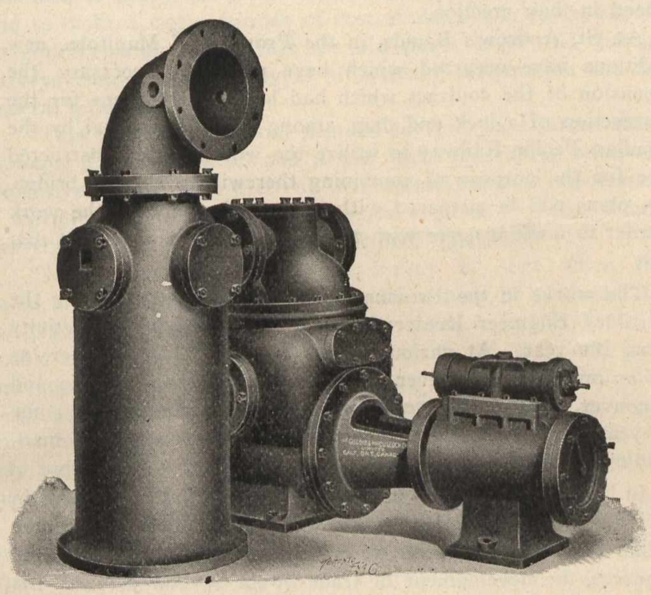
The fuel to be used is a local coal obtained from the Collie Coal Fields of Western Australia. It is estimated that some 30,000 tons of coal per annum will be required when the plant is running full time, i.e., the full twenty-four hours. The Government has therefore put in railway sidings at each pumping station, and has erected coal bunkers under cover capable of holding some 200 tons each. The trucks of coal are run onto an elevated timber gantry and the coal then unloaded.

But the greatest problem was to get the plant, which weighs some 3,500 tons, out to the Colony, and when there to get each piece of machinery sorted and sent on to its proper station and erected. As our readers are aware, there are twenty groups, each consisting of an engine and boiler, distributed over 330 miles of country. It will be readily seen that if mistakes were made in consigning the machinery it would be very costly to rectify them. An ingenious system of shipping was adopted which worked perfectly. Each group was given a distinctive color and letter, and every part of the group was painted with the distinctive group color to which it belonged. When the parts were cased one end of the packing case was also painted with the correct group color. In addition, each case or package was numbered consecutively and marked with the group letter. All marks were in duplicate, one set being painted on the case or package, and the other stamped on sheet tin tabs which were fastened on to the cases or packages. No parts of the different groups were allowed to be packed in the same case. By these simple precautions all trouble was avoided. The railway, shipping and wharf men were supplied with colored group key plans, and so were able to pick out at once the various cases and packages belonging to each group and to send them on to their correct destination. This will be appreciated when we state there were some 5,000 packages, and the only complaint received from the erection staff as to missing material referred to one ½-in. hydraulic valve.

In most countries where waterworks or other engines are to be erected, the site of the engine house, etc., is situated within reasonable distance of some town or available place, where men could find lodging and food, and where supplies, stores, etc., could be obtained. On the Coolgardie contract this was not possible. Most of the engine sites are miles away from any source of supply, not only of food, but of what is in a dry country even more necessary, water. The time given for the completion of the work, viz., twenty-seven calendar months, was exceedingly short, bearing in mind its magnitude. It was, therefore, necessary to arrange for the engine and boiler erection to be carried on simultaneously at the eight stations. The arrangements made were as follows: Sufficient land was leased from the Government by the contractors. This plot of land was enclosed and on it was erected the permanent camps, workshops and mess-rooms. The object in having the land formally leased was to enable the contractors to insist that everyone who came within the enclosure and enjoyed the use of the camp should conform to the regulations laid down for its running. The most stringent regulations as to sanitation were rigidly enforced, with the result that no serious case of illness in any of the camps occurred. In addition to the camps for the men to live in, small workshops were erected both for the storage of tools, gear, machinery, and the carrying out of small repairs. At No. 3 station the general workshop and store was erected. The plant was driven by a suitable engine and boiler, and the largest lathe could handle the outside piston rods, some 17 ft. long, or turn up a low pressure piston. In a country where labor is dear it paid to have the best and most perfect mechanical appliances that could be bought. The plant was erected with the greatest care, and has given results of the utmost value on the work.

INDEPENDENT AIR PUMP AND JET CONDENSER.

We herewith give an illustration of an independent air pump and jet condenser, made by the Goldie & McCulloch Co., Limited, Galt, Ont. The exhaust steam from main engines, pumps, etc., is admitted into the top of the condenser, and on its descent is met by a fine spray of cold water coming in the opposite direction through a spray pipe. By this process a complete mechanical mixture of the steam and in-



jection water is obtained. A vacuum is thus formed by the water depriving the steam of nearly all its latent heat and condensing it. The air pump removes the condensed steam from the condenser, the action being continuous. An automatic vacuum-breaking device is provided, consisting of a copper float and valve opening to the atmosphere.

Where water is available, a great saving of fuel or corresponding increase of power can be obtained by the use of one of these condensers. It is a well known fact that the atmospheric resistance, together with the back pressure in exhaust passages and pipes, is so much power taken from the steam on the engine piston. When the steam in an ordinary non-condensing or high pressure engine has performed its work in the cylinder, it is ejected into the atmosphere against atmospheric pressure, usually reckoned at 15 lbs. to the square inch.

The work of the condenser is to remove this back pressure and form a constant vacuum, equal to 13 or 14 lbs. per sq. in., on the exhaust side of the piston, and the steam can consequently be expanded to nearly the absolute zero of pressure, thereby obtaining its full expansive power. The use of a condenser will, therefore, cause a saving of from 20 to 25 per cent. or increase the power from 20 to 25 per cent.

An independent air pump and condenser has an advantage over a direct connected or belted air pump, as it can be started and vacuum obtained before the engine is started.

Another advantage with this condenser is that when a close heater of any pattern is already located, it need not be discarded, as it will act as a surface condenser between the engine and independent condenser and increase the temperature of the feed water so it can be returned to the boiler at a temperature of about 130 degrees. A single condenser can be used for two or more engines, pumps, etc., one or all of which may be stopped without interfering with the action of the condenser. This condenser will work as well with marine engines as with stationary, and it can be used as an independent bilge pump when necessary. No steam pump is required to lift its injection water. It will lift from any point that can be reached by pumps in general use. The water cylinder lining, stuffing boxes, gland and nuts are brass. The piston rod is Muntz metal. The valve seats are brass, but the valves are rubber with brass springs.

The Goldie & McCulloch Co., Limited, manufacturers of the above, issue interesting catalogues of both pumps and condensers, and would no doubt be pleased to send these to any one interested.

HARBOR AND RIVER WORKS IN CANADA.

The following extracts from the report of A. Gobeil, Deputy Minister of Public Works for Canada, give a general review of the works on harbors and rivers now under construction by the Government. It may be noted that, though bound with the report of the Department for the fiscal year ended June 30th, 1904, the Deputy Minister's report is dated January 30th, 1905.

The expenditure of the department, under this heading, including dredging, slides and booms, and roads and bridges, has amounted to nearly $5,000,000, a sum larger than the total expenditure of the department three or four years ago.

All the important harbor improvements executed in the Dominion are under the control of this branch of our service and the total sum expended, fairly large as it may be, hardly gives a sufficient idea of the amount of labor involved in its expenditure.

The engineering branch of the department has, in the designing of the works under its charge, to contend with nearly all the contingencies which it is possible for a fertile imagination to conceive.

In the Lower Provinces, the abnormal tides, the ravages of the sea worm, and the heavy storms of the spring and fall of each year, have to be taken into earnest consideration when the works have been planned and executed. In the St. Lawrence river, it is true that the ravages of the sea worm are not to be feared, but the heavy tides and, especially, the movement of the ice in the spring and fall of each year, have to be contended with and mastered by means which can best suggest themselves to the ingenuity and science of the hydraulic engineers.

In the lake region, the ever-changing aspect of the harbors which have to be accommodated, the discharge by the rivers, which in almost every case empty into the harbors, of detritus of all kinds brought down by the spring floods; the sometimes friable nature of the bottom upon which the sub-structures have to be founded, and the washing away by the contending currents of the surface upon which are deposited the cribs forming the basis of the piers and docks constructed, or in which piles are driven to serve as a foundation for the balance of the work, also present to the engineering staff problems which require all their knowledge and science to master.

These difficulties, coupled with the ever-prevailing scarcity of good and available timber for the construction of those works, have compelled the department to consider the advisability of, even at a greater cost, increasing the permanency of the works now constructed, especially in the most important harbors.

In the Lower Provinces, to contend against the ravages of the sea worm, the use of creosoted timber has been introduced and with very good results. However, as there are no creosoting works in Canada, the timber, after it has been treated, has to be imported from the United States, and this therefore precludes the utilization of native timber and compels us to send to our neighbors across the line large sums of money which would remain with us if creosoting works were established in our Dominion.

On several occasions the department has provided in its estimates for an amount of money necessary to establish such creosoting works, but up to the present time none have been erected and the practice of buying in the United States has continued.

Not only would the creation of such works be useful for our department, but they might also be utilized in connection with other departments of the service, namely: Railways and Canals and Marine and Fisheries, which to my knowledge, have to import yearly a certain proportion of timber in the same way as is done by our department.

In the upper St. Lawrence and on the lake region, the construction of concrete works has offered to the department the best degree of permanency which at the present time can be attained. The works now going on in the harbor of Quebec, those under contract at Three Rivers, the important improvements at Maisonneuve (Montreal), and the large works now going on at Port Colborne, are being built of concrete masonry.

With the gradual disappearance of timber of large dimensions and the consequent higher price to be paid for it, the cost of cement works is gradually becoming very near that which has to be paid for works constructed of sound durable timber of large size, and the permanency of such works, when the repair to harbor works is taken into consideration, will reduce the apparently higher initial cost.

It was with some degree of hesitation that the department, a few years ago, entered into that style of construction owing to the apparent increased price, but we have to congratulate ourselves at present for having ventured on that course and there is no doubt that all the future important works of the department will be constructed in this manner.

"Wooden structures must of necessity become obsolete; the cost of timber is each year greater, and renewals and repairs are too frequent. Concrete for all structures to be built, and for repairs, would be cheaper in every way, as well as stronger and more lasting, avoiding constant and expensive repairs. Now is the time to start and gain experience in the mode of construction. We have at nearly every harbor the stone, gravel and sand for the taking, and only the cost of cement and labor, with plant, is required to do the work.

"Recently in the Ontario district the department has built a wharf at Orillia with foundation of wooden cribs and superstructure of concrete, at a cost of no more than if built entirely of timber, decked over and filled with stone.

"At Sault Ste. Marie in the extension of the Government wharf, the contract called for wooden superstructure, but the contractor offered to build it of concrete for the same amount of cost and his offer was accepted. There is no comparison between the two methods of construction."*

Another improvement in the mode of construction of those works is being tried in the utilization of a system of beams of reinforced concrete manufactured to resemble timber structures, and put together in about the same manner, this plan having been invented and patented by the late J. W. Fraser, a talented young engineer of the department, who, unfortunately, lost his life in a drowning accident which occurred at Rivière du Loup, below Quebec, during the past summer. Mr. Fraser had been connected with the department for a good many years, in fact, had entered it quite young and had grown with it. He was fond of research and study, and utilized his spare moments to enquire into the adaptability of cement and concrete in the construction of works under the charge of the department. Out of his study of that question he evolved the principle of the construction of concrete cribs, which was tried for the first time on the works at Depot Harbor, and which has proved an absolute success. It is to be deplored that he did not live long enough to see the success of his discovery, and to have the opportunity of making such improvements as the use of his invention would surely have suggested to his knowledge and activity.

The principal works in connection with harbors, which have been under the control of the department, during the year under review, have been: In the Province of Nova Scotia, those of Cow Bay and Victoria Beach; in the Province of Prince Edward Island, those at Summerside; in New Brunswick, Cape Tormentine, Caraquet, and Richibucto works; in the Province of Quebec, those at Father Point, Quebec, Montreal, Sorel and Three Rivers; in the Province of Ontario, those at Collingwood, Depot Harbor, Midland, Burlington channel, Owen Sound, Port Burwell, Port Colborne, Toronto, Kaministiquia River, Fort William and Port Arthur; in British Columbia, those on the Fraser River and Victoria Harbor.

The works at Montreal (Maisonneuve), are nearing completion, and it is expected that they will be finished by the end of the present season. The works at Quebec were commenced under a contract passed on May 8th, 1903; they consist of timber cribwork as a foundation for a concrete superstructure, which will stand six feet above high water spring tides. When the work is fully completed, it will be 984 feet long and will afford much needed accommodation for ocean shipping. The works at Three Rivers are also of a permanent kind, consisting of a concrete superstructure built on a timber and stone foundation. This work has not been going on as rapidly as expected, but it is to be hoped that good progress will be made during the coming year. The harbor of Three Rivers is increasing its trade in a very rapid manner and from information obtained, the harbor can accommodate if the necessary wharfing were supplied, many thousand tons of traffic in addition to that which is now served.

In the Province of Ontario the works at Port Colborne are being pushed with energy with a view to protecting the harbor area which is being formed at the entrance of the Welland Canal. The structures which are being constructed there have been built with a view to permanency, concrete being largely utilized in their erection.

At. St. Andrew's Rapids, in the Province of Manitoba, new conditions have occurred which have rendered necessary the suspension of the contract which had been entered into for the construction of a lock and dam, among them a proposal by the Canadian Pacific Railway to utilize the works to be constructed there for the purpose of combining therewith a railway bridge. New plans will be prepared with a view of amending the work in order to make it agree with the new conditions arising at that place.

The works in the Province of British Columbia, under the control of Engineer Keefer, have been continued with activity during the year. At various points on the Columbia river, as well as on the Fraser river and in the harbors of Victoria and Vancouver, works of improvement which were commenced some two years ago will be carried on in the same satisfactory manner during the next fiscal year.

In brief, great activity has been shown by the department in providing throughout the country, from the Atlantic to the Pacific, those improvements to navigation which the increased commerce, the development of trade in the several parts of the country and the opening up of the West by the continually increasing stream of immigrants, have rendered absolutely necessary.

In this connection I may note here the important work performed by the Royal Commission on Transportation, which has already covered the ground in the eastern provinces and Ontario, and which will proceed to investigate the question of transportation in connection with Manitoba, the North-West Territories and British Columbia. I am sorry to record here the death of the chairman of that commission, John Bertram, which occurred on November 28th last. In Mr. Bertram, the commission has lost a very valuable member who, as chairman, had been conducting its work with a great degree of usefulness which promised very valuable information being derived from its labors. His position as chairman has been filled by the appointment of one of his brother commissioners, Robert Reford, well known in commercial and shipping circles of Montreal, and as member of the commission he has been replaced by J. H. Ashdown, of Winnipeg.

Although having taken place after the close of the fiscal year under review, I may also note the formation of the Canadian section of the International Commission on Deep Waterways, which is to act conjointly with the United States nominees to study and report on questions of navigation in adjoining waters of the Dominion of Canada and the United States of America. The members of the commission chosen are: J. H. Mabee, a legal gentleman from Stratford, Ont.; Louis Coste, formerly chief engineer of this department, and W. F. King, astronomer of the Department of the Interior. The members of this commission representing Canada will be called upon to perform valuable work, and the nominees selected to represent the Canadian Government are a guarantee that the interests of Canada will be well looked after.

I may also refer to the initial steps which have been taken by the department in connection with the surveys now being proceeded with as a preparation for the compiling of plans and estimates for the construction of the Georgian Bay Canal. This work, which is under the control of the chief engineer and more especially under the guidance of Arthur St. Laurent, as engineer

*Extract from a report by H. A. Gray.

in charge of the whole work, was commenced during the course of last summer, and at the present moment ten surveying parties are distributed over the area extending from Georgian Bay to the harbor of Montreal. It is expected that the field work will be completed by the end of the present calendar year.

"The proposed navigation route extends from the mouth of the French river down to Montreal, a distance of about 425 miles.

"It follows the French river and Lake Nipissing, passes, at the height of land, through Trout, Turtle and Talon lakes, follows the Mattawan river to its junction with the Ottawa, thence down the Ottawa as far as Montreal, leaving the bed of the river occasionally to evade difficult points.

"Sixty-two miles of this route having been carefully surveyed in 1901, there remained 368 miles to be covered by the new survey.

"It was decided, from the beginning, that the information gathered to study the feasibility of the route, to prepare plans and to make a close estimate of cost of the whole route, should be entirely original and that the old plans from old partial surveys should be used only as preliminary information and for general guidance.

"This will involve actual detailed surveys, on a larger scale, perhaps, than anticipated, and it will make the survey relatively expensive, but for a project of that magnitude and importance, it will prove much more satisfactory, in the end, to collect actual and complete data from the present field operations.

"The immediate object of the survey is, that when the notes are reduced and plotted, a location may be projected on the plans, for a ship canal of no less than 22 feet in depth, a profile drawn and a correct estimate made of the kind and amount of all material found necessary to be excavated, the kind, character of foundation and dimensions of all walls, dams and other structures, also the estimating of all extra right of way required for the canal proper, where it leaves the bed of the rivers and for spoil banks and overflowed areas."*

The despatching of so many engineering parties, at the same time as the surveying work for the transcontinental railway was being commenced, has given employment to a large number of Canadian engineers. It has been found, on the formation of parties, that the engineering profession in Canada was fully equal to the demand made upon it for the professional equipment which is required for the explorations and studies necessitated by the extensive surveys for those two great works. All the engineering staff has been supplied by Canadian intelligence and professional training, and there is no doubt that the profession in Canada is fully able to render a good account of itself in the performance of the arduous duties connected with the examinations now under way.

