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THE

Canadian Engineer

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The Canadian Engineer

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The Canadian Engineer.

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

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BIGGAR-SAMUEL, Limited, Publishers,

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

CONTENTS OF THIS NUMBER.

THE "CANADIAN MACHINE SHOP."

As announced in last issue, the publishers of the Canadian Engineer will issue this month a new magazine, the CANADIAN MACHINE SHOP, devoted to machine shop practice, mechanical engineering, and foundry work. An announcement is made elsewhere to those who wish to become charter subscribers. Charter subscribers are those who start with the first number of the first volume, and while these remain as paid-up subscribers, they will continue to receive the paper at 50 cents a year. Subscribers of the Canadian Engineer who wish to take both papers will be put on practically the same basis by getting the two papers for $1.50 as long as they are paid in advance. If anyone should wish to transfer his subscription to the Canadian Machine Shop only, he should advise us at once.

PUBLIC OWNERSHIP OF PUBLIC FRANCHISES.

A special correspondent of the Canadian Engineer gives elsewhere some instructive facts concerning the evolution of the municipal ownership of civic franchises at Port Arthur and Fort William. There appears to be in the conduct of municipal affairs in these "twin towns," something of the spirit which has made Glasgow famous among the great cities of the age for the integrity and wisdom of its administration. The citizens of Port Arthur and Fort William have only to maintain their public spirit and courage in order to give them as great a name for good government as they seem destined to have for commercial success and influence. A good name is rather to be chosen than great riches. The proverb is unfortunately not often enough demonstrated in public affairs to make it a mere truism; but there is nothing more certain than that a character for honor and honesty ultimately brings wealth if its possessor has the genuine article. Port Arthur and Fort William are therefore not only doing a great educational work for the other cities of the Dominion in showing that municipal ownership can be efficient and economical, but they are laying the very best foundation for their future power and wealth as commercial or manufacturing cities. They have created at no cost to themselves—except for plant—franchises, which in a day fast approaching will be worth millions. They own their own electric lighting plants, telephone systems, water-works, and street railway, and if their courage is equal to their present opportunity, they will acquire and control the power transmission line now projected from Kakabeka Falls, a power which in the near future will give them a vast opportunity for industrial expansion under the freest conditions.

Many students of municipal politics while admiring the courage and sound moral tone of administration of these towns hesitate to put the principle into practice for fear of corrupt influences in the application of municipal ownership to their own place. They are impressed with the argument of those advocates of private corporation ownership who sincerely believe that a private water-works, railway, or electric light company, whose business is conducted on business lines is safer for the public than such works under the control of aldermen of doubtful integrity. But is this a complete view of the case, and does it touch the principle on which local self-government is founded?

It will be admitted that employees of private corporations are just as apt to be dishonest as those in the service of municipalities, and, as we know, have just as frequent opportunities of being unfaithful to those they serve. And all the loss caused by the dishonest or extravagant administration of private companies falls ultimately upon the citizens out of whose pockets the revenue is derived, whether privately or publicly owned. All loss through dishonesty comes out of the citizens in any case, whereas the gain from good economy is not shared by the citizens generally, but goes into the pockets of a few shareholders, under private ownership, and some of these shareholders are often not even residents of the city from which they draw their dividends. Under municipal ownership a city or town gets just the government it deserves, and it has its destiny in its own hands. If its people are in the main honest and enterprising, they will put good men in control; if they are careless or lacking in public spirit or honor, they will get their reward, and the more certainly and more directly they reap what they sow the better for their descendants. The abnegation of their privileges, and prerogatives and the giving up of self-control in favor of private corporations, are, when analyzed down to their first elements, a cowardly shirking of the responsibilities of citizenship, and a hiding behind the skirts of private corporations who can be blamed when things go wrong. Corrupt aldermen and extravagant civic rule are the direct distillation of apathetic citizenship, and a low conception of responsibility to neighbors; and the citizens who put ignorant and corrupt men to rule over them can be just as sure that their representatives will carry on evil practices of as costly and disreputable a nature through the medium of private corporations as where the city itself is the victim of spoil. There is this great difference in favor of municipal ownership: corruption is not an incurable disease, it can be remedied by heroic treatment under public ownership in a single year, whereas under private ownership it may linger for a generation. Not only so, but, what is still more to be deplored, a corrupt body of aldermen may fasten upon a town or city, under private corporate rule, shackles which a century of repentant, watchful effort cannot break.

Gentlemen who hold civic franchises should not be set down as thieves and plunderers. They are men who, as a rule, want to earn honestly a dividend on their capital, and are in many cases men of immeasurably higher character than the stamp of men which a careless electorate set up to tempt them by sinister means from doing full justice to the public. The point is that utilities of a public nature such as water-works, sewage, lighting, telephones, street railways, etc., affecting public health, transportation and communication, should be directly controlled by the citizens whose interests they affect. They are in their very nature a public trust, and responsibility for their administration is not at an end because they are given into private hands.

* * *

—Montreal at the opening of the present century is an instructive example of what a city may have to pay through giving up its franchises to private control. No important city on the whole continent is more favorably situated for the application of cheap electric power to its various public needs and to the development of its industries, and yet the prices it pays for its public and private lighting, and other civic services are higher than in many cities of Canada and the States that are a thousand miles from a coal mine and have no hydro-electric power. For many classes of power, owners of factories in Montreal pay double the rates charged in Toronto where power is generated by steam. In a vain endeavor to get effective competition and cheap rates, encouragement has been given in the past to private companies, but one after another opponents have been absorbed by capitalists and manipulators who influence the legislation of the province as well as the city, and the result is that Montreal is a city of 300,000 where it might be a city of 900,000 if its natural advantages were administered for the benefit of its citizens and manufacturers instead of for the benefit of a handful of capitalists. The Montreal, Light, Heat & Power Co., which now owns the 100,000 electric horse-power at present available for transmission to Montreal, has total nominal assets of over $26,810,000, inclusive of its capital stock of $17,000,000. It owns the Montreal Gas Co., the Royal Electric Co., the Montreal and St. Lawrence Light & Power Co., the Imperial Electric Light Co., the Lachine Rapids Hydraulic and Land Co., the Standard Light & Power Co., the Citizens Light & Power Co., and the Temple Electric Co., all absorbed successively in the last ten or fifteen years. Just how much money was spent in the process, or how much water is in the present aggregate capital it is impossible to say, but that it is a large amount is self-evident from the fact that even with the economy of management achieved by the present single control, it is impossible for the company to pay dividends on its expanded stock without charging the citizens and manufacturers such rates for power and light as have driven numbers of them to supplying their own light and generating their own power by steam. There are now fourteen companies and private firms that have recently gone to the expense of erecting their own lighting and power plants, and in eight of these cases it is simply because the cost of maintenance and the interest on the investment, though expensive items, would still be less expensive than paying the rates charged by the big company which controls the city's public power and lighting. When the present syndicate was formed one of the baits held out to the city was that by the reduced expenses and the economy of administration incident to the amalgamation, the citizens would benefit by reduced rates, but the contrary has been the result. No sooner was the syndicate fairly seated in power than by a readjustment of schedules, the company made an increase of 25 or 30 per cent. in lighting rates; and for power there appears to be no publicly understood schedule, but customers are charged according to their ability to pay, or on the plan of getting "all that the traffic will bear." In reviewing the history of privately owned franchises in Montreal, and in estimating what the city will have to pay when it assumes its self-control some day, it is hard to imagine a reign of extravagance under public ownership that would be more costly to the people.

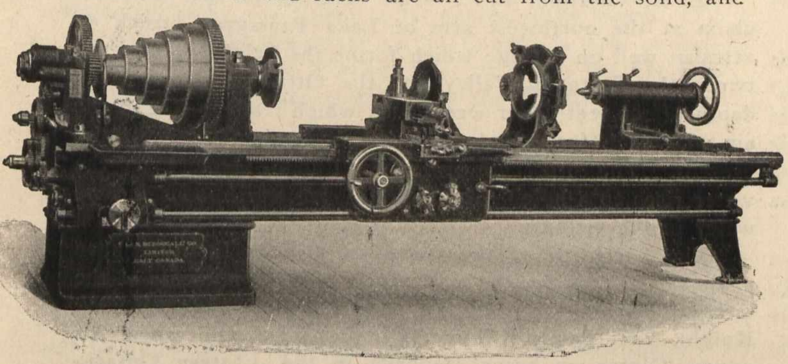
* * *

McDOUGALL 26-INCH ENGINE LATHE.

The lathe here illustrated is manufactured by the R. McDougall Co., Limited, Galt, Ont. It is made from new patterns throughout and shows exceptional points of strength where same are essential to rigidity while at same time combining a perfectly proportional appearance. The head stock is exceptionally heavy, carrying a spindle with hole to pass 2½-inch stock. The end play of the spindle is all taken up at the back end, and the bearings are all dust-proof and self-oiling. The cone has five steps for 3½-inch belt, and is of such size as to give about one-third more belt power than is the ordinary custom. The back gears are engaged and disengaged from the front end of the head stock without use of a wrench, and the gearing is well guarded to prevent accident to belts or operator. The tail stock is proportionally heavy and is made to reach over carriage and yet remain perfectly rigid. It is clamped to the bed by two heavy bolts, and the sleeve has also two handles to the clamping arrangement, thus facilitating rigidity. The bed is of ample strength, well bridged and is made either with inverted V-bearing for saddle or with box pattern square flat surfaces.

The carriage is very convenient and well arranged; the cross slide is extra heavy and is made to form a pan to catch water dropping from tool, and the droppings are discharged from the side into a trough which conveys drip through the centre of bed. The carriage is provided with a special dial and indicator, for the purpose of catching up the screw at any point when screw-cutting, obviating the necessity of reverse belt on countershaft and making the machine much more convenient to operate than has hitherto been the case. In screw-cutting the carriage may be run back rapidly, and the thread caught up at the right point by simply observing the dial, thus materially increasing the value of the machine for screw-cutting. The change gears are fastened on the end of the lead screw and the stud by nuts and split washers, which allow the gears to be changed without taking off the nuts. The compound rest is extra long and stiff, and can be set, for ordinary turning, parallel with the bed, as tail stock is designed to permit this, and in this position is well out of the way, and proves very useful in thread-cutting by enabling the tools, after regrinding, to be reset and tracked properly in the thread already roughed out. The rest is so constructed that with it a perfect ball may be turned.

The screws on both cross slide and compound rest are provided with dial reading one-hundredths and sixty-fourths. The rod feed is by a new arrangement, being driven direct from spindle, the motion being conveyed on inside of head stock through gears. The rod and screw are independent, and three quick changes of rod feed are effected by throwing a lever. The connection between spindle and carriage is by an adjustable friction clutch which forms a sure safety attachment. Gear and racks are all cut from the solid, and



all slides are scraped to surface plates. Follow rest and steady head of improved design together with necessary wrenches are included with machine. The countershaft is furnished with two speeds, having pulleys with a new friction clutch which has proved very effective. As it is not necessary to back up for screw-cutting, it will be seen that this arrangement gives 20 changes of speed on spindle.

Details.—12 foot bed; swing, 27-in.; between centres, 6-ft. 1-in.; cones, 5 steps for 3½-in. belt; smallest step, 6-in.; largest, 20-in.; ratio of back gears, 20 to 1; front bearing, 4½-in.; back bearing, 4-in.; hole through spindle, 2⅝-in.; tail stock spindle, 3½-in.; countershaft pulleys, 5½ by 20-in.; to run 140 and 200 revolutions per minute; weight, 8,000 lbs.; extra per foot, 200 lbs.

The workmanship on this machine will be found to be of the highest quality; all parts are given a close inspection while building, and each tool is given a rigid test before leaving the shop.

FRAZIL ICE.

A discussion upon this topic took place at the meeting of the Engineers' Club, Toronto, on December 8th.