During the past fiscal year, and under an appropriation granted by Parliament two sessions ago, an exploratory and instrumental survey and examination of the Ottawa river was undertaken commencing at or near the foot of Lake Temiscamingue and thence to the source of the river, including its principal tributaries and feeders.

Many valuable data have been obtained by the survey parties in spite of the unfavorable weather during the time they were in the field, from July to November. The work of plotting the data obtained and preparing the necessary plans is now being proceeded with, and it is hoped that the results will be in the possession of the department within a short time.

The work has been throughout under the direction of G. P. Brophy, the superintending engineer of the Ottawa river works.

DREDGING.

A very important part of the work performed by this branch of the department under the control of the Chief Engineer has been that covered by the dredging operations throughout Canada.

The fleet at the disposal of the department has been somewhat reduced by the transfer to the Department of Marine of the vessels engaged in the improvement of the channel between Montreal and Quebec, the seven dredges engaged on that work being no longer under our control. This work, however, the magnitude of which must not be underestimated, only comprises a small proportion of the dredging operations under our charge, and there is still a large fleet attending to the improvement of the harbors and rivers of Canada.

The fleet engaged in the Maritime Provinces will be augmented during the course of the present year by the placing in commission of the new steel dredge the W. S. Fielding. This vessel, I think, is the largest of the kind which will be afloat on American waters, and it is hoped that its output will be in due proportion to its size, its mode of construction and the expenditure connected with its buildings and final equipment. Another hydraulic dredge, of smaller proportions, but still very powerful, is being now constructed for the Maritime Provinces in the workshops of the Polson Iron Works in Toronto. She is being built upon the lines adopted for the King Edward, operating in British Columbia waters, but several improvements of great value have been added in her construction, and when completed she will be a powerful addition to our maritime fleet.

A new dredge will also be completed for work in Prince Edward Island waters. This one will be a dipper dredge but of modern design and construction.

Plans are now being prepared with a view of calling for tenders for an elevator dredge for the provinces of Ontario and Quebec, with the immediate object of proceeding with the work of improvement in the upper reaches of the River Saguenay, at Chicoutimi, where a pressing demand is made for greater depth of water by the more than extraordinary development of the lumber industry, more especially in connection with the manufacture of pulp at the town of Chicoutimi. A large stone lifter will also be provided for.

The powerful dredge, International, purchased by the department in 1903, has been at work during the past season in the harbor of Quebec.

The dredging fleet on the lakes, which was a year or so ago increased by the addition of a new dredge, Sir Richard, has been maintained to its full capacity during the past year, while improvements have also been made to the plant operating on Lakes Winnipeg and Manitoba.

The fleet in British Columbia, to which a valuable addition has been made by the construction two years ago of the hydraulic dredge King Edward, is being overhauled, the old snag boat Samson being replaced by a new one of an improved type. It is also the intention to provide another dredge to operate in British Columbia waters in the place of the old Mud Lark, which has nearly outlived its usefulness.

With the improvements under way and those still contemplated, the department will in a year or so be, I hope, in a position to be abreast of all the dredging work which will be necessary in the Dominion, and the work now being performed is a useful corollary to that which has been undertaken during the past eight years for the general improvement of the dredging plant rendered necessary by the urgent and numerous calls made in all the provinces.

The dredging service is being looked after, under the general directions of the Chief Engineer, by the General Superintendent of Dredging, James Howden, ably assisted by E. B. Godwin. This branch, the control of which comprises now the full service in the whole of the Dominion, will be looked after energetically by the officer in charge, who has had long and varied experience both under this department since 1889, and under the Harbor Commissioners of Montreal for many years before that period, when the fleet operating on the St. Lawrence was about the only one performing such work in Canada, and when the dredging operations for the improvement of harbors and rivers were still in their infancy.

SHIP CANAL.

The report of the operations on the deepening of the ship channel betwen Montreal and Quebec is the last one which will find a place in the report of this department as the review of the operations for the fiscal year 1904-05 will be recorded in the report of the Department of Marine. It is only fitting that when bidding adieu to such an important part of the work supervised by us during the past fifteen years, I should render a deserved testimony to the ability and care with which it was performed while under our control. The plans which are now followed are those which were elaborated by the engineers in charge of that service during the above-named period, and the success which has marked their performance is of itself the best evidence of the ability of those who were in charge of the work. The channel from Montreal to the head of Lake St. Peter is

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*Extract from a report by A. St. Laurent.

now, almost everywhere, of the standard depth of 30 feet and the width has been enlarged from 300 feet, at which it was originally placed, to 450 feet and widened in curves to 700 feet. The review of the operations on the channel this year is made by F. W. Cowie, who has been transferred to the Department of Marine to continue there the clever and useful work which he has performed for so many years in our own department. It is with some degree of sorrow that we have had to part with the useful officers employed here and at Sorel in connection with the ship channel, and it is only fair that this public testimony should be given of their value by one who has been associated with them and with this department for a period of over thirty years.

ELECTRICAL THAWING OF WATER PIPES.*

As to the method of procedure to thaw with electric current, assuming an alternating current of one or two thousand volts is available, the necessary requisites are as follows:

1. A transformer of 10 or 15-kilowatt capacity with 50 and 100-volt secondary; for ordinary house services 50 volts is sufficient.

2. An ammeter reading to 30 amperes if placed in the primary.

3. Primary cutouts.

4. Single-pole switch in secondary.

5. A resistance that can be made, as described below.

Connect up instrument, as shown in Fig. 1, leaving the movable electrode out of the water. Close the primary switch and drop the lower end of the electrode into the water, watching the ammeter, which should indicate 3 to 5 amperes and which will increase as the electrode is given more contact with the water; the maximum amount of current will depend on the resistance of the pipe. The most practical arrangement, aside from a transformer made for the purpose, is shown in Figure 2.

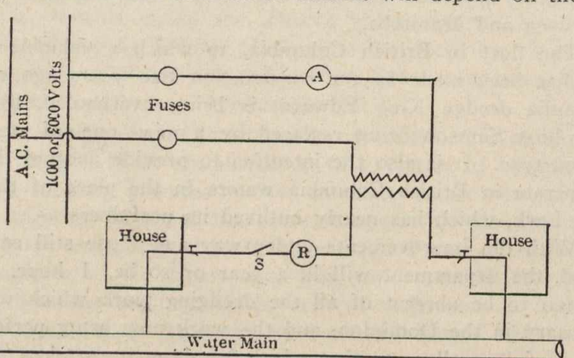

Fig. 1.

A choke coil, made as described below, and placed between the primary switch and the transformer, gives practically the same results and is much more efficient and easier handled.

Before closing the secondary switch, the position of the core of the choke coil should be noted. It should be completely inside the choke coil, and to increase the secondary current, withdraw it until the required amperes are obtained.

Figure 1 shows two house services being thawed at the same time, one end of each secondary being attached to the sill-cock of each house, the resistance *R* being placed in the secondary circuit. Ammeter *A* indicates the number of amperes in the primary circuit. The transformer should be protected by suitable fuses, located either upon the pole adjacent to the primary feeders or upon the wagon.

Figure 2 shows one house service being thawed and connected to one side of the secondary feeder, the other being connected to hydrant *H*. In the diagram, *A* represents the ammeter in the primary circuit, *M* a recording wattmeter in the secondary, and *V* a voltmeter across the secondary terminals of the transformer.

Figure 3 shows a connection for the use of 104 to 125 volts, alternating or direct current. This arrangement is applicable to isolated plants using two or three-wire low-voltage distribution. *A* indicates the ammeter and *R* the resistance.

Figure 4 shows the simplest outfit possible; a 10-kilowatt transformer connected for 104 volts, an ammeter and switch in the secondary, and fuse boxes in the primary either on the wagon or on the pole near the point of connection to the primary feeders. While the outfit will do the work, I would advise by all means the use of a resistance of some kind in order to control the quantity of current at the start.

In an outfit used at Gloversville, N.Y., a simple rack is built upon the body of a sled upon which are placed the primary cutouts. The primary wires are dropped from the pole to the top of this frame work, then to the cutouts. The current is measured by the wattmeter, which is connected in the secondary circuit. Standard transformers are used, which give a sufficient range of voltage. The wires used for primaries and secondaries are mounted upon reels in a convenient manner for easy handling. For a cheap and effective outfit, this seems to be the most practical that has been suggested.

A choke coil suitable to control for all purposes a 15 or 20-kilowatt transformer with 2,000 volts primary is constructed as follows:

A tube 16 inches long, 2 inches in diameter, made by winding a sheet of one-sixteenth inch red fibre around an iron mandrel four times and held in place by a few small tacks; two wooden beads are provided, six inches in diameter by three-quarters of an inch thick, and secured to the ends of the fibre tube. A winding consisting of 200 turns of No. 12 weatherproof wire is placed on the spool after it has been given several coats of shellac and dried. A core is made of No. 14 iron wire in pieces 16 inches long, held together by a few turns of fine iron wire and covered by two layers of tape. The centre wires are cut four inches longer, and over them is placed a wooden handle.

The simplest form of rheostat suitable for either primary or secondary, but recommended for secondary sides only, because of safety to those using it, consists of a barrel of water to which 10 pounds of common salt has been added, with two electrodes, each made of a coil of 10 feet of No. 2 bare copper wire in a flat spiral, or a six-inch pipe flange, one fastened to the side of the barrel near the bottom, the other so arranged that it can be raised or lowered. This form of resistance has been used by the majority of those who have thawed pipes by electric current, probably because it was the easiest obtained; and while not strictly up-to-date, electrically speaking, it certainly answers the purpose. A rheostat of this description will handle 300 amperes for a short time; if continued, the water will probably boil over.

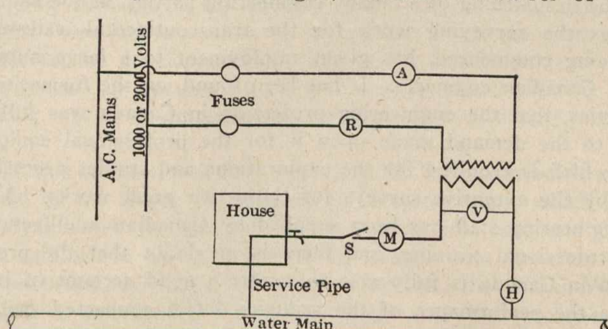

Fig. 2.

An outfit used in Durango, Col., is the most complete in detail of any that have come to our notice. Four small transformers, taken from the scrap pile with 55-volt secondaries, were placed in the wagon in front of the switchboard. In the secondary of each transformer is placed a choke coil, described as follows:

The choke coils are about 18 inches long with a core 2.5 inches in diameter, formed on a brass tube with cast ends, a slot being cut lengthwise through the tube and ends to prevent the formation of a closed secondary circuit in the spool. After being thoroughly insulated, each core is wound with two layers of No. 4 magnet wire. The cores, which are 18 inches long, consist of 500 pieces of No. 14 annealed iron wire, which are assembled around a central iron rod, threaded at each end, with two fibre heads turned to fit the tube. The whole core is covered with several layers of cotton tape, coated with insulating varnish. Above each choke coil is placed a 75-amp. double-

*From a report compiled by George S. Haley for the National Electric Light Association, and published by the Association at New York.

pole knife switch and a 100-amp. double-pole D. & W. cutout; also one 350-ampere ammeter and one 150-volt voltmeter. There are also four pilot lamps, one of each being connected to the four transformers, which by the switches mentioned can be thrown in multiple. On the back of the wagon cover are placed two G. E. primary cutouts, and just back of these is a 30-ampere double-pole, quick-break knife switch, placed in the primary circuit. The secondary leads are composed of No. 00 cable wire with connectors made of brass, to facilitate the connections of the pipe system. To use this outfit the primaries are brought from the pole to the cutouts. The secondary connections are made to two houses, or one house and a hydrant. The primaries and secondaries are then closed and the cores pulled out of the choke coil until the desired amount of current is obtained.

In compiling the report, replies to a series of questions were received from about two hundred central stations in the northern part of the United States and in Canada. Abstracts of a number of these replies are given in the report, and from these we quote the following:

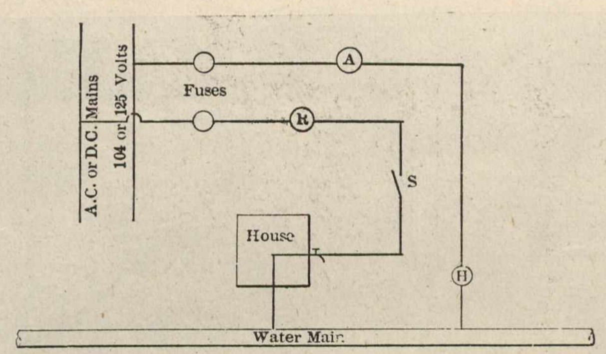

Fig. 3.

At least seventy-five electric light and power companies have employed the electric method of thawing frozen pipes. In the majority of cases the superintendent of the water-works requested this work done. Those that did not make any attempt were either not asked to do it, or did not consider it worth while to equip an outfit for this work. It is worthy of note that almost without exception those who have not already made the attempt now want all the information they can get, evidently just realizing that there is something in it. In the majority of cases the work was paid for by the residents or consumers, although in a great many instances it was paid for by the water-works company.

Very few correspondents seem to have taken the trouble to make accurate measurements of the current. Usually an ammeter was placed in the primary, in order that the transformers might not be overloaded to such an extent as to cause them to be damaged. A few used both an ammeter and a voltmeter, from which readings were kept and current figured on a volt-ampere basis.

A correspondent states, as follows, in reference to the measurement of current: "We find that the water always begins to flow before the lead pipe shows an appreciable heating. We intend, therefore, to dispense entirely with ammeters and instead to make use of the temperature of a piece of lead pipe filled with water, which will be inserted in the low-voltage circuit at the switch. Should the amperes in any particular case be twice as much as is needed—say 400 amperes instead of 200 amperes —I believe the only effect will be to shorten the time needed for melting the ice and starting the flow of water. The frozen pipe surrounded by earth at a temperature less than 32 degrees Fahrenheit, can be regarded as a reservoir for heat, in which a certain quantity of heat must be generated and stored before melting takes place. If this heat is stored in half the time, the same temperature approximately will be attained in each case and it therefore makes no difference whether or not the current is increased abnormally, provided the time is correspondingly shortened. The only danger in passing an abnormally large current through the water pipe is when the excessive current is kept on until the pipe reaches a steady temperature, and the lead-pipe temperature indicator mentioned above will be an absolute measure of this."

All voltages from 2.5 to 500 seem to have been used. Only a few answers indicate that elaborate tests have been made. The majority of the work has been done, apparently, with little regard to the current consumption, the price charged being high enough to make up for any deficiency in this respect. From one correspondent we have the following:

"A length of 40 feet of one-half inch lead pipe required 186 amperes at 12 volts applied for five minutes.

"For a length of 20 feet of half-inch extra heavy lead pipe, 10 volts was required to force 150 amperes through, and from 12 to 15 volts for 200 amperes. With a current of 200 amperes, the water was started in three minutes, but it was found necessary to raise the current to 281 amperes with a voltage of 18 applied for 15 minutes. By this time the pipe was quite warm, the temperature being about 115 degrees Fahrenheit, which proved that there was no longer any ice in the pipe and that the flow of water was obstructed by other causes. One hundred feet of half-inch lead pipe required a pressure of 37 volts to force 270 amperes through; time required, five minutes. In this case the current passed through 100 feet of water main. The actual kilowatts in this case were 7.5, which, for the space of five minutes, represents 0.62 kilowatt-hour. Another case of 60 feet of half-inch lead pipe in circuit with 60 feet of water main required 200 amperes at a voltage of ten for twenty minutes to free the pipe. The current consumption in this case was about 0.70 kilowatt-hour. One hundred feet of small service pipe, supposed to be of iron, required 200 amperes at 25 volts for five minutes; the current consumption being about 0.33 kilowatt-hour."

A correspondent writes: "In one instance a street service was thawed, using storage batteries; the pressure was 2.12 volts, the amount of current used was not given." He stated further that the safe maximum current that can be carried by a one-inch lead pipe is 300 amperes.

The alternating current seems to be used almost universally for this work, and in only one or two instances has the direct current been used. A correspondent states that in the use of direct current, he found that the energy would all be expended at or near the positive connection of the pipe, he having noticed that the ice had melted and the water boiled in the pipe at the

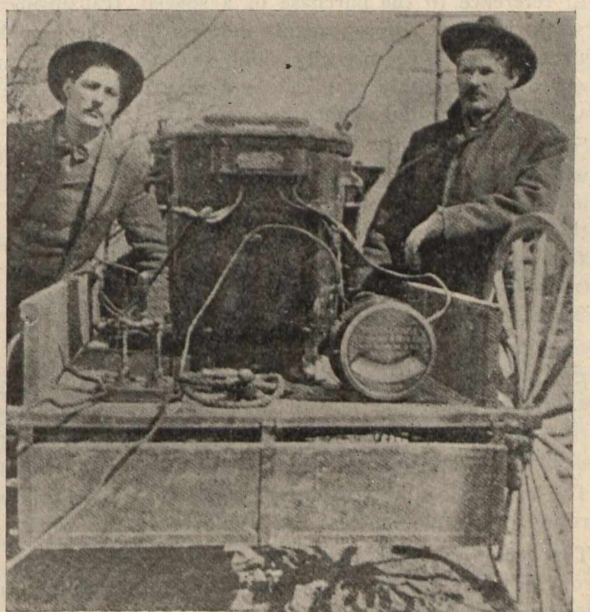

Fig. 4.

positive connection while at the negative connection, three feet away, there was no indication of heat whatever. He stated further that the alternating current was much more effective than the direct current, and that he could accomplish more with less than one-half the amperes of alternating current. In one instance he applied from 400 to 480 amperes at 104 volts direct-current to a 2-inch water main for six hours the first day, and eight hours the next, making no impression whatever. After four or five days of very cold weather, he applied 150 amperes of the alternating current and thawed it out in about three hours.