John S. Fielding gave a review of available information and literature upon the subject, pointing out that recent investigations have separated frazil ice and anchor ice from the ordinary ice formed in still water, as a substance practically similar to ordinary ice, but formed under totally different conditions, and subject to some undetermined laws involving degrees of motion in combination with certain degrees of temperature. He instanced the Lachine Power Company's trouble with frazil ice at very low temperatures but rapid flow, and the Detroit waterworks trouble at one-half degree below freezing with slow motion of the water. He defined frazil ice as water at a temperature just ready to freeze, but prevented from so doing by motion; the action of freezing taking place when the degree of motion was lowered.

Cecil B. Smith gave an interesting description of the means adopted by the development companies at Niagara Falls to ensure freedom from trouble with anchor ice, and described the long submerged intake of the Toronto and Niagara Power Company in which the flow was not expected to exceed one foot per second.

K. L. Aitken gave an instance of a power plant at Bracebridge, where the winters are severe, which had not been troubled by frazil ice, giving as a reason that the forebay was large, and the movement of water to the turbines was at a low velocity, on account of there being but one turbine. He expressed the opinion that if another wheel was put in, trouble from frazil ice would likely ensue.

Messrs. Sutherland and Van Nostrand took up the question of the difference between frazil ice and anchor ice, developing the view that anchor ice is simply frazil ice that had accumulated upon an obstruction.

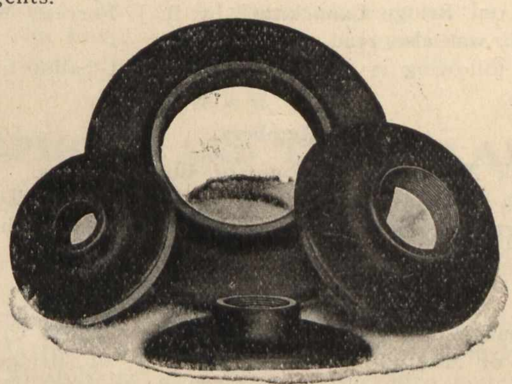
Prof. Meikle put forward an interesting theory as to the formation of frazil ice, comparing it to crystals that form in a jar of metals or alloys in solution when subjected to shock. This theory was taken up by Capt. Gamble, Mr. Van Nostrand and others, and was considered a distinct gain in the discussion.

The secretary, Willis Chipman, gave instances of means adopted at intake pipes for reversing the flow of water at intervals to clear the waterway of frazil ice.

Heating the bars of intake screens by means of electricity, steam or air and the employment of mechanical methods for removal of the ice were also discussed; the feeling of the meeting being, however, against such methods and in favor of research to determine the conditions under which the formation of frazil ice takes place.

FORGED STEEL FLANGES.

The greatest innovation in pipe work of recent years has been effected by the introduction of new forged flanges for spiral riveted pipe, manufactured by the American Spiral Pipe Works, for whom The Fairbanks Co. are Canadian sales agents.



By their use the difficulties which have heretofore hindered the use of flanged pipe have been overcome, enabling them to be riveted absolutely tight and securely to the pipe. All danger of breaking from rough handling in transportation, connecting, etc., is entirely eliminated.

These new forged steel pipe flanges, herewith illustrated,

for boiler work, are superior to anything yet produced, embodying as they do the many important features requisite for modern high pressure steam work. A heavy hub is forged on all screw flanges, and it is made of sufficient length to give a long perfect thread. The outside of the flange is finished with the proper bevel for caulking.

These flanges are furnished exceptionally smooth, thus insuring perfect contact when attached to work, and an inspection will satisfy the most fastidious that they are the best that can be made.

The threads of these flanges are tested with Briggs' standard gauges, thus ensuring a perfect fit for standard wrought pipe.

Flanges are furnished flat or bent to the desired circle and are threaded for wrought pipe unless specified plain.

The Fairbanks Co., Montreal, will be pleased to quote prices on these flanges, or give any further information, and we believe that they should particularly appeal to all manufacturers of boilers and tanks.

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CANADIAN SOCIETY OF CIVIL ENGINEERS.

The annual meeting of the Canadian Society of Civil Engineers will be held at the society's rooms, Montreal, on the 24th, 25th, and 26th inst. The first day, Tuesday, will be taken up with routine matters, and the address of the president Col. W. P. Anderson. On Wednesday the members will visit Lachine, where they will be the guests of the Dominion Bridge Co. at luncheon. During the trip they will inspect the Dominion Bridge Co.'s plant, the works of the Dominion Wire Co., and Allis-Chalmers-Bullock's new shops. The annual dinner will take place in the evening, and on Thursday papers will be read by Cecil B. Smith, Toronto, on the Canadian Niagara Power Co.'s plant; by E. M. Archibald on the "Effect of Load Factor on the Cost of Electric Power," Papers by Dr. Haanel, of Ottawa, on the electric smelting of metals, and by James White, of Ottawa, on Canadian maps, are also expected. It is understood that Ernest Marceau, of Montreal, will be elected president for 1905. It is proposed to appoint a secretary whose whole time shall be devoted to the work of the society, and ballots are now out to decide this question.

A meeting of the General Section was held on Thursday, 22nd December, to hear the conclusion of the discussion on Mr. Leonard's paper on "Loss of Heat from Iron Pipes." A paper on "Bridge Launching," by B. J. Forrest, M. Can. Soc. C.E., was also read.

The following is the result of the last ballot for new members:

Members.

Frank Alexander Barbour, of Boston, Mass. Frank Creelman, of Ottawa. John Charles T. Crofts, of Toronto, Ont. Arthur Nassau Molesworth, of Ottawa. Theodore Edward Naish, of Ottawa.

Associate Members.

William Clifford, of North Bay, Ont. Jacob C. N. B. Krumm, of Montreal. Horace Longley, of Bridgewater, N.S. Francis Easton Leach, of Revelstoke, B.C. Edward B. Merrill, of Toronto. Norman de C. Walker, of Montreal.

Transferred from the Class of Associate Member to the Class of Member.

Thomas Henry Alison, of New York. Richard John Durley, of Montreal. Charles Henry B. Topp, of Victoria, B.C.