Referring to that portion in which the correspondent states that in the use of direct current he finds the energy would all be expended at or near the positive connection, etc.—this seems hardly possible and might be due to several reasons; for instance, poor connection at the positive end, the pipe being exposed to the air only while the other end of the pipe might have been buried in the frost, or near some other substance that could rapidly conduct away the heat.

The water rheostat seems to have been used by about 90 per cent. of those who have used this method of thawing pipes, because it was so easily obtained. In the majority of cases the work came upon all of us very unexpectedly, and it was a question of how quickly we could get ready, and not how complete an outfit we could devise for the purpose. In only a few instances has the water rheostat been used in the primary side. As a matter of safety, this would not seem advisable. Almost everything has been used for electrodes, from copper wire to railroad fish plates. Any metal with a sufficient area will answer the purpose. In a few instances choke coils have been used in the primaries of standard transformers, and in a small number of cases, no method whatever was used for controlling the current.

One correspondent writes that he is operating a two-wire, 110-volt direct-current plant, which does not give any day service. To thaw service pipes, he connects one side of his system to the water main at his station. He then connects the other side of his circuit to the house service, having previously arranged with the engineer at the station to give the required amperes on the station ammeter. From a point of labor, this is probably the simplest method of thawing water pipes that has been used, but as the majority of central stations operate twenty-four hours a day, this plan would not be applicable.

Transformers of all descriptions were used. In many cases they were taken from scrap piles, and put to good use thawing pipes. The secondary voltage seems about equally divided between 50 and 100 volts; evidently because standard transformers were used and 50 volts in some instances not found enough, 100 was used, as it covered all cases, regardless, however, of current consumption. In thawing lengths from 100 to 200 feet of service pipes or of mains, the opinion seems to be that from 75 to 100 volts are necessary at times. The average capacity of transformers used is about 15 kilowatts.

In reference to the purchase of a special transformer for this work, but few correspondents indicate that they would go to this expense. The majority think that the standard transformers are thoroughly practical, and that they have the advantage of being useful upon other work.

Special attachments for connecting wires to faucets or mains seem to be used in only a few instances, the ordinary method being to wrap about 12 inches of the bare wire, used for the secondary, around the faucet or main. Regarding the handling of primary feeders, the majority of operators were particular to have them insulated, while a number allowed them to lie on the ground without special care other than to keep pedestrians and teams away from them.

But very little damage seems to have been done to pipes in general from this method of thawing. In a few instances, where the water did not start to flow through, the pipes being clogged, the lead pipes were melted off at the faucets.

The opinion of the correspondents is that the work is not hazardous if capable linemen are employed in the work.

The report contains two tables giving details of the kind of work done by the correspondents, with all available information, such as size and kind of pipe or main, current and time consumed, basis of charge for the work, etc. A few instances of the thawing of gas pipes are also recorded in the report.

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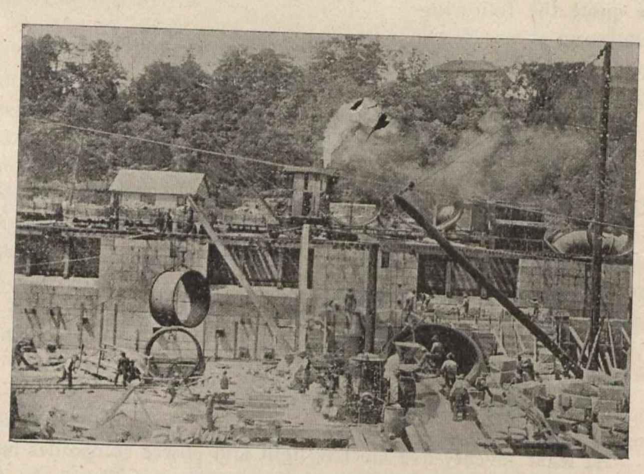
—R. C. Miller, 781 Craig Street, Montreal, has obtained the agency for Canada for the Greenwood & Daggett Co.'s specialties in mechanical rubber, asbestos, mica and other goods. Mr. Miller has been only a little over a year in business in these lines, but the results have been most gratifying, and his engineering supply trade promises to be one of the largest in Canada. A circular of the Greenwood & Daggett Co.'s lines is just off the press, and will be sent on request.

CONSTRUCTION OF CANADIAN NIAGARA POWER COMPANY'S 100,000 H.P. HYDRO ELECTRIC PLANT AT NIAGARA FALLS, ONT.*

By CECIL B. SMITH, MA. E., M. CAN. SOC. C.E.

When the writer became resident engineer for this company in August, 1901, he found that the location of the works and discharging tunnel had been already decided upon, and a shaft for tunnel construction partly sunken, and, under directions from Consulting Hydraulic Engineer Herschel, the turbine units were being given preliminary study by Escher, Wyss & Co., who also finally designed them.

Aside from the tunnel, which evidently should be built at once of full capacity, the construction then authorized was for a canal of 50,000-h.p., with temporary cribbing on the south side, a wheel pit for 50,000-h.p., and machinery and power house for 30,000-h.p.; but the company in 1902 decided to build the canal for 100,000-h.p., the wheelpit for 110,000-h.p. (one 10,000-h.p. unit as a spare), to erect a power house for 50,000-h.p., and equip it with machinery to the same extent;



View of Wheelpit Lining Wall; Placing Mouthpiece Rings.

and this plant, along with conduits for carrying underground cables to Niagara Falls, N.Y., and to a transformer station for 25,000-h.p. outside Queen Victoria Niagara Falls Park, is now practically completed, and is in partial operation.

COFFERDAM.

Some hazardous and approximate soundings had been taken in the Niagara River at the canal entrance, but they gave assurance that the depth of water adjacent to shore was sufficient without extending operations very far out into the rapids, and a cofferdam was built on the location shown on Fig. 1. Fig. 2 gives details of the cofferdam itself.

It will be noticed that these cribs, if placed separately, would have been in rather unstable equilibrium, and the contractor accordingly sank them in pairs, with turnbuckles in place, using temporary binding timbers to hold each two cribs in correct relative position until sunken into place, after which these timbers were removed by divers.

The soundings for each crib were taken from a platform extending out over the water from the cribs previously placed, and the bottoms of the cribs were framed upside down, so as to fit the inequalities of bottom, denoted by the soundings. A floor for sustaining the rock filling was also placed in each crib as nearly as possible to the bottom, and the cribs were partly loaded before being floated into place.

In order to hold on to the cribs when placing them in a current of 10 to 12 feet per second, several lines of wire rope operated by hoisting engines were used, and only one mishap occurred, when the bottom of the large corner crib was torn off. It was found advisable to add vertical binding timbers, not shown on plan, when cribs were to be placed in the heavy current. These are being found of advantage also during the removal of the cofferdam.

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*A paper presented at annual meeting, Canadian Society of Civil Engineers, January, 1905.

The puddle used was composed of about 2-3 gravel and 1-3 clay artificially mixed, as a natural mixture could not be obtained within a reasonable distance, and this mixture was found to fall quickly into place whenever leaks opened up, and could be rammed into a perfectly water-tight mass. It was found best, however, to keep the puddle wall well below water level on one side, so as to enable leaks to be promptly reached and the puddle to settle quickly.

The continuous decking was built in place as soon as cribs were filled with rock, and being tied across by timbers above water and turnbuckles below, the cofferdam acted as one mass.

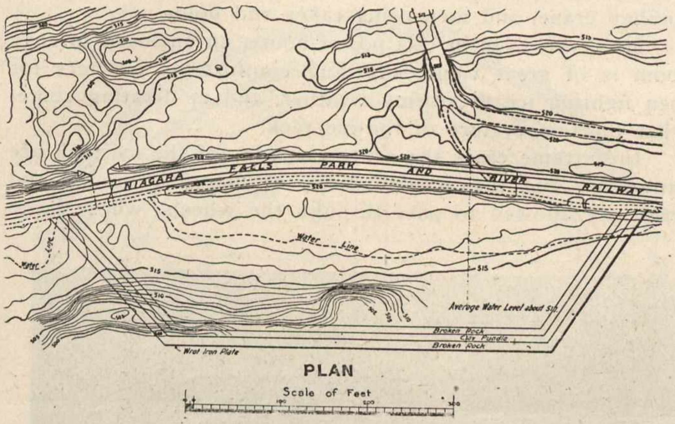


Fig. 1—Coffer Dam for Canal Entrance.

In placing tongued and grooved sheeting, it was broomed down by hand mauls on to natural bottom, and fitted snugly around timber ties and turnbuckles, after which all openings at bottom, located by divers, were made tight by piling bags of rich cement mortar, and ramming them into the apertures.

When the cofferdam was pumped out by a battery of 12", 10", and 8" centrifugal pumps lifting about 10,000 gallons per minute, it was found that there was, even after temporary leakage through puddle had been cut down to nominal proportions, a heavy flow of water through the boulders and gravel lying between the cofferdam and solid rock, and as this would have had to be handled for over two years it was considered advisable to take steps to stop it, and a puddle trench was sunk to rock at each end of area unwatered, being carried in each case from shore to adjacent points on inside of cofferdam. The cofferdam proper was sheeted on inside between these two puddle cut-off walls, with double tongued and grooved sheeting extending from above water level down to solid rock, layers of tar paper being placed between the two layers of sheeting, and in order to seal the bottom a toe of rich concrete was carried along the bottom being tied to the rock by thoroughly washing the surface of same, and spiking a heavy line of timber, about 12" above the bottom, to the sheeting.

This interior sheeting held the pressure of water against it until torn off when letting water into the canal, and the whole leakage was cut down to about ½ of the capacity of one 8" pump, during this period of over two years.

BRIDGE.

The original intention of the company was to build a steel bridge across the entrance canal, to carry the tracks of the International Railway Co., and to provide width for a park drive and a sidewalk, and the plans approved by the Park Commissioners showed this class of bridge.

When, however, it was decided to build the whole canal at once, the company and its engineers decided that the style of construction to be used for canal walls, power house, etc., demanded a bridge in keeping, and accordingly a stone and concrete bridge 55 feet wide, composed of five spans of 50 feet each, and costing nearly 100 per cent .more than a steel bridge and piers, was designed and built. The most interesting feature of design was to obtain a bridge with high springings and low crowns, as the difference in level between the water of Niagara River and base of rail was very limited. This was obtained by using steel arch trusses and concrete filling; and various studies of stone parapet walls, seeking to give satisfactory proportions and chasteness of outline have, it is believed, been successful. There are five 50 feet spans, and when building the bridge an allowance of ¼" was made for settlement, but this much has not taken place, although a curious condition has arisen of the arch rings settling slightly away from the parapet walls, which carry their own weight without appreciable settlement although two expansion joints were placed in parapet walls above piers.

CANAL AND FOREBAY.

The canal walls were carried out to the river entrance by 50 ft. curves, and from the bridge, westward, expand out into a forebay 570 feet long.

These walls are second class rock-filled coursed ashlar backed with 1:3:5 concrete, and plans were also prepared showing solid concrete walls below low water, but the use of concrete as a facing to be presented to the wear of moving water ice-laden, although at a slow velocity, was not approved of by Consulting Engineer Herschel, and the present plans were adopted instead, at considerably increased cost. The same remarks apply to bridge piers and to inlet breast walls.

After deducting all losses the net effective head that this plant is designed to operate under is 136 feet with all wheels running and under this head about 8,870 cubic feet per sec. will be the maximum draft.

This amount of water will pass through the bridge openings at about 2¼ feet per second with river at normal level, but in the forebay, under the same condition, the water will approach the line of submerged arches, supporting the forebay room, at only 1 ft. per second.

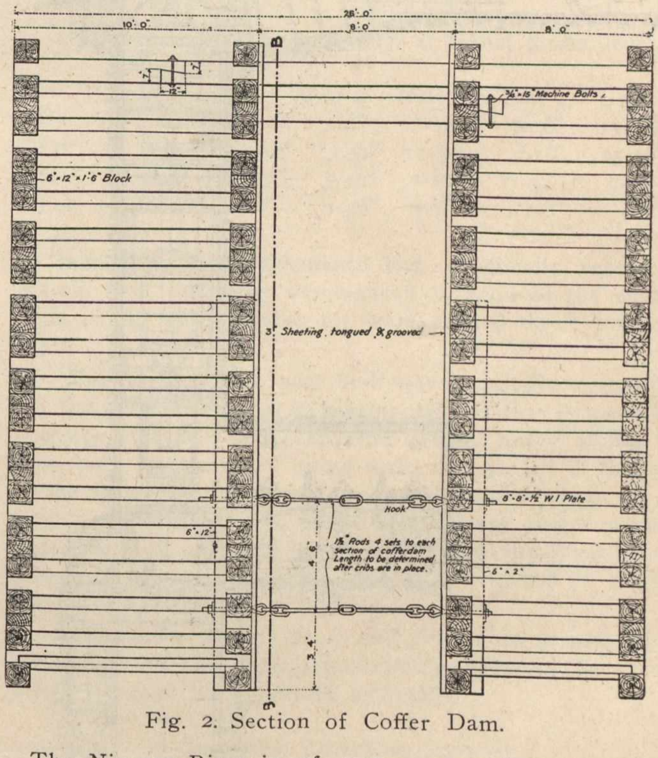


Fig. 2. Section of Coffer Dam.

The Niagara River is, of course, never frozen over at the canal entrance, but after a prevailing east wind the drift ice from Lake Erie and the frazil ice formed in the rapid immediately above the works, come down in a steady flow from 50 to 100 feet wide, hugging the Canadian shore, and prepared to float into the canal whenever a flow of water creates a tendency or draft in that direction.

At first it was proposed to allow this ice to float freely into the canal and forebay, depending on the submerged arches to hold it back from the fine ice rack in front of inlets, and on the ice sluiceway to carry it back to the river, but the writer considered a protection along the river face to be of inestimable value, and an outer ice rack was added. This rack is supported vertically by first-class masonry piers 29 feet centres, and consists of a steel footwalk with never slip plates and another steel beam some 8 feet lower; these carry 2" rods spaced 12" centres, extending 4½ feet below and 4 feet above meanwater level, and sloping at 30° with the tops down stream. This rack will keep all heavy ice out, and the swift current will roll it along the sloping rods, and should it be found desirable a steel curtain can be suspended outside the rack and down to 3 or 4 feet below water level, thus shutting out floating fine ice, but it is not expected that frazil ice can be kept out of the forebay, as it comes down the river mixed in the water from top to bottom.

At the north end of the forebay there is a weir with three 16 feet openings, two outside and one inside the forebay room, and a fall of nearly two feet can be utilized in the winter for the purpose of creating a cross current in the forebay, thus tending to draw the floating ice back into the river, but the writer does not believe that the effect of this weir will be felt for any great distance away from the north end of the plant, although by carrying lines of floating booms diagonally across the forebay a large amount of floating ice can be poled toward the weir and thus passed back to the river; when not in use the weir will be closed by steel lift gates to above the water level of the canal.

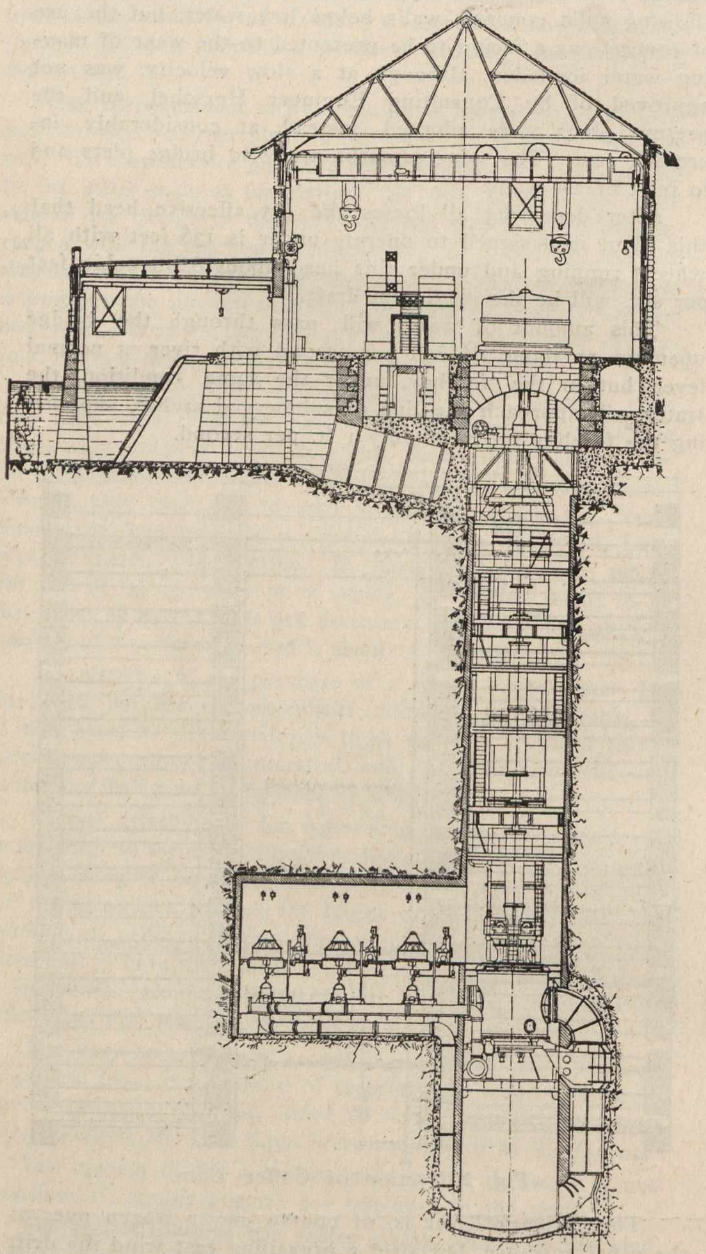


Fig. 3. Cross Section of Power House and Wheelpit, showing machinery installed.

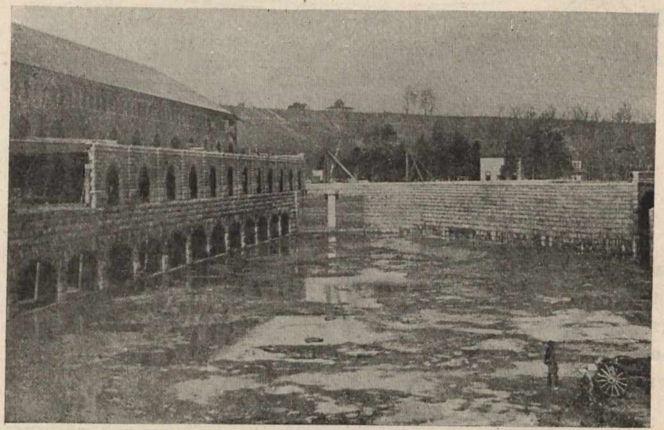
The ice protections thus far mentioned will not keep back frazil ice, but no doubt the slow current in the forebay will allow a large proportion to rise to the surface, while the remainder will pass under the submerged arches into the forebay room, where there is a continuous line of fine ice racks resting at a 30° slope against the main inlet or breast walls.

These racks are carried on a steel framework, and are composed of 3" × ⅜" bars on edge, spaced 1 13-16" centres, built into groups 3' 6" wide, by three tiers high; the bottom tier is 3' 0", the centre 11' 0°, and top 9' 0" high, the centre ones being movable and capable of being raised up to the top, and of being held there by hooks designed for the purpose.

The functions of an enclosed forebay room will vary with the direction of current approaching the power-house, and whereas this direction is parallel to power-house No. 2 of the Niagara Falls Power Company, it is practically at right angles to that of the plant now being described, and therefore all floating and suspended ice adjacent to the submerged arches will, in time, pass under them and enter the forebay room, to be dealt with there by means of a travelling forebay crane, and men using rakes and poles.

However, even in this power-house, an enclosed forebay room is of great value, affording comfortable quarters for men fighting ice in stormy weather, and moderating somewhat the temperature of the ice rack.

In extreme cases the centre sections of the ice rack are raised up, and the accumulations of fine floating ice and frazil are allowed to pass through the wheels, whose large ports will take care of considerable quantities of fairly large ice without any injury to the bronze runners.



General View of Power House, Forebay and Canal.

The water, after passing the fine ice rack, enters 18 ft. openings in the masonry inlet walls, thence passes through cast iron penstock mouth-pieces which are elliptical (18' × 12') at the outer end and 10 feet in diameter at the inner end where they pass through the main wheelpit walls, and flows into the upper elbows of the main penstocks. During ordinary operation the movement of water is controlled by head gates set in lubricated cast iron grooves in the inlet walls, and operated by lifting screws, a box girder fastened onto the steel columns of the power-house, and a 20-h.p. 125 volt D.C. motor mounted on this girder, and for the purpose of filling the penstocks, so as to release the pressure on the gates, small hand operated wicket gates have been inserted in the main gate bodies.

Outside of these lift gates two sets of stop log grooves have been cut at each inlet, so that in case the lift gates require unwatering stop logs can be inserted.

Wheelpit.

This pit, which is 570 feet long and 18 feet wide, after lining, was excavated through 15 feet of boulders and gravel, 100 feet of limestone, and 50 feet of shale, the sides being separated, before blasting, by channelling. The channelling machines are self propelling and have a travel of about 12 feet, the cuts being carried down in 6 foot benches, having 6" batter. After blasting and excavating a bench, the channelling was again proceeded with, an off-set of 6" being required for clearance.

For the reception of numerous castings, draft tubes, etc., a great amount of excavation was required in the form of recesses, and in order to do this without unduly shattering the side walls, the whole periphery of each recess was separated, preliminary to blasting, by gadding and broaching, the process being that of a drill body, mounted on a vertical column and truck, and working horizontally; by using small charges of dynamite, these detached masses of rock were then blown out, leaving the adjoining walls usually intact.

When the wheelpit for first installation of 50,000-h.p. was about two-thirds excavated, the tunnel excavation had been completed to the wheelpit, and in order to expedite the completion of the plant the writer urged that the general design should be changed, substituting two branch tunnels, turbines resting on the solid bottom, lower penstock elbows ditto, and draft tubes leading from the wheel cases to the branch tunnels, which would admit of tunnel excavation being pushed forward, and wheelpit excavation being completed four months sooner than would be the case if the lower part of the wheelpit was to constitute the beginning of the tail race.

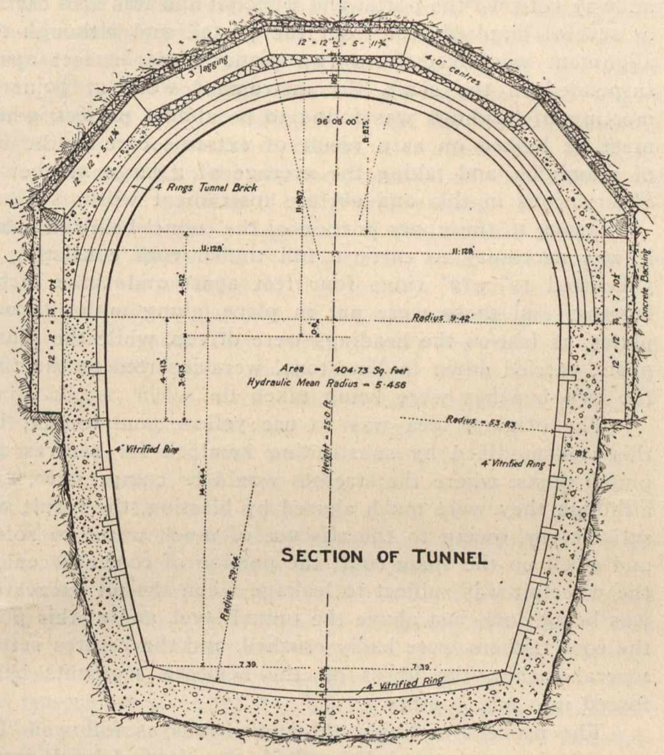


Fig. 4.

The merits of this method had already been suggested by Escher, Wyss & Co., the simplifying of the lower penstock elbow and greater solidity of the turbine unit when in operation being evident, and, in passing, it is interesting to note that the Toronto and Niagara Power Co. has adopted this identical design for the plant they are now building. However, the view of the consulting hydraulic engineer was against the change and in order to hasten the completion of the wheelpit excavation which, on the lower levels, is very much cut up by various checks and recesses, it was decided to carry forward the tunnel excavation immediately underneath, and bring down the wheelpit excavation on the tunnel roof.

This process was fairly successful until about two-thirds completed, when the blasting from above and below had so weakened and opened up the remaining shale that wheelpit water commenced to leak into the tunnel, throwing excessive loads on the tunnel roof, and necessitating increased timbering at this place, until finally tunnelling operations had to be abandoned, and the remainder of the pit excavated in open cutting as originally intended.

The after effects of this effort to hasten operations were that the sides of the wheelpit, where excavated by tunnelling, were badly shattered, and before the brick lining could be placed large masses of shale broke away, so that as the brick lining was being put in it was necessary not only to fill up these enormous cavities with concrete, but the walls had to be continually watched and scaled down for fear of accidents.

As soon as excavation was well forward it was decided to take measurements for anticipated movement of the rock walls, and the following table will serve to illustrate what actually took place, it being understood that excavation was being carried forward continuously from March, 1902, to June, 1903, and that the measurements given are only a few of those taken.

TABLE OF WHEELPIT SQUEEZE.

Measurements taken between steel plugs at centre of a pit 275 feet long, and at a point 15 feet below rock surface.

Date.		Total width.	Depth of pit at time of measurement.
July	8, 1902.	20' 11 1-2"	35 ft.
Aug.	23, 1902.	20' 11 1-16"	50 ft.
Sept.	10, 1902.	20' 10 15-16"	55 ft.
Oct.	13, 1902.	20' 10 13-16"	65 ft.
Nov.	13, 1902.	20' 10 13-16"	75 ft.
Dec,	18, 1902.	20' 10 13-16"	85 ft.
March	6, 1903.	20' 10 13-16"	100 ft.
April	7, 1903.	20' 10 12-16"	110 ft.
May	8, 1903.	20' 10 25-32"	125 ft.
Oct.	15, 1903.	20' 10 7-16"	full depth.

Giving a total of 1 1-16 inches, although at lower levels a movement of 1½ inches was observed between November, 1902, and October, 1903.

Not the least curious feature of these movements was the fact that the east side next the river moved about twice as much as the west side adjacent to higher ground. But the most noticeable fact of the table is that the movements, which had practically ceased by March, 1903, had again become serious by October, 1903, and this had been caused by the excavation of the wheelpit extension 300 feet further, freeing one end of the rock walls. This is further shown by measurements on thrust girder castings of west wall, which had been set in September and October, 1902. It will be seen that the movements had practically ceased in March, 1903, but again commenced as soon as the excavations of the extension to pit were carried down for some depth.

TABLE OF WHEELPIT SQUEEZE.

Total movements of west wall at thrust girder level.

Date.	Unit 1.	Unit 2.	Unit 3.	Unit 4.	Unit 5.
Dec. 18, 1902.	— 1-16"	1-4"	7-16"	7-16"	15-32"
Jan. 27, 1903.	— 1-16"	7-32"	11-32"	7-16"	15-32"
Mar. 6, 1903.	— 1-16"	3-16"	7-16"	11-32"	9-16"
Feb. 13, 1904.	+ 1-8"	1-32"	5-8"	1 1-8"	1"

The first generator arch built was at unit No. 4, and during the summer of 1904 it became evident that it was being severely squeezed, and even after several heavy arches had been built, the masonry lining walls of wheelpit at the level of the springing of the arches showed slight movements. It was therefore decided to put in a few heavy cast iron struts across the pit at units No. 4 and No. 5, thrusting against cast iron strut bases, which had been provided in over 20 places in anticipation of trouble.

Four struts at unit No. 5 and two struts at unit No. 4, each of about 250 tons safe capacity, seem to have completely stopped the squeezing movement.

TABLE OF WHEELPIT SQUEEZE.

At unit No. 3 after struts had been placed at various levels at units No. 4 and No. 5.

Date.	Thrust Deck.	Turbine Deck.
Nov. 14, 1904.	18,882 ft.	16,451 ft.
Nov. 23, 1904.	18,881 ft.	16,447 ft.
Nov. 28, 1904.	18,884 ft.	
Dec. 6, 1904.	18,882 ft.	16,450 ft.
Dec. 13, 1904.	18,884 ft.	16,446 ft.
Dec. 21, 1904.	18,884 ft.	16,445 ft.
Jan. 2, 1905.	18,883 ft.	16,442 ft.

The lining of the wheelpit, which consists of 24 inches of solid shale brick from invert up to rack deck, and 12 inches of solid shale brick backed by 4 inches of hollow brick thence to top, is anchored to the rock walls by anchor bolts with wedges and having large plate washers embedded in the brick work, and, as the work was laid with a shove joint with one to three cement mortar, it is practically watertight, the leakage through the seams in the rock passing into the hollow brick and down openings left in the hollow brick lining to cast-iron weeper boxes at the rack deck level, the water falling from them freely into the wheelpit just above tail race level.

During the placing of the brick lining a great number of castings were placed in position. These consisted of the main and auxiliary draft tubes, which were buried in the brick walls (the bracket casting section alone of each draft tube weighing about 25 tons) and castings for supporting the lower penstock elbows, guide girders, thrust girders, and the various floors placed in the pit for purposes of operation.

These castings varied in weight from ½ ton to 6 tons, and extended back from the face of the wall from 3 to 5 feet depending on the loads to be carried, while the lip or shoulder carrying the loads extended only a few inches beyond the face of the walls. These castings were, of course, hollow and were filled with concrete before being placed in position.

Accuracy being necessary, great care was taken as to height and longitudinal position. In placing all castings, piano wires on a reel carried heavy plumbobs immersed in water, and elevations were transferred from one level to another by a steel tape, which had been standardized at Washington, D.C. All work was carried to 1-1000ths. of a foot, and, with very few exceptions, the results obtained were found very satisfactory during the period of machinery setting.

On the east side three chambers, averaging about 40′ × 16′ × 30′ high, were built at right angles to the wheelpit and just above the level of the rack deck, which is the first floor above the water in the tailrace part of the wheelpit.

They were excavated as tunnels by top headings and benches, but being in limestone did not need timbering. The lining was the same as that of the wheelpit, and they were divided up into various levels by steel floors carried on brick ledges on the lining walls.

In the extension of the wheelpit two more similar ones are being built.

These chambers contain the exciter units, the pumps for forcing water to the transformer station, an air compressor (Pelton driven) and a system of oil tanks, filters and pumps for supplying oil to the high and low pressure bearings. The machinery in these chambers will be referred to later on.

Tailrace Tunnel.

The original design for this tunnel was of a section 21 feet high, with brick lining 16½ inches thick, but this was finally modified to the present section, which is 25 feet high, and has a composite lining, the bottom and sides being of concrete, faced with 4 inches of highly burnt brick, while in the arch a brick ring with dry packing was adhered to on account of the difficulty which would have attended the building of a concrete arch (see Fig. 4).

When the discharge tunnel was built for the Niagara Falls Power Company there was no exact information as to the value of the friction coefficient for a brick lined channel of such large dimensions carrying water at a high speed, and even when the present tunnel was commenced, the United States tunnel had not yet been tested to its full capacity, nor properly calibrated, but an examination in the winter of 1902 showed the brick lining, although of a very ordinary quality, to be absolutely intact, unworn, and slimed over after seven years' use, with water flowing at about 27 feet per second. Still, to make assurance doubly sure, the brick facing of the present tunnel was made of a superior burnt smooth brick, and the section made about 20 per cent. larger than the earlier one, so that the velocity will be slightly increased as the grade of seven feet per 1,000 is continuous, and the alignment of the tunnel very favorable, consisting of two curves of long radius with direct outlet in line of wheelpit.

This tunnel is 2,200 feet long, including the headworks at portal, which consist of a square headwall 60 feet wide. 12 feet thick, and 55 feet high, extending to a depth of 35 feet below water level resting on a foundation well into the Medina sandstone; from this headwall the tunnel rises in an ogee curve for some 80 feet to the tunnel proper, and this portion is lined with 2 feet of granite, which it was considered advisable to use in place of brick, owing to the excessive speed of the water when dropping to the river level, it being understood that the invert of the tunnel at the top of the ogee curve is at the low water river level.

The excavation was carried both ways from a shaft sunk midway between the portal and wheelpit and was also carried in several hundred feet from the portal, and although the alignment was fixed from two piano wires 12 feet apart, suspended in the shaft, the instrument work at point of meeting of headings was found to be almost perfect, which must be looked on as a result of extreme care in the use of plumbobs, and taking the average of a large number of observations in this and surface instrument work.

Owing to the upper portion of the tunnel being in shale, it was necessary to carry a full timber roof consisting of 5 centred 12″ x 12″ rings four feet apart and three inches lagging, and these were put in place, along with the wall plates, as fast as the headings were driven, while the plumb posts, carried down to limestone, were inserted at the time the two benches were being taken up.

The original idea was to use yellow pine timber, but this was modified by substituting hemlock for centres and plumb posts, where the stresses would be compressive, and, although they were much abused by blasting, the result was satisfactory, owing to the absence of much water to soften and swell up the shale roof; the portion of roof adjacent to the wheelpit was subject to leakage when the pit excavation was being done just above the tunnel level, and at this point the roof timbers were badly crushed, and the centres settled several inches, the fibres of the hemlock segments being forced into one another.

The process of lining the tunnel was as follows:—The concrete invert (1:3:5:) being laid, the vitrified brick invert was placed as far as the corner specials, side forms were then put up and lagging, wedged back 4½ inches, was placed as high as the first course of brick headers. After the concrete side walls were built up to this height, the lagging was removed, and the brick facing carried up to and including a header course, after which the process was repeated to the springing, the only variation being that dry packing was used between and behind the plumb posts, in place of concrete shown on plans.

The brick arch was built in the ordinary way on full centres, and 4″ x 4″ lagging, a night man building in the key of the arch work done during the day, and laborers placing dry packing above the haunches and driving it home against the roof timbers, also removing centres after being in position two or three days, and bringing them forward to a new position.

After side forms and arch centres were removed, the whole tunnel was scraped clear of all mortar with sharp iron tools, leaving the surface smooth and clean. It is believed that a very low friction coefficient will exist in this tunnel, especially when the walls become slimed over with deposits from water such as have formed on the walls of the Niagara Falls Power Company's tunnel. The shaft for this tunnel was sunk from May to September, 1901. Excavation was completed December, 1902, and lining and headwall in May, 1904, after which the shaft was bricked up, and outlet excavation at portal completed during the summer of 1904.

No attempt was made to hasten the completion of this portion of the plant before the machinery installation demanded it, otherwise much greater speed could have been made.

(To be Continued).

* * *

The Manitoba Peat Co., of Winnipeg, has secured valuable tracts of peat lands, and will immediately proceed to erect its first plant, which is expected to be in full operation by August next.

THE MINERAL PRODUCTION OF CANADA.