Transferred from the Class of Student to the Class of Associate Member.

Walter Wilfred Benny, of Farnham, P.Q. Frank Simpson Drummond, of North Bay. Richard T. Gough, of Montreal.

For Admission as Associate.

Charles Berkeley Powell, of Ottawa, Ont.

For Admission as Students.

William Persse Caddell, of Montreal. Edward Coltrin Keefer, of Toronto, Ont. Colin J. F. Isbester, of Farnham, P.Q. Godfrey Hugh Brunner, of Montreal. Samuel Barber Code, of Smith's Falls, Ont. William J. Carnes, of Montreal. Pierre Charton, of Montreal. Ernest Anaclet Cormier, of Montreal. Henry Hadley, of Montreal. S. Wilfred Hamilton, of Montreal. John Hogan, of Montreal. Douglas Lauchlin McLean, of Ottawa. Robert Potter, of Kingston, Ont. Joseph Robitaille, of Montreal. Nicholas James Slater, of Montreal.

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H. T. Hazen, C.E., has been appointed divisional engineer for the James Bay Railway, now under construction from Toronto to Sudbury and north. Mr. Hazen's division will be from Parry Sound to Sudbury, a distance of 110 miles.

MINING MATTERS.

The Granby Company will spend $125,000 this year adding two furnaces to its smelter and increasing its daily tonnage from 2,000 tons to 2,700 tons.

A new strike of rich gold ore has been made at Paymaster Mine near Dinorwic, Ont. The Northern Development Co. of Detroit are the owners, and have sent an official to make a complete investigation of the present condition of the mine, in view of the recent glowing reports.

The Newcastle Collieries Co. is boring for new coal seams underlying the one at present being worked at Port Morien, Cape Breton. An eight foot seam has been passed at a depth of 450 feet, and it is expected that at about 350 feet further down they will meet a seam located in the neighborhood some months ago, said to be an excellent grade of coal without stone.

T. B. Caldwell, M.P., while drilling on his iron ore claim at the northwest arm of Lake Temagami struck an artesian well on a ridge which forms the height of land between the Sturgeon Valley and the Ottawa Valley. At a depth of 200 feet water was struck which rises 30 feet in the air with such force that work has been abandoned for the present. The presence of the well is a mystery as the water rises to a height of 100 feet above any known surface water in the vicinity.

The executive of the Canadian Mining Institute have made the awards for the best papers read by students at the institute convention held last March, as follows: C. W. Knight, B.S., Queen's University, Kingston, gold medal for paper, "Notes on Some Deposits in the Eastern Ontario Clay Belt." E. T. Caskill, Queen's University, $25 for best paper, "Notes on the Occurrences, Productions and Uses of Mica." J. F. Hamilton, School of Practical Science, Toronto, $25 for paper entitled, "The Relative Attraction of Some Common Minerals for Residuum Oil." E. J. Carlyle, McGill University, Montreal, $25 for essay on "The Pioneer Iron Mine, Eby, Minn."

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RAILWAY NOTES.

The contract for the double-tracking of the C.P.R. from Winnipeg to Fort William has been let to Foley Bros. About 430 miles of track will be laid, and work will commence almost immediately.

A thousand men are now at work on the line of the James Bay Railway. D. D. Mann, vice-president of the Canadian Northern, states that the line will be completed as far as Parry Sound by next September, and next year will reach Sudbury.

Haines Bros., of New York, have let the contract for the construction of the Hamilton, Ancaster, and Brantford Electric Railway. The line will be forty-three miles long, and the estimated cost is $500,000. It is to be in running order by December 1st.

Application will be made at the approaching session of the Manitoba Legislature for an act incorporating the Central Canada Railroad and Power Co., for the purpose of building a line of electric railway to the Winnipeg river and developing power on said river.

For some time past there have been reports in Victoria, B.C., to the effect that the Great Northern Railway were about to abandon their interests in that city. This is now authoritatively denied. The Canadian Pacific also will make good their hold there, and will continue on an improved scale their car ferry service between Victoria and Vancouver.

It is calculated that the Canadian railways will require 200,000 tons of steel rails for 1905, costing about $5,000,000. The Canadian Northern will buy 60,000 tons, the Temiskaming and Intercolonial 30,000 to 40,000 tons, and the Grand Trunk, C.P.R., and other roads the balance. The Sault rail mills and the Dominion Iron & Steel Co. will supply most of these orders.

The Midland Railway, of Nova Scotia, which has a line from Truro to Windsor, is being taken over this month by the Dominion Atlantic Railway, having been purchased for $1,250,000. The latter road thus obtains a valuable connecting link with the eastern end of the province. The former road will probably be extended to some point on Northumberland Strait, from which a line of steamers to Prince Edward Island will be operated.

The Canadian Street Railway Association was organized in Montreal last month. W. G. Ross, of the Montreal Street Railway, is president, and W. H. Moore, of the Toronto Railway Co. is vice-president. Several representatives of the American Association were present. The object of the organization is to bring about a better understanding between the street railway employees and employers throughout the Dominion.

LIGHT, HEAT, POWER, ETC.

Westmount, the western suburb of Montreal, has decided to own its own electric light and power, and will build a municipal plant, the power to be generated by steam.

The first turbo-generator set in Canada is now operating at the plant of the Toronto Electric Light Co. It is a 500-K.W. Curtis turbine installed by the Canadian General Electric Co.

The Gladstone Gas Company, of Gladstone, Man., has organized with the following officers: President, A. G. Williams; vice-president, Dr. J. W. Armstrong; directors, Thos. Morton, R. L. Cross, and R. A. Wylie, of Winnipeg.

Early this year a new mill will be erected at Atwood, Ont., by W. F. Forrest, in which will be installed sufficient power to furnish the town with electric light. The new mill will be thoroughly equipped with all modern machinery.

Gas has been struck at the North-West Gas and Oil Company's well at Edmonton. It was a pocket of considerable size, at the depth of some 700 feet below the surface. This is held to be a good indication. The boring is likely to be continued some 2,000 feet or more.