The Geological Survey has issued a preliminary statement of the mineral production of this country for 1904, which shows that the aggregate value of these products for the year aggregated over $60,000,000. This figure is about $2,300,000 lower than the production of last year, and $6,000,000 lower than in 1901. In explanation of this fact, the compiler of the report, Elfric D. Ingall, M.E., says:

"In comparing this record with that of previous years, it must be borne in mind that complete figures are never available at this time of the year, so that in a number of items the data are necessarily partly estimated. Allowing for this, there nevertheless remains a falling off of about $2,250,000 in the grand total. This does not necessarily indicate a general slackening in the permanent mineral industries of the country, but rather a gradual return to natural conditions after a few years of abnormal inflation due to the rapid exploitation of the richer and easily accessible portions of the Yukon placers. To this cause can be attributed nearly $2,000,000 of the decrease shown."

Gold now shares with coal (including coke) first place in the list of minerals produced in this country. Each of these products forms over 27 per cent. of the total mineral production of Canada, and together they constitute more than half the mineral values produced. After these two items follow building material, copper, nickel, silver, lead, cement, asbestos, petroleum and pig iron in the order named. Comparing this with a similar list for 1903, we find that lead has moved up from tenth place to seventh, cement has been forced thus to take eighth place, and petroleum has gone down from eighth place to tenth.

The situation by individual metals is tersely reviewed in the report, from which we quote the following:

Gold.—Practically every province in Canada shows a falling off in gold production, in 1904, as compared with 1903. Nova Scotia, which ordinarily has an output of about half a million dollars, shows a decrease of nearly half its production. Several reasons are given for this, among which may be mentioned: (1) the extreme drought during the past season, (2) the closing down, owing to financial difficulties, of a number of the best producing mines, and (3) the cessation of production at the Richardson mine owing to the destruction of the shaft and workings by an extensive crush.

In Ontario, although a considerable amount of prospecting and development work has been done, most of the mines that were formerly important producers, were not operated during the year.

In British Columbia, an increased output from placer mines is indicated, while a smaller production was obtained from the lode mines. The ore shipments from Rossland and vicinity, the chief gold-producing district, were less than in 1903 by about 20,000 tons.

The Yukon output for the year, $10,337,000, is based on the receipts of Canadian Yukon gold at the United States mint at San Francisco and other receiving offices.

Silver.—The bounty granted by the Dominion Government on the production of lead ores, seems to have stimulated the operations of the silver-lead mines. The St. Eugene mine, in East Kootenay, was re-opened and its production probably accounts for the greater part of the increase.

Silver .999 fine is now turned out at the refinery of the Canadian Smelting Works, at Trail, B.C., as is also gold, .994 fine. Refined silver has been shipped to New York, San Francisco and to China.

The average price per ounce of fine silver in New York during the year was 57.221 cents, as compared with 53.45 cents in 1903.

Lead.—Although over twice as much lead was produced in 1904 as in 1903, the output is still far from its former maximum viz., 31,584 tons in 1900. The production in 1904 was about 19,000 tons as compared with 9,070 in 1903.

An electrolytic lead refinery is now in operation at the Canadian Smelting Works, Trail, B.C., producing pig lead, lead pipe, sheet lead, etc.

Copper.—The copper contained in ore, matte, etc., shipped from Canadian mines in 1904 was about 21,485 tons, as compared with 21,342 tons in 1903.

In Ontario there was a falling off of over a thousand tons, which was more than made up by the increased production from the Boundary District and the Coast District of British Columbia. From Sudbury district,, Ontario, 10,154 tons of matte were shipped, containing 2,455 tons of copper (see further under nickel.) In British Columbia, shipments from the Boundary District were approximately 818,000 tons in 1904, and from Rossland 342,000 tons, as compared with 697,284 tons from the Boundary District and 360,786 tons from Rossland in 1903.

The average price per pound of electrolytic copper in New York in 1904 was 12.823 cents, as compared with 13.235 cents in 1903.

Cobalt, Etc.—The discovery of certain cobalt, nickel, arsenic and silver ores, which was made public in November, 1903, promises to add in the near future, largely to the production of these metals. The deposits were found during the building of the Temiskaming and Northern Ontario Railway, the roadbed running almost over the top of the first of the outcrops discovered. The ores are contained in a series of almost vertical veins varying in width from eight inches up to six feet although the wider portions always contain more or less rocky matter. The veins intersect the conglomerate and slate usually classified as Huronian. All of the deposits thus far discovered possess certain features in common. The minerals represented are chiefly smaltite, nicolite, and native silver, with smaller quantities of erythrite dyscrasite, chloanthite and tetrahedrite. In some the native silver is very abundant and a sample which was fairly representative of one of the smaller veins showed an assay value of $5,237.60 per ton. Analysis of the ore from one of the veins composed mainly of smaltite showed from 16 to 19 per cent. of cobalt, 4 to 7 per cent. of nickel, 60 to 66 per cent. of arsenic, and 3 to 7 per cent. of sulphur. The ores are thus so rich, that comparatively small veins could be worked at a handsome profit.

Although no returns have yet been received at this office, it is stated that several carloads of ore have been shipped from this district, which realized very high values.

Nickel.—The following were the results of operations on the nickel-copper deposits of Ontario in 1903:

	Tons.
Ore mined	203,388
Ore smelted	118,470
Matte produced	8,924
Matte shipped	10,154
Copper contents of matte shipped	2,455
Nickel contents in matte	5,274
Value of matte shipped	$2,193,198

According to customs returns, exports of nickel in matte, etc., were as follows:

	Lbs.
To Great Britain	2,028,908
United States	9,204,961
Total	11,233,869

The price of refined nickel in New York remained steady throughout the year at from 40 to 47 cents per pound.

Zinc.—About 533 tons of zinc ore worth $3,700 were shipped during the year from the Long Lake zinc mine in the County of Frontenac, Ont. No returns have been received of zinc production in British Columbia.

Iron.—Exports of iron ore were 168,828 tons valued at $401,738. In addition to the ore exported, about 180,932 tons of ore worth about $498,687, were mined in Canada and charged to Canadian blast furnaces.

Besides the above Canadian ore, 454,671 tons of imported ore valued at $922,594 were used in Canadian furnaces. The total amount of pig iron manufactured from both Canadian and imported ores was 303,454 tons, of which 21,583 tons were made with charcoal as fuel and 281,871 tons with coke. The quantity of charcoal used was 3,477,470 bushels and of coke 387,392 tons.

The pig iron was made by three firms in Nova Scotia, two in Quebec and four in Ontario.

Coal and Coke.—With the exception of a small decrease in shipments, coal production in Nova Scotia in 1904 shows but little change. A smaller amount of coke was made owing to the smaller production of pig iron by the Dominion Iron and Steel

Company. Efforts are being made to find new markets farther west in Ontario, as well as to increase the exportation. In the North-West Territories many small mines have been opened, and the output shows a substantial growth. Coke is now being made in Alberta. On December 31st, 1904, fifty-six beehive ovens were in operation at Coleman, Alta., and thirty-four Belgian ovens, Bernard type, were in operation at Lille, Alta. In British Columbia, the output of the Western Fuel Company in Vancouver Island was considerably diminished owing to the destruction by fire of the head works at No. 1 mine. The Crow's Nest Pass Company, however, continued to increase its output, over 1,000,000 tons of coal being produced, of which more than half was used in making coke. This company has now 1,128 coke ovens completed.

Asbestos.—The production of asbestos divided into crude and mill stocks was as follows:

	Tons.	
Crude	4,239	$509,001
Mill stock	31,396	658,277
Total	35,635	$1,167,278

Exports of asbestos according to customs returns were: 37,272 tons valued at $1,160,887.

Natural Gas.—There was a somewhat increased production of natural gas in Ontario, due entirely to operations in the Welland field, production in the Essex field having dropped to very small amounts.

The development of the gas field at Medicine Hat, North-West Territories, seems to have been continued with much success. The gas commission of the town of Medicine Hat has now six producing wells, one of which has been put down to a depth of nearly a thousand feet yielding 1⅛ million feet per twenty-four hours. The Canadian Pacific Railway Company has just completed drilling a well to a depth of 989 feet with 4⅝-in. casing to 941 feet. The pressure per square inch developed in eighteen hours was 525 pounds.

Cement.—The production of natural rock cement, which has for a number of years been small in comparison with the output of Portland cement, shows another large decrease in 1904, the sales being only 56,814 barrels, valued at $49,397, as compared with 92,252 barrels valued at $74,655 in 1903.

Although a much larger quantity of Portland cement was sold in 1904, the total value, owing to the fall in price, is only slightly in excess of that in 1903.

In the absence of complete returns, Portland cement statistics have been partially estimated. The following is, however, a close approximation:

	Barrels.	Valued at.
Portland cement sold	900,358	$1,272,992
Portland cement manufactured	908,990	
Stock on hand, Jan. 1st, 1904	124,919	
Stock on hand, December 1st, 1904	133,551	

The imports of Portland cement in 1904 were:

Six months ending June,	cwt.	829,872	$ 320,137
Six months ending December	cwt.	1,916,336	740,919
Total	cwt.	2,746,208	$1,061,056

This is equivalent to about 784,630 barrels of 350 pounds each, at an average price per pound of $1.35. The duty is twelve and a half cents per hundred pounds.

LIGHT, HEAT, POWER, ETC.

An electric lighting and power plant will probably be installed at Granby, Que.

Messrs. Ratz Bros. have installed a new dynamo of 1,500 lights' capacity in their electric plant at Elmira, Ont.

The MacLaren Electric Light Co., Buckingham, Que., will install a new dynamo in their plant for additional power purposes.

To provide against any emergency arising from failure of electric power, the British Columbia Copper Company has installed a pumping plant on the artificial lake created by damming up Copper Creek with hot slag.

Officials of the Grand Trunk Railway have selected a site for the proposed electric power house at Sarnia, Ont.

William Kennedy, C.E., and R. S. Kelsch, of Montreal, are reporting upon the Kakabeka Falls power development at Fort William, Ont.

At the second annual meeting of the Electrical Development Co., of Ontario, it was stated that the work at Niagara Falls would be completed and in operation by the summer of 1906.

It is proposed to place dams at the outlets of the lakes feeding the Ottawa river, in order to store the surplus water for use during the summer drouths and regulate the flow to the water powers at Ottawa.

It is announced that the Canadian Electric Light Company, Quebec and Levis, has successfully emerged from the difficulties which have been threatening it, and that the reorganization of the company is now complete.

The Montreal plant of the Canadian General Electric Company will be shut down in April, and the equipment removed to Peterboro', because the cost of power is one-third greater in Montreal than it is in Peterboro'.

Hydraulic operations on a large scale will be conducted next year by W. Lawrence Brooze, of New York, on his claims on Bullion Creek, B.C. He intends to install a $300,000 dredge, an electric plant to run by water power and the best modern appliances for the recovery of gold. A flume 600 feet long will be constructed.

The contract between the city of Sherbrooke, Que., and the Sherbrooke Power, Light and Heat Company for lighting the streets having expired, the company has made an offer to the city that if a contract for ten years is entered into it will reduce the $60 rate for street lighting to $50 and give a discount of 10 per cent. on the meter rate.

Herschel & Pringle, engineers, have estimated on the repairing of the foundation of the power house of the Consolidated Lake Superior Co., naming $750,000 as an approximate figure. One of the company's engineers has estimated that the work can be done for about half that amount. It is thought that to develop 45,000-h.p. an expenditure of about $1,600,000 will be necessary.

The Metal and Jewelry Section of the Canadian Manufacturers' Association held a luncheon on February 8th, at which K. L. Aitken, consulting engineer of Toronto, spoke on "The Comparative Advantages and Cost of Steam and Electric Power." Relative cost of buying and making power was first dealt with, after which the question of mechanical versus electrical drive was taken up. About fifty members were present, and at the adjournment, a very hearty vote of thanks was tendered to Mr. Aitken for his remarks.

The new electric lighting system which is owned and controlled by Moose Jaw, Assiniboia, is now in effective operation. The electrical apparatus, including the generator, switchboard, pole, line and wiring system, was supplied by Allis-Chalmers-Bullock, Limited, Montreal. The generator is a two-phase, 2,200 volt, 100 k.w., Bullock revolving field type. The power house is equipped with a tandem compounding condensing engine of 160 h.p., built by the Robb Engineering Company, of Amherst, N.S. When the pumps are installed the cost of the building and machinery will be about $38,000.

The Westinghouse Electric and Manufacturing Company has closed a contract with the Ontario Power Company for an alternating current generator with a rated output of 10,000-h.p. at 85 per cent. power factor. This is in addition to three other machines of similar type which the Westinghouse Company is furnishing for this plant. The generators are of the revolving-field, two-bearing type, designed for direct connection to water-wheels; they generate three-phase current at 12,000 volts and 25 cycles, and run at a speed of 187-½-R.P.M. Among other apparatus included in the contracts are twelve 3,000-K.W., oil-insulated, water-cooled transformers, wound for 12,000 and 60,000 volts; two 375-K.W. exciters, and complete switchboards. P. N. Nunn and L. L. Nunn are engineers in charge, and the plant is being built by the Niagara Construction Company, of which Francis V. Greene is president.

HEATING THE HUMAN BODY.

The normal internal temperature of the human body is very near 100 degrees, independent of the temperature of the surrounding air. By respiration the continuous process of slow combustion is kept up,—the oxygen of the air uniting with the carbon of the blood passing through the lungs, to form carbonic acid. As in any case of combustion, overheating takes place unless provision is made for the distribution of the heat generated, so that the body is kept at its normal temperature only by the abstraction of heat from it. The actual heating of the body is not the ultimate object of heating, but in reality provision is made for the abstraction of heat generated by the vital functions, without making too great a demand upon the physical endurance of the individual. Three means are provided for the healthful dispersion of heat from the human body. First: By radiation into the air and surrounding objects. Second: By conduction, principally to the air immediately in contact with the body. Third: By evaporation of moisture from the lungs, throat and skin. Under the conditions of summer air, the last two are generally about equal, but the greater part of the heat is dissipated by the first means. Air is nearly a perfect non-conductor of heat, but radiation takes place through it readily. We may enter a room having a temperature of 75 degrees, with walls at 50 degrees, and feel chilled, simply because heat is rapidly radiated from the body, through the air to the colder walls. In comparatively dry air equality of temperature is kept up by a steady but imperceptible evaporation from the skin. In moist air this rapid evaporation is prevented, and the water is deposited as perspiration, the air being too heavily laden to take it up. On the other hand when the air is in motion, it increases both the evaporation and conduction by the constant bringing of fresh air to take the place of that already moistened or heated. If, under any circumstances, one of these three means fails to abstract heat rapidly enough, the removal by the other means is increased, and equilibrium of temperature kept up. High humidity has the effect of modifying very materially the temperature at which comfort may be secured. The excessive humidity of the atmosphere in the west and south of England has, owing to the reduced evaporation from the body, the effect of making a temperature of 56 deg. in that country as comfortable as 80 deg. in the dryer climate of Canada or Minnesota. In this country, where some means of heating is usually required during about seven months of the year, the amount of heat necessary and the economy exercised in supplying it are vital questions. Convenience and economy can best be secured by an intelligent union of the heating and ventilating systems.—From "Ventilation and Heating," by B. F. Sturtevant Co., Boston, Mass.

ESSENTIAL ELEMENTS IN THE DESIGN OF DAMS.

JOHN S. FIELDING, C.E., TORONTO.

(Continued from last issue.)

Curvilinear Plan.

The list of important dams, both ancient and modern, that have a curved plan, is a long one. With but few exceptions, these dams have been designed as gravity sections, and the curving has been done to afford additional safety. The ratio of length of radius to length of chord for gravity sections varies from 2.43 in the case of the Beetaloo dam to .8 for the Villar dam, with a vers. sine of .063 and .156 respectively. It is not easy to see wherein much advantage is gained by using an arch with a vers. sine of .063, but a vers. sine of .156 should add strength; and in the case of a short dam, with 131 feet length of crest, as in the Verdon dam, loads may be delivered to the abutments.

The most apparent advantage, however, would come from the fact that a considerable amount of curvature would enable the structure to transmit moving loads. To do this would not entail the delivery of an enormous load to the abutments, or even power to carry a concentrated load and maintain its form while delivering unequal reactions, but simply, that if the one portion pressed forward at the top (in the manner described in a previous article), so as to give it a greater forward movement than another part, that the arch form would tend to preserve the alignment, and maintain equality of such movement; and again, if different coefficients of friction exist at different parts of the length of the dam, that the curved form would enable the structure to act as an arch, thrusting back to portions that had a good coefficient of friction. This may be over a portion ten, twenty, or fifty feet of its length. If a dam be provided with considerable top width, so as to be able to preserve its alignment, and be equipped for transmitting moving loads, it would require no curving on plan.

It is clear from this, then, that a dam with a narrow top should be curved on plan.

Amongst curved dams there are the following:—

	Date.	Radius.	Base.	Crest.	Proportion.	
1. Alicante	1579	371′	30′	190′	$\frac{371}{190} = 2$	Spanish
2. Elche		205′	60′	230′	$\frac{230}{203} = 1.12$	"
3. Villar	1870	440′		546′	$\frac{440}{546} = .8$	"
4. Hijar	1880	210′		236′	$\frac{210}{236} = .89$	"
5. Zola	1843	158′	230′	205′	$\frac{158}{205} = .77$	French
6. Furens	1858	‘828′	30′	328′	$\frac{828}{328} = 2.5$	"
7. Pas Du Riot ..	1872		curve	not	given	"
8. Ternay	1865	1312′	"	"	"	"
9. Ban	1867		"	"	"	"
10. Verdon	1866	108′		131′	$\frac{108}{131} = .82$	"
11. Pont	1883	1312′		495′	$\frac{1312}{495} = 2.6$	"
12. Chartrain	1882	1312′	curve	not	given	"
13. Gileppe	1869	1640′	269′	771′	$\frac{1640}{771} = 2.5$	Belgian
14. Remschied	1889	410′	curve	not	given	German
15. Einsiedel	1890	1310′		590′	$\frac{1310}{590} = 2.22$	"
16. Betwa	1873		curve	not	given	India
17. Beetaloo	1888	637′		580′	$\frac{1414}{580} = 2.43$	Austral'
18. Geelong		300′		226′	$\frac{300}{226} = 1.33$	"
19. San Mateo	1887	637′		680′	$\frac{637}{680} = .956$	Am.
20. Bear Valley ...	1884	300′		450′	$\frac{300}{450} = .66$	"
21. La Grange ...	1890	300′		320′	$\frac{300}{320} = .93$	"
22. Sweet Water ..	1886	222′		380′	$\frac{222}{380} = .6$	"
23. Hemmet	1891	225′	40′	280′	$\frac{225}{280} = .8$	"
24. Butte City ...	1892	350′		350′	$\frac{350}{350} = 1$	"

Coefficient of Friction on Sub-base.

The conditions affecting the Sliding Safety Factor will be the nature of the bed of stream and material used in the structure. As has been explained in a previous article, the depth of the water should be taken into account also, but this has evidently been neglected in all existing structures:

	Trautwine.	Rankin.	Turneaure.
Soft limestone well dressed on same	.64		
Soft limestone on hard limestone.	.65		
Hard limestone on hard limestone, both well dressed	.38		.38
Hard limestone on soft limestone, both well dressed	.67		
Hard limestone, dressed (medium) on brickwork			.60
Masonry and brickwork, dry	.65	.6 to .7	
Masonry and brickwork, with wet mortar	.47		
Masonry and brickwork, with slightly damp mortar	.74	.74	
Masonry on dry clay	.51	.51	.510
" " moist clay	.33	.33	.325
Concrete on clay, dry			
" " " wet			
" " soft stone			
" " hard stone			
Beton blocks on like blocks			.66
Masonry on clayey gravel			.577
Granite (roughly worked) on dry sand			.65
Granite (roughly worked) on wet sand			.47
Granite (roughly worked) on gravel and sand			.41
Fine cut granite (medium) on like granite			.58
Point dressed granite (medium) on like granite			.70
Point dressed granite (medium) on c. brick			.63
Point dressed granite (medium) on s. concrete			.62
Common bricks on common bricks.			.64
Common bricks on hard-dressed limestone			.60

The above table gives the coefficient of friction for different materials as quoted by the authors named.

With a coefficient of .65, and allowing a safety-factor (S.S.F.) of 1.3, the working coefficient would require to be taken at .500; for S.S.F. = 1.5 we would use .433.

For S.S.F. = 2.0, we would use .325. By reference to plate on page 15, giving S.S.F. of various existing structures, it will be seen how rare is a coefficient of friction of .325, and how frequent is a coefficient of .5; the Assuan, New Croton, San Mateo, Vyrnwy and Gileppe being the only ones in that long list of dams built since the introduction of the Theoretical Profile which have a coefficient approaching .325.

Water Flowing Over Crest of Dam.

It may be interesting to investigate the effect upon the safety-factor of water flowing over the crests of dams of various heights:

S.S.F. of 1.3. Ultimate coefficient of friction.... .65
Working coefficient of friction... .50

Height of dam in feet	10	20	40	60	80	100
Depth of flood in feet over crest required to eliminate S.S.F. of 1.3	1.4	2.8	5.6	8.41	11.21	14.01
Coefficient of .50 would increase to.	.65	.65	.65	.65	.65	.65

S.S.F. of 1.5. Ultimate coefficient of friction.. .65
Working coefficient of friction.. .433

Depth of flood in ft.	2.2	4.5	9.0	13.4	17.9	22.4
Coefficient of .433 would increase to.	.65	.65	.65	.65	.65	.65

S.S.F. of 2. Ultimate coefficient of friction... .65
Working coefficient of friction... .325

Depth of flood in feet	4.14	8.28	16.5	24.85	33.13
Coefficient of .325 would increase to.	.65	.65	.65	.65	.65

With a safety factor of 2 against overturning, any of the above dams would, with the depth of flood given in each case, have this factor of 2 reduced to 1.19.

With a safety factor of 2½, it would be reduced to 1.42; or with 3, to 1.70.

If the O.S.F. had been only 1½, any of the dams would have overturned before reaching the height of flood given in tables, the O.S.F. being reduced to .85.

Safety Margins.

When we say that a structure has a factor of safety of two, we mean that the strength divided by the pressure will give a quotient of 2; i.e., for sliding safety factor

$$\frac{w}{p} = 2, \text{ or } \frac{W}{P} = 2.$$

w = weight of dam per lineal foot.

p = pressure on dam per lineal foot.

W = total weight of dam.

P = total pressure on dam.

For overturning safety-factor we would mean the stability moment divided by the overturning moment, i.e.,

$$\frac{wz}{pz'} = 2, \text{ or } \frac{WZ}{PZ'} = 2.$$

$$z = \frac{1}{3} \text{ height of dam.}$$

Z' = distance from centre of gravity to toe.

A safety-factor of 2 does not mean, however, a surplus strength of 2, but only a surplus strength of 1.

A safety-factor of 1.5 does not mean a surplus strength of 1.5, but only a surplus strength of .5.

Some authorities claim that 1.5 is a sufficiently large safety-factor, but if we bear in mind that the total surplus strength is only .5 of the pressure, it will be seen how precarious is the life of such a structure.

The great majority of engineers seem content with a sliding safety-factor of 2, and since this equals a surplus strength of P × 1 only, and this surplus strength has to make up any deficit in stability, or increase in pressure, that may occur, it is easily seen how precarious is the life of this structure also.

The following may be termed as actual forces tending to prevent the structure from having the full strength intended to be contained by it:—

1. Defects in sub-base, i.e., bed of stream.
2. " in material composing the structure.
3. " in material composing the joints of structure.
4. " in method of building.
5. " in workmanship.
6. " through action of rain during construction.
7. " through action of frost during construction.
8. " through action of the sun during construction.
9. Wrong assumption as to value of coefficient of friction.
10. Wrong assumption as to specific gravity of material.
11. Change in value of coefficient of friction due to pressure from head of water affecting condition of the mass.

12. Presence of springs under the dam.
13. Undermining.

The following forces tend to increase the pressure:—

14. Increased pressure due to increase in head.
15. Blows on top of dam by ice, and pressure of ice.
16. Blows on top of dam by debris.
17. Increase of pressure on top of dam through friction of water upon a horizontal plane level with crest, such friction being communicated to this horizontal plane by the rushing plane of water during flood times.
18. Any wrong assumption in estimating the pressure, or any improper method of figuring, or mathematical errors.
19. The action of unequal loads.
20. Unknown internal stresses.
21. The action of back-water, vacuum below the dam, or any unknown force.

Thus we have 21 conditions or forces, each one capable of depriving the structure of some of its surplus strength.

By reference to article: "Water Flowing over Crest of Dam," it will be seen how easily the item No. 14 may eliminate a surplus strength of 1; and by reference to articles: "Moving loads," and "Unequal loads," (in last issue), it will be seen how easily the items Nos. 9, 19, and 20 may eliminate a surplus strength of 1; and by reference to article: "Assumed coefficient of friction should decrease as height of dam increases," (in January issue), it will be seen how item No. 11 may affect the surplus strength.

With any of these items, namely, No. 14, No. 9, No. 19, No. 20, or No. 11, capable of eliminating the surplus strength, we have then no provision whatever for any of the others, namely, Nos. 1, 2, 3, 4, 5, 6, 7, 8, 12, 13, 17, 18 or 21, and it must be admitted that this is an altogether unsatisfactory condition of affairs, and that a factor of safety of 2 is entirely inadequate for any structure of this type.

The meaning of the word "factor" is, of course, well understood. Webster gives it as a term, applied to the multiplier or multiplicand, from the multiplication of which proceeds the product. A safety-factor is the multiplier, which, when multiplied by the pressure, gives the strength, or multiplicand. In considering very low safety-factors, however, such as are given to dams, it will be seen that the gist of the matter is not clearly expressed by such a multiplier. A structure with a safety-factor of 3, has three pressure equivalents, one equivalent to take care of the known pressure, and two of unknown loads and imperfections. A structure with a safety-factor of 2, has two pressure equivalents, one to take care of the known pressure, and one to take care of unknown loads and imperfections. A structure with a safety-factor of 1.5, has 1.5 pressure equivalents, 1 to take care of the known pressure, and .5 to take care of unknown loads and imperfections. A structure with a safety-factor of 1, has one pressure equivalent to take care of the pressure, and nothing for unknown loads or imperfections. A structure with a safety-factor of .99 would have no safety at all, although it may have a factor of .99. The usual safety-factor is, in reality, a strength factor, and the actual safety-factor is this strength-factor, less 1.

No special plea is intended in favor of any change in the use of the word "safety-factor," but rather to point out the true value of the different safety-factors, so as to emphasize the enhanced value accruing to a dam through any increase in its safety factor.

Factors of Safety and Margins of Safety.

The Folly of Low Factors of Safety.

Let us assume a case of three dams.

A having $\frac{W}{P} = 1.3 =$ S.S.F. (sliding safety-factor).

B having $\frac{W}{P} = 1.6 =$ S.S.F.

C having $\frac{W}{P} = 1.9 =$ S.S.F.

The area of B would be 23 per cent. greater than A.
" " " C " " 46 " " " " A.

The cost may be assumed to vary with the area.

The surplus strength of A would be $1.3 - 1.0 = .3$.
" " " " B " " $1.6 - 1.0 = .6$.
" " " " C " " $1.9 - 1.0 = .9$.

The probabilities of the maximum pressure ever being less than assumed, are remote, the surplus strength, then, of .3, .6, and .9 is all that we have as a margin of safety; and it will be seen that while B has but 23 per cent. more area than A, it has doubled the margin of safety; that while C has but 46 per cent. more area, it has three times the safety-margin.

Take as other instances dams D, E, and F.

D having $\frac{W}{P} = 1.5$.

E having $\frac{W}{P} = 2.0$.

F having $\frac{W}{P} = 3.0$.

E costs 33 per cent. more than D, but has double the safety-margin.

F costs 100 per cent. more than D, but has four times the safety-margin.

A large safety-factor would seem, then, to be a good investment, since the cost increases in a simple ratio, while the thing of real value, namely, the surplus strength, increases at a much greater ratio.

As a case of buying insurance: with four times the insurance at but double the premium, as with F to D; or three times the insurance at an increase in premium of 46 per cent., as with C to A, most people would prefer F or C.

The margin of safety is the essential feature, and the one in dispute, since the normal strength must equal the pressure, but the excess must take care of that list of 21 items already mentioned.

Any assumption that the total inertia of the structure can exceed the weight multiplied by the coefficient of friction is deceptive, and disaster only can accrue from assuming the total adhesion upon the sub-base to be equal to the shearing strength at any horizontal plane above the line of sub-base.

Some writers advise the use of a low safety-factor against sliding, claiming that the cement deposited upon the sub-strata becomes a part of such strata, and that to be separated from it shearing must take place.

The many records of failures of dams that have slid out of place, such as Austin, Chambly, Columbus, Portman Shoals, Roxbury, Winston, etc., all tend to show that in their individual instances at least, no such unification of the two units, i.e., the structure and the rock sub-base, had ever taken place.

The Austin Dam is an instance wherein the structure moved out just when the flood had reached a point that gave the pressure that theory showed was just sufficient to move it, theory being based upon the weight multiplied by the coefficient of friction of .65.

No shear ever came to the help of the Austin Dam, or with such a powerful force to its aid it would have held its own against the flood.

The material composing a dam, whether it be masonry or concrete, must of necessity differ in resilience and other characteristics from the sub-base.

This decrement of length under pressure and any movement of the structure due to forward movement of the top under pressure or any other cause, at any point above the line of adhesion, may safely be assumed as sufficient to interfere with the unification of the two component parts.

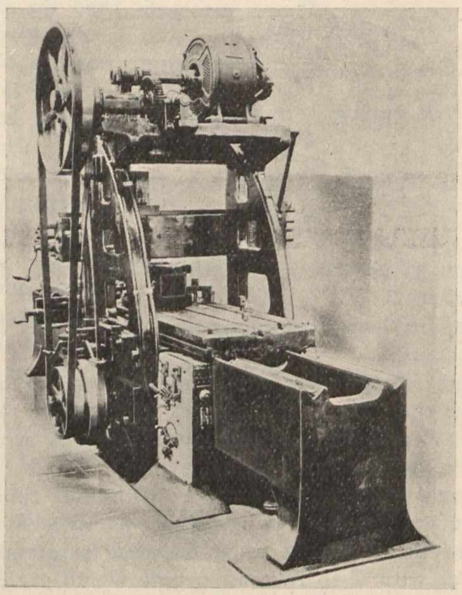
(To be Continued).

* * *

The Pender Nail Works, St. John, N.B., will build another mill at a cost of $25,000.

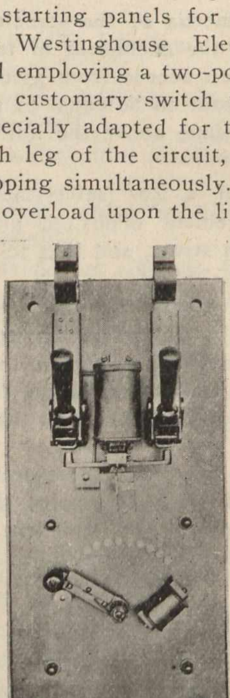
MOTOR-STARTING PANELS WITH CIRCUIT BREAKERS.

One of the recent changes in electrical practice is the general adoption of switchboard panels containing the control apparatus for individual motors. Before their introduction, and in those installations where they are not yet used, controlling rheostats, line switches and protective devices have been mounted in the most convenient place available, often with apparent disregard of fire risk or the protection of the operator. The use of a panel insures the proper mounting of the apparatus, and provides a neat and convenient arrangement, with means for mounting in any desired location.

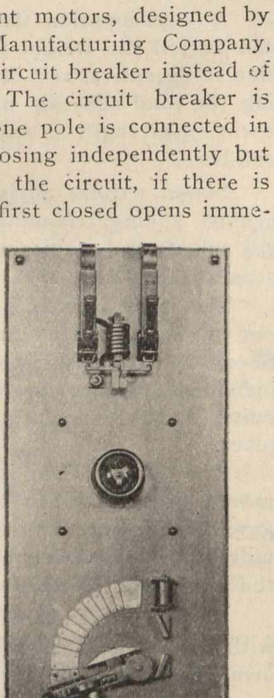


32 x 32 x 10 Planer, Operated by 5-h.p. Type S Motor. Shop of Union Pacific R.R., Omaha, Neb.

The accompanying illustrations show two of the styles of starting panels for direct current motors, designed by the Westinghouse Electric and Manufacturing Company, and employing a two-pole Type D circuit breaker instead of the customary switch with fuses. The circuit breaker is especially adapted for this use, as one pole is connected in each leg of the circuit, the poles closing independently but tripping simultaneously. In closing the circuit, if there is an overload upon the line, the pole first closed opens imme-



Special D.C. Switchboard.



Switchboard, Panel Type, D.C.

diately upon closing the second thus instantly interrupting the circuit and preventing damage. It is strongly built, with few parts, none of which is small. It is provided with hinged, movable contacts of the brush type, and with carbon tips, to which the current is shunted when the circuit is broken, preventing sparking at the contacts. The circuit is fully broken at the contacts before there is any movement of the carbon tips. There are no springs except the strong strip of spring steel which carries the carbons, the blow of the armature tending to open the breaker, and not simply to release the moving parts. The device is reliable in its action, and is adjustable for different loads. These panels, with circuit breakers, are furnished in two styles: those with field rheostats for motors requiring shunt field regulation for varying speed, and those without field rheostats for constant speed motors. Since the field and starting rheostats accompany the motors, the price of the panel includes only the mounting of the rheostats. A starting rheostat with minimum voltage release is generally employed with Westinghouse motors. As soon as the supply circuit is interrupted, the rheostat automatically opens the circuit, making it impossible to damage the motor by restoring full line potential to the circuit when the motor is at rest.

These panels are especially adapted for separate machine tool drive, being so designed as to permit mounting directly on the frame of the machine tool driven by the motor as shown in the accompanying illustrations.

PROGRESS IN PEAT.

In our February number of last year a description was given of the peat fuel industry in Canada, illustrated with cuts of some of the Dobson patented appliances, which had been in successful commercial operation for three years.

During the year 1904 progress has been made by Mr. Dobson and his associates in the formation of the Montreal and Ottawa Peat Company of Ottawa, and in the construction of a plant on the company's property, situated on the line of the C.P.R., between Montreal and Ottawa, which is intended to supply the Montreal market with a superior class of fuel. The railway company having granted station privileges at this point, the name "Dobson" was given it. The plant was erected by Mr. Dobson for the company, and has a capacity of fifty tons of fuel per day of twenty hours' run. Work was begun in May under the superintendence of Mr. Dobson, and by the end of September a well-equipped plant was in operation, which was tested, and proved its success in producing a superior quality of fuel. As the time for harvesting operations was past, nothing was attempted in the way of making fuel further than to satisfy those interested of the efficiency of the equipment and the character of the fuel, a carload having been shipped to Ottawa for the use of the directors and their friends, which gave great satisfaction. The plant is ready for a full season's run as soon as the frost is out of the ground.

During the summer a considerable time was spent in locating peat deposits from which Winnipeg might be supplied. The result was that two very good beds were found, and the Manitoba Peat Company, of Winnipeg, has been organized, with abundant capital to build plants and sell the product in the West. The first plant will be erected at Fort Frances, and material and machinery have already been purchased, and it is expected the plant will be running by the middle of the summer, and a considerable quantity of fuel put upon the market in Winnipeg for the next autumn and winter. The high price of coal in Manitoba—$11 and upwards per ton—and the large number of air-tight stoves used for domestic heating in Manitoba should combine to give a favorable chance to a native fuel industry there. In the Toronto market peat fuel is sold at $4.25 per ton against $8 per cord for hard wood. We understand that the peat of the Ottawa beds and of Manitoba has only about 4 per cent. of ash, against 12 per cent. in the product now in the market in central Ontario.