The water rights at Kakabeka Falls, eighteen miles from Fort William, have been transferred from the original promoter, E. S. Jenison, to C. R. Hosmer, H. S. Holt, and F. W. Thompson, capitalists, of Montreal. The new company will commence development at once, and expect to have 30,000-h.p. ready for use by June, 1906. Power will be supplied to the municipality at $25 per horse-power, which will be a saving of $20 per horse-power over the present generation by steam.

The California Gas and Electric Corporation, San Francisco, Cal., has just placed an order with Crocker-Wheeler Company, Ampere, N.J., for three 4,000-K.W. capacity, 3-phase, 13,200-volt, 25-cycle, 88-R.P.M. revolving field alternating current generators to be driven by 5,400 horse-power gas engines. These generators are the largest in capacity in the world driven by gas engines, and will furnish power for operating all the street railways in San Francisco and vicinity. The Crocker-Wheeler Company are the American licensees of Brown, Boveri & Cie, the celebrated Swiss electrical engineers. But the reputation for excellence which the Crocker-Wheeler Company has built up during the past sixteen years of manufacture of direct current apparatus, has had much to do with the result. Canadian representatives, the Packard Electric Co., St. Catharines, Ont.

The Canadian Niagara Power Co. formally opened its installation on the 2nd inst., when two turbines of 10,000-h.p. each were set in motion. Three other similar units are being installed and will be ready for operation about the first of May; and six further units, making a total of eleven or 110,000-h.p., will be put in later. The occasion of the opening was celebrated in fitting style, the following being some of those present at the ceremony: J. W. Langmuir, president of the Queen Victoria Park Commission, and Commissioners Robt. Jaffray, A. W. Campbell, James Bampfield, and George H. Wilkes; Superintendent James Wilson and President William H. Beatty, of the Power Co.; A. Monroe Grier, K.C., secretary; Edward D. Adams, F. L. Stetson, Edward A. Wickes, and William B. Rankine, of the Niagara Falls Power Co., N.Y.; George Urban, Jr. and Charles R. Huntley, of the Cataract Power and Conduit Co., of Buffalo; De Lancey Rankine of the Tonawanda Power Co. The Canadian company is owned by the Niagara Falls Power Co., on the United States side of the river, and the two installations will be operated as one plant, so that customers will always be sure of continuous service. A cable laid across the steel arch bridge connects the Canadian plant with the older power houses.

MUNICIPAL WORKS, ETC.

Citizens of St. Albert, Alberta, are circulating a petition calling on the village council to pass by-laws to borrow $30,000 to erect a grist mill and to install a system of electric lights in the village.

Winnipeg and neighboring municipalities are discussing the building of a new traffic bridge across the Red River at a cost of about $75,000, shared as follows: Government grant to be asked for, $10,000; Springfield municipality, $5,000; Kildonan, $8,000; St. Paul's, $3,500; St. Clement's, $3,500; Winnipeg, the balance, probably $40,000. The matter will be taken up by the new council this month.

A difficulty has been met in the proposed purchase by the city of St. John, N.B., of the electric light plant of Carleton, as it is discovered that the present owners cannot transfer the franchise without special legislation. The city will have to obtain this legislation or have the property transferred to the former holder, who has the right, by an act passed three years ago, to sell the franchise.

The Portage la Prairie Board of Trade is taking steps to prevent spring floods along the Assiniboine river, and two schemes are proposed. One is to cut the arms of the river and straighten its course, and the other is to cut a channel from the town to Lake Manitoba to carry off the surplus water. The latter scheme appears to be more feasible. The Board has asked the co-operation of the Winnipeg Board in the matter.

TELEPHONE AND TELEGRAPH.

Application will be made at the next session of Parliament for the incorporation of the North-West Telephone Co., to construct and operate lines throughout Ontario, Manitoba and the North-West Territories.

The following resolution was unanimously passed by the Waterloo County Council: "That this council strongly endorse the establishing of a farmers' telephone system in Waterloo County; that such a system should be a great benefit to both farmer and merchant, and we would suggest that no exclusive franchises should be given to telephone companies by municipalities in this county, whereby the farmers' telephone system could be shut out from obtaining connection with any municipality, and that we again memorialize the Government that until the telephone systems are taken over, compulsory service should be given over any long-distance lines at rates approved by the Governor-in-Council, not exceeding the ordinary rates charged by the telephone company owning the line."

A petition has been presented to the Manitoba Legislature asking for the incorporation of the Independent Telephone Company of Canada. The promoters of this company are residents of Minneapolis and the State of Iowa, and it is their purpose to establish in Winnipeg and in towns throughout the province a dial (automatic) system of telephones. They have fixed their capital stock at $10,000,000, and they estimate that it will cost them $2,000,000 to instal a service in Winnipeg. The bill provides that all wires should be placed under ground and that municipalities should have the right to expropriate and operate systems within the limits of their corporations, and also that the Government shall have the right to expropriate and control rates. The company also agree to connect their urban system with rural lines that any group of farmers may establish. A number of Western Canadian capitalists have secured a financial interest in the enterprise.

The latest addition to the municipal telephone systems in Great Britain is that of Hull, where the formal opening of the exchange took place on November 28th. There are 700 lines in operation, the total number of subscribers connected and on hand being 1,800. The ultimate capacity of the system is 5,000. The rates are: For unlimited service;

business, 1st connection, $30.68; 2nd connections, $28; special rates to large customers. Residence: $24.35. Measured service: $14.61, and two cents per outgoing call. Extension telephones: $4.87 per annum. Desk telephones: $1.22 per annum additional. Three-fourths of the subscribers take the unlimited service. The system, which includes nineteen miles of conduits, and thirty-five miles of ducts, containing 4,910 miles of wire, cost $210,400. A special feature in connection with the Hull system provides for free intercommunication between the subscribers of the municipal service and those of the National Telephone Company in Hull and other towns. This arrangement is due to the fact that an agreement granting the company underground privileges was entered into some years ago, and upon the municipality deciding to establish its own service, notice to terminate these rights was given to the "National." The company fought the issue to the House of Lords, and being defeated, the matter was finally settled on terms which enable the municipality to carry on its business under much more favorable conditions than prevail elsewhere.