A new clam-canning plant has been installed at Sidney Inlet, Vancouver, with an output of 100 cases a day.

The Montreal Land and Improvement Co. will erect a block of thirty houses, comprising fifty dwellings, for the workmen of the Angus Shops. It will be built in Alexandra Park, adjoining the Angus shops.

An automobile and power launch manufactory, equipped with the latest and best machinery, is to be ready for business within three months at Victoria, B.C. This is the first factory of its kind to be established in Western Canada.

MUNICIPAL TELEPHONE PLANT AT NEEPAWA, MANITOBA.

(Concluded.)

After the mate plug is inserted into the line jack of the subscriber wanted, and the key is pulled toward the operator, it cuts in the generator and rings the subscriber's bell. When the key is in the ringing position, it is automatically restored when the operator releases the pressure on the cam. The key may, however, be locked in the listening position so that an operator can carry on a long conversation with a subscriber, if necessary, without holding the key in position.

When it is desired to ring back on the line originating the call, the small button back of the regular ringing cam is pressed toward the board, which throws the generator on the answering cord. This combination key is so constructed that it requires but one set of main ringing springs, making two less springs and four less contacts than any other key of its kind now in use. The keys are provided with long heavy springs, punched from the highest quality spring German silver sheet. The springs are provided with platinum contacts.

The springs in the complete key are firmly clamped between mica insulations by heavy machine screws bolted into heavy brass nuts, making it absolutely impossible for these parts to get out of adjustment. The keys are mounted on a hinged shelf, so that the shelf may be raised for conveniently inspecting any other part. Under the key shelf is mounted the operator's receiver cut-in jack, so that the operator may conveniently connect or disconnect the receiver. Immediately under the cut-in jack is mounted the night-bell switch. At the right end of the board is mounted the generator and the power generator key.

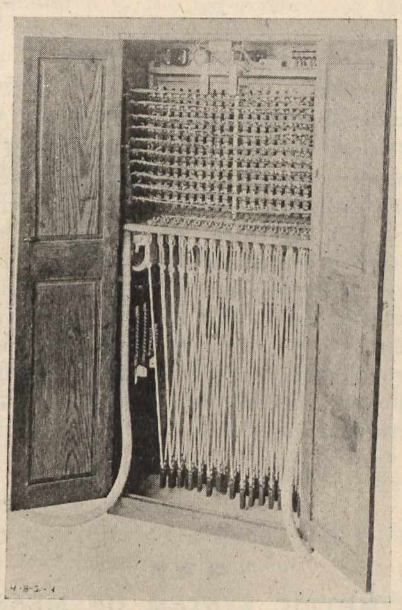


Fig. 2.—Switch-Board, Showing Wiring for Central Energy System.

Fig. 2 shows an interior view of the rear of the switchboard, showing the wiring of the line equipments, the night bell, the operator's instrument induction coil, the central energy coil, the cord circuits, etc. The wiring shown is for either a generator-call or central energy system. As contructed and used at the present time, it is for generator-call and local battery system.

At the top of the board, between the night-bell and induction coil on the central energy coil, is shown a direction card reading: "Take short off this coil for central energy." This is the only work required for changing this switchboard from a magneto call local battery system to a complete central energy apparatus, in addition to connecting the central energy wires at the line equipments, which are provided with screw terminal wire clips so that the change may be readily made.

This system enables companies who are not in position to install complete central energy when first building or rebuilding their plants, to equip their central office so that the plant may be changed at any time when installing metallic construction, to full central energy without discarding any of the apparatus already installed. In re-equipping exchanges, this system may also be used with other makes of the old type telephones by cutting out the generator and installing a condenser so that the signalling at the central office may be done automatically by taking the receiver from the hook, and the disconnecting signal may be thrown by replacing the receiver and leaving the telephones with batteries locally. This enables re-equipping any exchange on the installment plan, making the change in sections, and when completed, costing practically no more than if the change were made at any one time.

The cabinet-work of the switchboard is highly finished, close-grained and well-seasoned quarter-sawed oak, with all parts properly fitted and well joined, to make the equipment rigid and durable. At the bottom of the switchboard is provided a heavy brass foot-rail to brace the front of the board as well as provide a foot-rest for the operators.

This equipment, which has been recently installed at Neepawa, places the municipality in position to connect the subscribers that have been awaiting the increase of the plant for their connection.

The municipality, at the present time, has in operation about 180 subscribers, which shows one instrument for less than every nine inhabitants, notwithstanding the fact that the Bell Company has made strong efforts to regain that field.

The Bell Company, although having the advantage of offering long distance connection with Winnipeg and throughout the North-West, have only seven subscribers remaining in their exchange. This is certainly another good example of the great benefits of the independent competitive telephone service, and well demonstrates what may be done in every city, town, village, hamlet and in rural districts throughout the Dominion.

FRAZIL ICE.

Editor Canadian Engineer:

Sir,—In your February issue Prof. Barnes commends the Toronto Engineers' Club for delving into the mysteries of frazil ice, but without fully concurring in the theories advanced.

We can all agree with Prof. Barnes upon the importance of the subject. My own investigations lead to the conclusion that further subdivisions in the names are necessary before a clear discussion of the subject can be carried on or a clear conception of the matter be entertained. We have, first, water at an ordinary temperature; then there is water that is just about to freeze. Prof. Barnes states that the 1-100 part of a degree of frost separates the water from being ice.

The word frazil no doubt comes from the French word "fraiche," meaning cool, new, recent. The word would equally well apply to water, and frazil water would represent that water which is separated from being ice by a fraction of a degree or by degrees of motion. Then there can be named what I would call eight different kinds of ice, viz.:—

1. Ordinary ice formed in still water, named surface ice.
2. Frazil ice, being ice formed by shock or change of motion (lowering).
3. Then anchor ice, which is a formation from frazil ice, accumulating on obstructions below the surface of the water.
4. Spray ice, which is from water that is thrown in the air in the form of spray, becoming thoroughly charged with cold air, and freezing instantly from shock upon landing upon any object.
5. Float ice, which consists of pieces of ordinary ice broken in fragments of various sizes.
6. Sponge ice, which is an accumulation of frazil ice in a forebay, or such a place, or partially dissolved anchor ice, or partially dissolved float ice.
7. Ice that is formed by successive increments caused by raising the water level above the top of the surface ice already formed there, or forming from wave action of water

flowing over ice already formed. This ice could well be named layer ice.

8. An accumulation of increments of frazil, float or sponge ice upon the underside of surface ice. This could well be named canker ice.

Nos. 5 and 6 are easily controlled, since they are prone to float near the surface, and can be trained past an intake by glance booms.

No. 4 is in the usual instance of a water-fall or precipitous rapids, only controllable by elimination of the sudden changes in fall or sudden changes of course of the water.

No. 7 is hard to control, but an extremely wide raceway, with vertical sides, or an extremely narrow one, are an aid. In the one case the ice cannot hang, but drops up and down, floating with each change in elevation of the surface of the water. In the other case it arches.

No. 8 gives trouble in the St. Lawrence river and such places, where surface ice and strong currents and rapids are present.

No. 2. This is the ice that gives the trouble. It cannot be kept away from a screen, because it may be only water before it touches the screen. The water that gets past the bars of intake screen without sufficient change (lowering) of motion to turn it into ice will strike the wheel, and turn to ice at that point.

With two kinds of water and eight kinds of ice, the peck of troubles of a water-power user should be full. I have added nothing to his troubles, however, and if they can be simmered down to frazil ice, and the conditions governing frazil ice can be agreed upon, then the way to a remedy will be found. The best way in my view is to seek hub marks upon which agreement may be found.

Prof. Barnes disagrees with the definition that "frazil ice is water just ready to freeze, but prevented from so doing by motion, the action of freezing taking place when the rate of motion is lowered," and says it is contrary to all the known laws of ice formation. The only criticism I would make to this statement is that the laws of ice formation are not known. When a pail of water is placed out doors on a cold day, and after a certain period of time one should suddenly shock that water by a blow, then ice crystals will form. According to Prof. Barnes, it is the motion imparted to the water that caused the formation of the crystals.

According to the view developed at the meeting of the Engineers' Club it would be the circulation of the water, which we know must be taking place in a liquid that has one surface exposed to a low temperature, being suddenly stopped by shock, that caused the formation of the crystals. In a similar manner the frazil ice will form from frazil water when the degree of motion to correspond with the prevailing temperature of the frazil water is not maintained. As an aid to plant hubs or milestones on this question I would propose the following for adoption or rejection, viz.:

a. That night-time is more often the time when trouble with frazil ice occurs.

b. That cloudy days are also conducive to trouble.

c. That with an unclouded sun no trouble ever occurs.

d. That frazil ice will not cause trouble when the reservoir or river is frozen over, excepting in the case of very rapid streams.

e. That piers in the reservoir, extending to the surface of the water booms or other devices tending to assist the formation of surface ice are an advantage.

f. That frazil ice will form in slight currents when the water is at a half degree below freezing point.

g. That frazil ice will form in strong currents at any temperature.

h. That the degree of frost at which frazil ice forms is proportioned to the velocity of the current.

i. That frazil ice never forms in quiescent water.

j. That agitation of a lake or pond by winds is analogous to the flow of the stream, and will cause the formation of frazil ice.

k. That the thickness of the particles or crystals is in some proportion to the temperature of the water at which it formed, which temperature is again determined by the velocity of the stream.

l. That the greater the depth of intake the greater assurance of freedom from frazil ice, forty feet being considered a safe depth.

m. That in a strong current the temperature of the water at all depths is practically uniform, and frazil ice will form as readily at one portion of that depth as at another.

n. That in a lake or pond the frazil ice will form only in the upper layers, where agitation occurs from wind, and the greater the degree of cold at which frazil ice forms the thicker will be the particles, and the stronger will be a necessary suction to draw them to a given depth; thus, an intake crib with a strong suction will suffer from frazil ice at any degree of temperature below freezing and any degree of agitation of the water, while a weak suction will suffer only at moderate or slight degrees of frost, with slight agitation of the water.

o. The stronger the suction the greater should be the depth of the intake below the surface to insure freedom from frazil ice.

p. In a river the greater the velocity of the current the greater should be the depth of the intake below the surface to ensure freedom from frazil ice.

q. Is more trouble encountered early in the season before cold weather has become settled, or vice versa?

r. Is the trouble which is often encountered after a thaw, caused by frazil ice or by freed anchor ice?

s. The ice that forms on intake bars is frazil ice.

t. The ice that sticks to wheels is frazil ice.

u. The ice that sticks to any obstruction below surface of water is frazil ice, an accumulation of which is called anchor ice.

John S. Fielding.

Toronto, Feb. 22, 1905.

* * *

MOTOR BOATS.

Editor Canadian Engineer:

Sir,—We notice in the February number of the Canadian Engineer an item stating that the Canada Launch and Engine Works is the only firm in Canada which builds complete motor boats. We beg to say that we are building complete outfits, and are prepared to design and build motor boats of any kind in either wood or steel, for any purpose, to run at any speed that any other firm can, and we will equip them with either two or four-cycle gasoline engines of from one to four cylinders. We build these engines and boats ourselves, so that you will see that there is more than one firm in Canada building complete motor boats.

Georgian Bay Engineering Works,
G. W. Thexton, Manager.

Midland, 18th Feb., 1905.

* * *

THE METRIC SYSTEM OF MEASURES.

Editor Canadian Engineer:

Sir,—In a recent issue of the Canadian Engineer there appeared a letter by F. A. Halsey attacking the metric system, but containing so many errors that they should not be allowed to pass without correction.

The first point regards the number of countries which have up to date adopted the metric system. The extravagant language used by Mr. Halsey in this connection may be passed over without notice, but the criticisms, while neither new nor true, deserve answer, lest the uninformed might be misled to think the metric system had not been adopted in the larger portion of the world. It is of little consequence to know the exact number of countries which have adopted this system, but the fact remains that upwards of forty countries have done so, comprising a population of over 480,000,000. This statement may be verified by consulting the "Reports of Her Majesty's Representatives Abroad," made upon the official request of the Prime Minister of Great Britain "for information as to the actual experience of nations which have adopted the metric system." These reports were presented to both Houses of Parliament by command of His Majesty, February, 1901. These reports contain authoritative statements of great interest upon (1) the ease or difficulty with which the system was adopted; (2) the satisfaction attending its adoption, and (3) the commercial effect attending its adoption, and contain full and convincing testimony in refutation of the statements made by the critic referred to. Of Austria the report says: "The system has now been in compulsory use for twenty-four years, and may be said to give complete satisfaction. Not the smallest desire is evinced in any quarter to revert to the old and more cumbersome method." Of Belgium: "It may be safely stated that if an effort were made to return to the old weights and measures, the attempt would meet with more resistance and encounter greater difficulties than it was ever necessary to overcome in order to establish the system now in force." In Switzerland: "The Federal Government state that they can confidently affirm that the metric system has in every respect proved satisfactory." "All over the Netherlands at the present time no other system than the metric system of weights and measures is in use; the old weights and measures which have been abolished have everywhere disappeared" "The introduction of the metric system into Norway has been hailed by the commercial classes with much satisfaction." These are a few examples of the abundant evidence which can be cited to show the error of Mr. Halsey's statement that "there is not the slightest pretext that it is in common use in trade and commerce."

The claim that the laws in the countries which have adopted the metric system are not enforced so that all other units are excluded, scarcely needs a reply, for few, indeed, have been the laws which have not been broken. It is noteworthy, however, that it is only in those countries where the general intelligence is low that any particular difficulty has been encountered in the enforcement of the law. The consensus of opinion in those countries where the system is compulsory is one of complete satisfaction, and this is emphasized by the fact that nowhere is there any desire to return to the old system. Monsieur Chalon, an eminent French engineer, has "repudiated forcibly the objection made by Americans to the adoption of the metric system, based upon the pretended persistance of the old measures in France. He remarked that this objection, which had made a great impression in the United States, and which the enemies of the metric system had spread abroad through the medium of the press, was untrue, and even ridiculous. He demonstrated by numerous examples that the old names which persist in France, were not the old measures; they were simply popular expressions, habitually used to express certain metric and decimal divisions." (Minutes of the Proceedings of the Sociéte des Ingenieurs Civils de France, May 1, 1903.) With the younger generations the old names fall more and more into disuse.

Mr. Halsey says: "Nowhere has the system been adopted by any people except under compulsion." One might infer from this that legislatures the world over, unmindful of the good of their countries, had forced some pernicious law upon the people. Legislation would be meaningless if the power of enforcement were lacking, and whatever compulsion there is in the law has been placed there voluntarily by the people. The Constitution of the United States is a list of the powers which the people ceded to the National Government. Among these is expressly included the duty "to fix the standard of weights and measures." That arbitrary individual initiative has but little place in matters of such general concern as weights and measures has long been recognized by intelligent classes in all countries. It is only by governmental action that a uniform system applicable to a whole nation can be secured. But let it be noted that not until the common people had secured adequate representation in the National Assembly did France secure a uniform system of weights and measures, and the first step taken was to refer the formulation of such a system to a corps of scientific men and practical engineers, whose proposals, made after the most careful deliberation, were enthusiastically accepted. If this was "compulsion," it was of the same order as the compulsion which is at the base of every act ever enacted by a free people. The previous confusion in weights and measures had shown the folly of allowing each little district to set up its own arbitrary or local standards.

The time for ridiculing the metric system has long passed by, but what a perversion of logic it is to say that the metric system has received a "staggering blow" because a people demand its use in places where up to this time it has not been compulsory! On the contrary, a demand for more stringent legislation emphatically stamps the metric system with approval. The metric system has been repeatedly endorsed by congresses of textile manufacturers in Europe, including the International Congress for the Unification of the Numbering of Yarns at Paris in 1901, at which sixteen leading nations of the world, including the United States and Great Britain, were officially represented. The Yarn Tables, issued by McLennan, Blair & Co., large yarn merchants of Glasgow, states that "The metric system of weights and measures is so near perfect, and has been adopted so widely that it forms the most suitable basis for a uniform system of counts of yarns." The secretary of the National Association of Wool Manufacturers, now Director of the Census, in his last annual report emphatically urges the adoption of the metric system, stating that "it would seem to be the duty of all intelligent manufacturers to urge and encourage that legislation." The Lowell Textile School, which is in close touch with the textile industry of New England, has adopted the metric system by direct vote of its trustees, two-thirds of whom are active textile manufacturers.

Neither can Mr. Halsey gain anything by belittling the scientific men for championing the metric system. It is absolutely incorrect to say that "scientific men are measurers, not makers." Did not James Watt, a scientific man, construct the model of the first successful steam engine? It might be added that Watt also advocated an international decimal system of weights and measures involving the very principles which ten years later were actually embodied in the metric system. Did not Michael Faraday, one of the greatest scientists of England, actually construct the model which resulted in the electric motor? Did not Professor Henry, another scientific man, actually construct the working model of the electric dynamo? The thousands of successful engineers whom our schools of science have taught how to apply the best scientific methods to practical work will resent the statement of Mr. Halsey.

Lord Kelvin, who designed and constructed the mirror galvanometer, which made the Atlantic cable a success for the first time, who has designed the practical details of scores of practical measuring instruments, and who is a scientist certainly well qualified to render an opinion upon this subject, has said: "I do not think we could do better practically than take the French metrical system as it is; and it is admirably convenient just as we have it now. No change has been suggested that would better it."

From Mr. Halsey's point of view "the crux of the whole matter" centres in the effect upon the machine shop. This is, of course, an important consideration; but the permanent advantages of the metric system have been shown here as elsewhere to be worth whatever temporary inconvenience might be occasioned by the change. There are several large shops in the United States in which the metric system is now being used with perfect satisfaction. The adoption of a standard screw thread is entirely apart from the general question, although it has long been the aim of the anti-metric conservatives to concentrate their fire upon this irrelevant subject in order to divert attention from the real issue. But this is a matter, as is frequently the case in treaties made between countries, which can be left to subsequent diplomacy while the major benefits are immediately secured. The preponderating Anglo-Saxon influence in the machine tool industry has until now delayed somewhat the change in this matter, even in countries which are otherwise on a metric basis. The action of the German engineers last July to which Mr. Halsey refers, though but a half-way measure, is significant as an effort to get on to a metric basis. It remains to be seen in how far the new thread is adopted, for there is nothing "compulsory" about it. The adoption of an international screw thread system must ultimately come, because international uniformity is necessary, and not because any particular system of weights and measures is used. And it will not come by Act of Parliament, but by concerted action in international technical congresses, which will also effect the standardization of many other things of importance in mechanical work. The adoption of the metric system need no more affect the present trade sizes than it would affect the size of a shop in which the articles are manufactured. The alteration of the system of longitude did not affect the position of the cities upon the earth's surface, although it did require the restatement of their position, but the advantages of a single universal standard of longitude and time were found to easily compensate for the temporary inconvenience of the transition period.

In a footnote to Mr. Halsey's article the incorrect statement is made that "the (metric) system is not required in governmental or any other transactions" (in the United States). Numerous governmental actions show that Mr. Halsey was uninformed on this point.

First. The foreign postage rates of the United States are fixed in terms of the metric system, fifteen grams being sent to all countries in the postal union for five cents.

Second. The subsidiary silver coinage is made in accordance with the units of the metric system. (Revised Statutes, Sec. 3513.)

Third. The metric system is obligatory in all transactions, sales and contracts in Porto Rico. (Action of March 18, 1899, containing the statement "that wholesale and retail mercantile establishments shall sell their goods to the public conformable to the metric system.")

Fourth. The metric system is required in the Philippine Islands. (Act September 17, 1901, Sec. 9, Philippine Tariff.)

Fifth. In the United States army since January 1, 1895, the use of the metric system has been required in all work of the medical and surgical department.

Since April 27, 1878, the officers of the Marine Hospital Service for all official, medical and pharmacal purposes have been required to "use the metric system of weights and measures."

Regarding the opposition to the metric system, it is of the usual kind which obstructs any forward movement. The plea of *laissez faire* is easily raised, and proves nothing but the apathy of human nature. The organizations mentioned as opposing the system are more than balanced by the overwhelming sentiment in favor of the change which prevails among those who have actually studied the matter or come into active touch with the system.. But as a matter of fact the adverse actions which Mr. Halsey enumerates were taken without proper consideration of the merits of the system and a misconstruction of the purport of the bill favorably reported by the Congressional Committee. Manufacturers have been made to believe that they would be compelled to change their patterns, drawings and machines, and that the change would come upon them all at once. The truth of the matter is that no manufacturer can be compelled to do these things, nor does the Act now before Congress contemplate anything of the kind. Every manufacturer can continue along his present practice until he desires to make a change. When he makes new patterns and drawings he will naturally make them in the metric system, and without extra cost.

It is interesting to note that the American Machinist, a representative paper of the machine trade in the United States, has limited its columns to expression of opinion from those only who have had actual experience in the use of both systems, and the consensus of these opinions as expressed within the past year is nearly unanimous in favor of the metric system. This expression of opinion of those who are best in position to know should outweigh the conservatism of those who are unfamiliar with the system in their actual experience. The active opponents of the metric system in the United States are few. They appear not to see that we are really in the transition period which they had viewed with apprehension. It is not a question of introducing the metric system, which is already here, but whether we shall continue to maintain side by side two systems: one a cumbersome work of mediæval times; the other, an international system of maximum simplicity and efficiency.

Respectfully,

Albert S. Merrill,
Mechanical Engineer.

Member American Metrological Society, Washington, D.C., Feb., 1905.

THE STEEL HARDENING METALS.*

There are included, under the head of steel-hardening metals, nickel and cobalt, chromium, tungsten, molybdenum, vanadium, titanium, and uranium, which are named in the order of the importance of their production and use for steel-hardening purposes. These metals are not added to the steel to cause chemical reactions to take place, by which harmful ingredients are made to go into the slag or to pass off as gases, as is the case in the use of ferrosilicon or ferromanganese (spiegeleisen), which are added to the furnace in the original manufacture of the steel. These other ferro alloys are not added until after the steel has been manufactured, and their use is as a physical addition to the manufactured steel for the physical benefits that they confer upon it, and hence they accomplish their purpose in a manner entirely different from that of the ferrosilicon or ferromanganese.

Some of the metals, as nickel, chromium, and tungsten, are now entirely beyond the experimental stage and are well established in the commercial world as definite steel-hardening metals, and new uses are being constantly devised for the different steels, which are causing a constant increase in their production. Others, as molybdenum and vanadium, although they have been proved to give certain positive values to steel, have not been utilized to any large extent as yet in the manufacture of molybdenum or vanadium steel, partly on account of the cost of the ores containing these metals. Titanium and uranium are still in the experimental stage; and, although a good deal has been written as to the value of titanium as an alloy with steel, there is at the present time very little if any of it used in the manufacture of a commercial steel.

Since the introduction of the electric furnace and the consequent methods that have been devised for reducing ores, it has become possible to obtain these ferro alloys directly from the ores by reducing them in the electric furnace, and hence experiments have been conducted on a much larger scale than formerly.

The prices of the various ferro alloys vary considerably. Ferrochrome in December, 1903, was quoted at $120 to $225 per ton of 2,240 pounds; cost, insurance and freight, New York, on the basis of 60 per cent., with variations up and down at $1.75 per unit. Ferrotungsten was quoted at 40 cents per pound, or $896 per ton, on 100 per cent., cost, insurance and freight, New York. Ferrovanadium was quoted at $7.50 per to $2.50 per pound, or $3,360 to $5,600 per ton, on 100 per cent., cost, insurance and freight, New York; in May, 1904, this had dropped to $1.25 per pound on 100 per cent., cost, insurance and freight, New York. Ferrovanadium was quoted at $7.50 per pound, or $16,800 per ton, on 100 per cent., in the English market, and $6.40 per pound in the French market; for ton lots the price has been quoted as low as $4.50 per pound. Ferromanganese has, during the last two or three years, been very steady, and on contract, 100-ton lots and over, was quoted at $50 per ton, duty paid, with freight paid east of the Mississippi River. In May, 1904, this price had dropped to $44 per ton. Ferro-nickel alloy and metallic nickel vary from 50 to 56 cents per pound for the nickel content.

Besides the use of ferromanganese for the chemical effect which it produces in the manufacture of steel in eliminating injurious substances, it is also used in the production of a special steel which possesses to a considerable degree combined hardness and toughness. Such steel contains from 0.8 to 1¼ per cent. of carbon and about 12 per cent. of manganese, and is known as "Hadfield manganese steel." If only 1.5 per cent. of

*The Bulletin of the American Iron and Steel Association, December 10th, 1904.

manganese is added, the steel is very brittle, and the further addition increases this brittleness until the quantity of manganese has reached 4 to 5.5 per cent. when the steel can be pulverized under the hammer. With a further increase, however, of the quantity of manganese, the steel becomes ductile and very hard, reaching its maximum degree of these qualities with 12 per cent. of manganese. The ductility of the steel is brought out by sudden cooling, a process the opposite of that used for carbon steel. These properties of manganese steel make it especially adapted for use in the manufacture of rock--crushing machinery, safes and mine car wheels.

Nickel finds its largest use in the manufacture of special nickel and nickel-chromium steels, and the use of these steels for various purposes in the arts is constantly increasing. The greatest quantity of nickel steel is used in the manufacture of armor plate, either with or without the addition of chromium. There is probably no armor or protective-deck plate made which does not contain from 3 up to 5 per cent. of nickel. Nickel steel is also used for the manufacture of ammunition hoists, communication tubes and turrets on battleships, and for gun shields and armor.

The properties of nickel steel, or nickel-chromium steel, that make it especially adapted for these purposes, are its hardness and great tensile strength, combined with great ductility and a very high limit of elasticity. One of the strongest points in favor of a nickel-steel armor plate is that when it is perforated by a projectile it does not crack. The Krupp steel, which represents in composition about the universal armor-plate steel, contains, approximately, 3.5 per cent. of nickel, 1.5 per cent. of chromium and 0.25 per cent. of carbon.

Another use for nickel steel that is gradually increasing is the manufacture of nickel-steel rails. During 1903 there were over 11,000 tons of these rails manufactured, which were used by the Pennsylvania, the Baltimore & Ohio, the New York Central, the Bessemer & Lake Erie, the Erie, and the Chesapeake & Ohio railroads. These orders for nickel-steel rails resulted from the comparison of nickel-steel and carbon-steel rails in their resistance to wear during the five-months' trial of the nickel-steel rails that were used on the horsehoe curve of the Pennsylvania Railroad. The advantages that are claimed for the nickel-steel rail are its increased resistance to abrasion and its higher elastic limit, which increases the value of the rail as a girder. On sharp curves it has been estimated that a nickel-steel rail will outlast four ordinary rails.

Nickel steel has also been largely adopted for forgings in large engines, particularly marine engines, and it is understood that this is now the standard material for this purpose in the United States navy. There is a very great variety of these forgings and drop forgings which include the axles and certain other parts of automobiles, shafting and crank shafts for Government and merchant-marine engines and stationary engines, for locomotive forgings, the last including axles, connecting rods, piston rods, crank pins, link pins, and pedestal cap bolts, and for sea-water pumps.

Another important application that is being tried with nickel steel is the manufacture of wire cables, and during the last year such cables have been made by the American Steel and Wire Company, but no comparison can as yet be made between them and the ordinary carbon-steel cables with respect to their wearing qualities. In the manufacture of electrical apparatus nickel steel is beginning to be used in considerable quantity. The properties of this steel which make it especially valuable for such uses are, first, its high tensile strength and elastic limit, and second, its high permeability at high inductions. For rock drills and other rock-working machinery nickel steel is used in the manufacture of the forgings, which are subjected to repeated and violent shocks. The nickel content of the steel used in these forgings is approximately 3 per cent., with about 0.40 per cent. of carbon. The rock drills or bits are made for the most part of ordinary crucible cast steel, which has been hardened and tempered. A nickel-chrome steel is now being made, which is used to some extent in the manufacture of tools.

Nickel steel in the form of wire has been used quite extensively and for many purposes—for wet mines, torpedo-defense netting, electric-lamp wire, umbrella wire, corset wire, etc.—where a non-corrosive wire is especially desired. When a low coefficient of expansion is desired—as in the manufacture of armored glass, in the mounting of lenses, mirrors, level tubes, balances for clocks, weighing machines, etc.—nickel steel gives good satisfaction. For special springs, both in the form of wire and flats, a high carbon nickel steel has been introduced to a considerable extent. Nickel steel is also being used in the manufacture of dies and shoes for stamp mills, for cutlery, tableware, harness mountings, etc.

Nickel steels containing from 25 to 30 per cent. nickel are used abroad to some considerable extent for boiler and condenser tubes and are now being introduced into this country. The striking characteristic of these steels is their resistance to corrosion, either by fresh, salt or acid waters, by heat and by superheated steam. In addition to marine boilers, high nickel-steel tubes can be used to advantage for stationary boilers, automobile boilers and locomotive safe ends.

The largest use of chromium is in the manufacture of a ferro-chromium alloy which is used in the manufacture of chrome steel. In the manufacture of armor plate ferro-chrome plays a very important part, and, although it is sometimes used alone for giving hardness and toughness to the armor plate, it is more commonly used in combination with nickel, making a nickel-chromium steel armor plate. Other uses of chrome steel are in connection with five-ply welded chrome steel and iron plates for burglar-proof vaults, safes, etc., and for castings that are to be subjected to unusually severe service, such as battery shoes and dies, wearing plates for stone crushers, etc. A higher chromium steel, which is free from manganese will resist oxidation and the corrosive action of steam, fire, water, etc., to a considerable extent, and these properties make it valuable in the manufacture of boiler tubes. Chromium steel is also used to some extent as a tool steel, but for high-speed tools it is being largely replaced by tungsten steel, which seems to be especially adapted to this purpose.

Ferrochromium is made in an electric furnace and is produced directly from the ore. In the United States the company producing the largest quantity of ferrochromium is the Willson Aluminum Company, whose electric furnaces are located at Kanawha Falls, W. Va. Besides the manufacture of ferrochromium this company also makes ferrotungsten, ferromolybdenum, ferrosilicon, ferrovanadium and ferrotitanium. The company obtains its chief supply of chrome ores from the Daghardi mines, in Asia Minor, and the Thiebargi mines in New Caledonia. Ferrochromium has also been made by the Willson Aluminum Company from the chromium ores from the Black Lake District, Quebec.

The Willson Aluminum Company has been supplying the ferrochromium used by the Bethlehem and the Carnegie steel companies for the armor plates which these companies have manufactured.

The demand for tungsten ores for use in the manufacture of ferrotungsten to be used in the manufacture of tungsten steel continues to increase, especially from abroad. Tungsten steel is used to some extent, more generally abroad than in the United States, in the manufacture of armor plate and armor-piercing projectiles. For this purpose it is used in combination either with nickel or chromium, or with both of these metals. The use for which tungsten steel seeems to be best adapted is in the manufacture of high-speed tools and magnet steels. There is considerable variation of opinion as to the value of tungsten in the manufacture of armor plate.

The use of molybdenum steel continues to increase, and hence there is an increasing demand for the ores of this metal. The main use of ferromolybdenum is in the manufacture of tool steel.

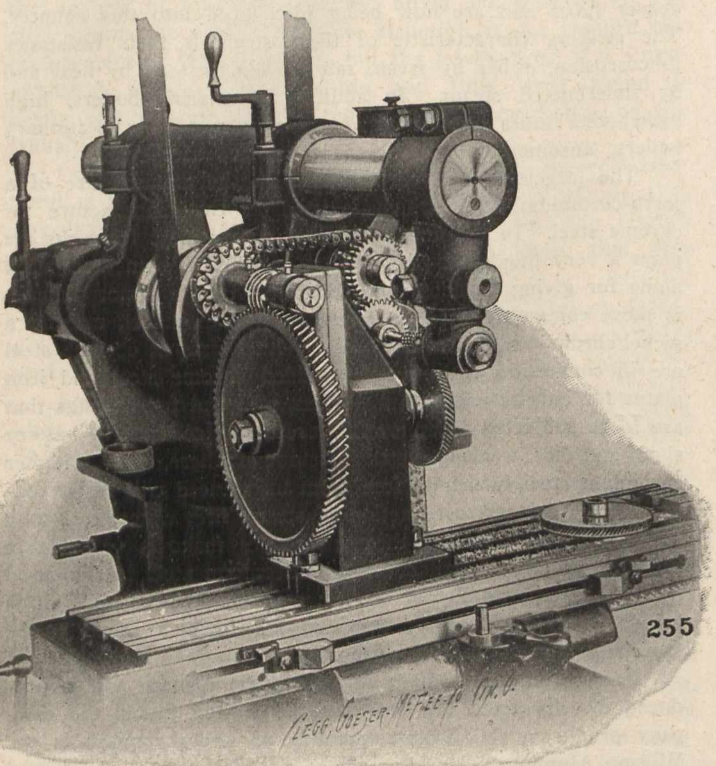
MACHINE SHOP NOTES FROM THE STATES.

By Charles S. Gingrich, M.E.

XIII.

The manufacture of cream separators has grown to be a special industry of considerable proportions, there being a great many large shops devoted entirely to their manufacture. The development of the industry carried with it a great many special tools and processes adapted to these particular requirements.

Nearly all cream separators employ as part of their speed-accelerating mechanism a set of worm gearing; and the economic manufacture of the worms and worm wheels has, perhaps, formed the most serious problem. The tool that came nearest to meeting the requirements was the small Universal Miller; and this has done very well on the worms, but was hardly adapted to the economic manufacture of worm wheels without the use of special appliances. One of the latest of these is shown in the illustration. It is a worm hobbing attachment, made up especially for automatically hobbing cream separator worm wheels, and is shown mounted on a No. 1½ Cincinnati Universal Miller, and in operation on this work.



The worm wheel is approximately 5⅞ in. diameter, has 87 teeth, and the actual milling is done in less than two minutes on each wheel. The chucking requires about a minute, so that this piece of work, which formerly required about an hour's time, is now done very much better in about three minutes.

The attachment is very simple in construction, and can readily be adapted to cutting any size of worm wheels within the capacity of the miller.

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Montreal is to have the first turbine power plant to be erected in Canada. The contract for the steel work, requiring 3,000 tons of steel, has been awarded to the Dominion Bridge Co., and for the boilers to Babcock & Wilcox. The cost will be $1,000,000.

The firm of Morris, Baird & Co., Victoria, B.C., and Port Renfrew, Vancouver, has commenced to manufacture writing inks, metal polish and blueing. The company owns a deposit of tripoli of excellent quality at Port Renfrew. This material forms the basis of all the best metal polishes on the market.

The Manitoba Iron Works, Limited, of Winnipeg, have under construction in their boiler shops at Winnipeg the largest tubular boiler ever seen west of Lake Superior. It is 7 feet in diameter, 18 feet long, 9-16 of an inch thick in shell, with ⅝ in. heads, double butt stop joints, quadruple riveted with eight rows of rivets, and 106 4-inch tubes, with manhole in end under the tubes. It is guaranteed for a working pressure of 140 lbs. per square inch. It is an indication of the advance of manufacture in the West that a boiler of this size can be turned out of a Winnipeg shop, where all the work was done, including the flanging of the heads and manholes.