PERSONAL.

John F. Johnson, special engineer of the Canada Car Co., was in Toronto the last week in December.

W. W. Brown, superintendent of the Crow's Nest Pass Co.'s light and power plant, at Fernie, B.C., is holidaying at his home in Petrolia, Ont.

Theophile Viau, contractor, of Hull, died last month of consumption of the throat, at the age of 57. Mr. Viau was a well-known citizen, and had a large share in the construction of the city waterworks.

Robert J. Fleming, assessment commissioner for Toronto, has been appointed manager of the Toronto Railway Co. E. H. Keating, his predecessor in this office, becomes consulting engineer for Mackenzie & Mann, and has left for Mexico in connection with the syndicate's concessions in that country.

E. W. Carr, formerly assistant engineer to Mr. Goldmark, chief engineer of the C.P.R. shops at Montreal, has been transferred temporarily to Winnipeg, to assist F. Crosby, the company's resident engineer, in the installation of the steam and electrical power plants.

The following were visitors to Toronto during December: D. W. Robb, of the Robb-Armstrong Co., Amherst, N.S.; H. J. Fuller, of the Fairbanks Co., Montreal; F. H. Leonard, of Montreal; E. G. Yeates, of the London Machine Tool Co., London; F. D. Shallow, of Moniteur du Commerce, Montreal.

The friends of E. G. Barrow, city engineer of Hamilton, will sympathize with him in the bereavements he has suffered in the past month. Mr. Barrow's son, John J., died as the result of injuries sustained while working on the double tracking of the Grand Trunk, and Mrs. Barrow died the next day from the shock of her son's death.

J. F. Birchard, formerly with the C. H. Mortimer Publishing Co., and for the last three years with J. T. Wing & Co., of Detroit, has severed his connection with that company, and after January 1st will represent on the road J. N. Tallman & Sons, of Hamilton, manufacturers of babbit metals and solders and high grade bronze and brass castings.

The name of J. H. Ashdown, of Winnipeg, is being mentioned for the vacant position on the Transportation Commission, caused by the death of John Bertram. Mr. Ashdown is sixty years of age, and is the owner of the largest hardware business west of Toronto. He has been president of the Winnipeg Board of Trade, has taken a leading part in municipal affairs for many years, and is known throughout the West as one of the ablest business men of the Dominion.

After having built the Canadian Niagara Power Co.'s great hydraulic plant, at Niagara Falls, Cecil B. Smith has returned to Toronto to resume practice as consulting and contracting engineer, with offices at 36 Toronto St. Mr. Smith is a "made in Canada" engineer, and the record he has made as resident supervising engineer of one of the greatest water-power plants of the world, reflects credit upon the rising generation of Canadian civil engineers. At the annual meeting of the Canadian Society of Civil Engineers this month, Mr. Smith will give some account of the huge work completed at Niagara Falls.

PORT ARTHUR AND FORT WILLIAM.

Examples of Municipal Ownership.

(Correspondence of Canadian Engineer.)

The men who have been administrators of the affairs of the "twin towns" of Port Arthur and Fort William have only to maintain their integrity along with their local patriotism to be regarded as statesmen when the civic and industrial history of Canada is written. They have already successfully dealt with problems in civic government at which the large cities of Eastern Canada have baulked, and they are now laying the foundations of public control on lines that will make for the best development of the power which these cities of the future seem destined to exert upon the Dominion commercially and otherwise. That they have a destiny, no one who looks at the map of Canada can doubt. They are the great natural harbors of the greatest lake in the world, this lake itself being the Atlantic Ocean of the wonderful chain of inland seas that makes Canada unique in the geography of the world. Whatever the future of Hudson Bay may be, these cities will be a great entre-port for the grain going out of and the merchandise coming into the prairie lands of the West. Thunder Bay and the mouths of the Kaministiquia were a great trading post in the days of the Indians and canoe traffic, and the hardy French pioneers endorsed the judgment of the Indians as early as 1669. Verendrye made Fort William a base of supplies when he made his first journey to the Red River in 1731. Nature has marked the position out as a great port under modern conditions of traffic in great ships more distinctly than under the primitive conditions of the past. Fort William alone has over 25 miles of natural waterfront, the shallowest depth of which is 21 feet, while in the marshy flat, that now separates it from Port Arthur, there is easy dredging for the creation of more docks than there are in London or New York. It is said that vessels of 18 ft. draft can navigate for eight miles or more up the river Kaministiquia, and level land runs back over a mile from the river for nearly seven miles of this distance, affording still more docking and railway accommodation. Then there is the Mission river, a delta of the main river, giving in its two miles of course more deep water frontage.

Port Arthur is already a great lake port, and there is at present a keen rivalry between the towns for leadership in the lake and railway traffic. In civic and commercial relationship there is much analogy between the history of these towns and Minneapolis and St. Paul, which, while separated only by a river, are rivals in everything but their dealings with the outside world. Port Arthur and Fort William are eagerly competing for the advantage of being the lake terminus of the Grand Trunk Pacific, but it may be that both will get a share of this new traffic. Gold, copper and iron give variety to the resources of the country back of Thunder Bay, the great Mesaba iron range of Minnesota extending into this country. As noted in the local papers, preparations are being made to establish iron blast furnaces here and to develop a part of the 30,000 electrical horse-power available from the Kakabeka Falls on the Kaministiquia, which are sixteen miles distant from the town as the crow flies, or eighteen miles following the course of the river. These falls have a total fall of 118 feet, and if all the power is developed that can be, it will easily yield 50,-000-h.p. Then Port Arthur has its own water power from the Current river, now supplying the lighting system of the town. About 5,000-h.p. is available now, and this can be extended when required by several thousand horse-power more. Some of this power has already been contracted for by the Ogilvies for their elevators and projected flour mills and by Mackenzie, Mann & Co. in connection with the Canadian Northern Railway, and the blast furnaces in which they will be interested. No doubt, also, the Canadian Pacific Railway, whose transcontinental line first brought Port

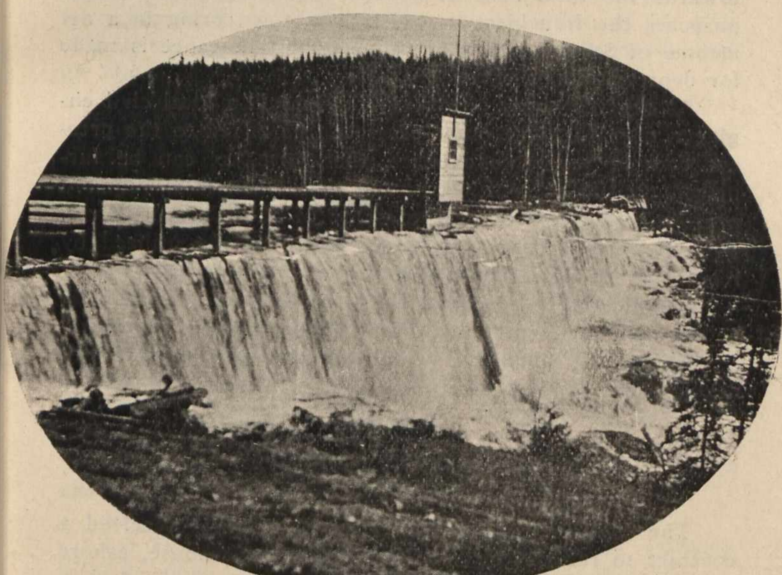
Arthur and Fort William into commercial touch with the West and East of Canada in the era of steam traffic, will use electric power in its elevators, shops, etc.

Thus, with almost ready made docks, with cheap electric power, with choice brown building stone in exhaustless quantities on Isle Verte, near by, and with all the other advantages here enumerated, Port Arthur and Fort William have a manifest destiny.

The chief purpose of this article, however, is not to describe their resources or forecast their future, so much as to show the courage with which these towns have grappled with problems of civic ownership, and the success they have already achieved in the face of great difficulties at the start.

Fort William.

In 1884, when the C.P.R. reached the "West Fort" of Fort William, the population was 200 or 300. Two years ago it had reached a population of 5,500, now it has 7,000 inhabitants, and if the enterprises now planned are carried out, it will have within another two years sufficient population to give it the legal status of a city. The town covers an area of 7,000 acres, its assessment is $2,147,170, besides exemptions in favor of the C.P.R. to the value of $2,000,000, and the taxes amount to 25 mills on the $1. Both towns own their public utilities, such as waterworks, electric light and power, and street railways, and though they are rivals in commercial development, they work together in a broad spirit in making the cause of municipal ownership a success. For instance, there is a free exchange in the telephone service between the two places, and passengers are carried at a single 5-cent fare from any point in one town to any point in the other, the towns being four miles apart. Fort William went into municipal ownership of its franchises more from necessity than from any fixed purpose in the beginning. When the town first required its waterworks system in 1896, no company would touch the contract. The town undertook the work itself, and now it could easily get $100,000 for the franchise if it wished to sell. It was the same with the electric lighting system, while with regard to the telephone system both Fort William and Port Arthur were forced to take up this work, not from any preconception as to the policy of public ownership, but because they could not get a decent service from the Bell Telephone Co. The people having put their hands to the plow, have not turned back, but carry on all their franchises under public ownership and in a public spirit. The best of the citizens serve on the council and no one is there for graft. The attempts to get men into civic positions by "personal favor" are frowned upon, and when a civic official is found incompetent, he is replaced as promptly as he would be in the service of a private firm. Though Kakabeka Falls, the great source of power for the future Fort William, is outside of the town, it is a question whether the civic authorities are not likely to make their first serious mistake in allowing the power privileges to remain in the hands of concessionaires as they are at present, even though the offer of power at $25 per horse-power per year is scarcely more than half of the cost of generating by the town's present steam plant.



The Kakabeka Falls.

About 1,000-h.p. is generated at the town's power house on the river above the town. Of this total, 700-h.p. was installed during the past year. This consisted of a Goldie & McCulloch engine of 600-h.p. and a dynamo of 600-K.W. capacity. The pump is run by a separate engine of 100-h.p. The water, which is very soft, is supplied by two pumps of 500,000 gallons' capacity each—this is sufficient for a town of 25,000. Over 5,000 lights are supplied from the power house, the charge being 35 cents a month for 16-c.p. lights. The meter rate is 10 cents per 1,000 watts with $2 a year charge for meter. A discount of 10 per cent. is allowed for prompt payment. The total cost, including the new machinery, was $94,000, and the annual cost of maintenance, including the interest and sinking fund, is $14,802, while the earnings in 1903 were $14,666. When it is remembered that the total earnings in 1898 were only $3,992, and in 1900, $8,945, it will be seen that this branch of the service will soon show a surplus.

The expenditure on waterworks last year in Fort William was $71,951. The cost of maintenance, including interest and sinking fund, is $11,254. The number of services is 750, of which 80 new ones were put in in a single recent month. About 400,000 gallons are pumped per day. There are 75 hydrants costing $20 a year. Coal, in 1902, cost $3.10 per ton, and in 1903, $2.80. The earnings of the waterworks branch were $2,112 in 1899, $8,777 in 1901, and $13,304 in 1903, this department already showing a good surplus.

The town's municipal telephone system cost a total of $26,644 up to the middle of last year. A full description of the telephone systems of the twin towns was given in the Canadian Engineer of January, 1903, but it may be of interest to mention here that Fort William has over 400 phones, and the daily calls average over 3,000. It is a central energy system put in by the International Telephone Co., Chicago, and the charge is $2 a month for business phones, and $1 a month for residential phones. In March, 1903, a fire destroyed the building and all the equipment, but a new exchange was put in and was got into working order in May of the same year. At that time there were only 71 phones in use, and the Bell Company taking advantage of the fire did its utmost to draw off the merchants and others by offering three-year contracts on very attractive terms, but the people stood by their municipal system, despite the attempts of the Bell Company to destroy its usefulness as far as possible by preventing the C.P.R. from making connections at the stations of both towns. As stated, the town has over 400 phones, while the Bell has about 110, of which, according to the statements of local men who claim to know, a certain number are dead heads.

Fort William builds its own sewers and sidewalks. Both are being steadily extended. The sidewalks are of cement 10 feet wide, and are laid by day labor, as are the sewers.

Port Arthur.

Port Arthur has a population of 6,200, the number of its inhabitants having doubled in five years. The town started on its career of municipal ownership in 1891 with the electric street railway, which was put into operation in 1892, with seven miles of track. It now has nine miles and extends east through the town from Fort William to the Current river, where a handsome park is being laid out by the town, this being a development of the past year. The fares are 5 cents or six tickets for 25 cents, with eight for 25 cents during morning and evening hours, and 10 for 25 cents for school children. It is owned by Port Arthur alone, and is now on a paying basis. The revenue of 1903 was as follows: $22,933 for cash fares, $4,148 for tickets, $157 for special trips, $59 for advertising in cars, and $271 for power sold; a total of $27,568. There was spent on the dam and extension about $18,000, and in all $35,000 for new equipment, etc., but there is a good surplus on the year's operations taken by themselves.

The electric lighting system of the town dates practically from 1897, when it was run by steam and continued to be a steam plant till two years ago, when water power from the Current river, two miles distant, (but still within the town limits), was made available. The turbines now in operation have a capacity of 700-h.p., but penstocks are already in for 450-h.p. more, making 1,150-h.p., all of which will be utilized this year for lighting and power. At present 250-h.p. is used for the railway. Current is furnished for store elevators and power purposes at $25 per horse-power per year. There were 4,833 lights in operation last June, and 309 lights on the streets. New incandescent lights are being put in every day, and it is in contemplation to reduce the rates. These rates are on a graduated scale, varying according to service and number used. As these may be of interest to other municipalities, the table of present rates as prepared by Thomas H. McCauley, Superintendent, is here given:

Monthly Flat Rate for Lights.

	Commercial.			Domestic.		
No. Lamps.	8 C.P.	16 C.P.	32 C.P.	8 C.P.	16 C.P.	32 C.P.
1 light ...	$ 45	$ 75	$ 1 50	$ 35	$ 55	$ 1 10
2 " ...	60	1 00	2 00	50	80	1 60
3 " ...	90	1 50	2 90	75	1 25	2 25
4 " ...	1 20	2 00	3 85	90	1 50	2 75
5 " ...	1 50	2 50	4 75	1 05	1 75	3 25
6 " ...	1 80	3 00	5 65	1 20	2 00	3 75
7 " ...	2 05	3 40	6 60	1 35	2 25	4 25
8 " ...	2 25	3 80	7 50	1 50	2 50	4 75
9 " ...	2 50	4 20	8 40	1 65	2 75	5 25
10 " ...	2 75	4 60	9 00	1 80	3 00	5 75
11 " ...	3 00	5 00	9 75	2 00	3 30	6 25
12 " ...	3 25	5 40	10 70	2 15	3 60	6 75
13 " ...	3 40	5 80	11 50	2 30	3 85	7 25
14 " ...	3 70	6 20	12 30	2 45	4 10	7 75
15 " ...	3 95	6 60	13 00	2 60	4 35	8 00
16 " ...	4 20	7 00	13 75	2 75	4 60	8 25
17 " ...	4 45	7 40	14 60	2 90	4 80	8 75
18 " ...	4 65	7 75	15 25	3 00	5 00	9 10
19 " ...	4 85	8 10	16 00	3 10	5 20	9 50
20 " ...	5 10	8 45	16 75	3 20	5 40	10 00
Additional, each.....	25	40	80	12	20	40

All lighting rates are due on the first of each month, and when paid on or before the 10th, a discount of 10 per cent. on resident rates, and 15 per cent. on commercial rates will be allowed.

Meter Rates.

Meters.—To be supplied by the town at cost or rented at following rates: 30 lights and under, 1c. per light per month. 40 lights and over, ¾c. per light per month. Even sizes to be used only, and all lights to be based on 16 candle power.

To Stores.—For 16 lights and less, 10c. per M. watts. For over 16 lights, 8c. per M. watts.

Hotels.—For 30 lights or less, 10c. per M. watts. For 30 to 45 lights, 8c. per M. watts. For 45 lights and over, 6c. per M. watts.

Residences.—For 12 lights and under, 10c. per M. watts. For 20 lights and under, 8c. per M. watts. For over 20 lights, 7c. per M. watts.

Lodges, Churches, Etc.—For 20 lights or less, 10c. per M. watts. For 21 lights to 40 lights, 8c. per M. watts. For over 40 lights, 6c. per M. watts.

Minimum Rates.—Stores and hotels, 15c. per 16 c.p. light. Residences, 12c. per 16 c.p. light. Churches, halls, etc., 10c per 16 c.p. light.

Discounts for Payment, 10 Days from Date of Account.—

5%	for payment	of	monthly	Acct's	of	$ 3 00 to $ 5 00
6%	"	"	"	"	"	5 00 to 7 50
7%	"	"	"	"	"	7 50 to 10 00
8%	"	"	"	"	"	10 00 to 12 50
9%	"	"	"	"	"	12 50 to 15 00
10%	"	"	"	"	"	15 00 and over.

In 1903 there was an income of $13,362 for electric lights and supplies, or $20,392 counting stock on hand and accounts due. The year's results showed a net balance to the good of $2,264, after paying interest, salaries, and all other charges.

The municipal telephone system is operated in close association with that of Fort William, and is as satisfactory and as well supported. As in the case of that town the people here say there is no thought of going back to the wretched service of the Bell Co., or of taking the risks that would be involved in a return to the old system of outside control, even if the Bell Co. did its utmost to give an efficient and cheap service for the time. On the 6th of August last Port Arthur had 146 business phones and 276 residential phones, while 27 new connections were then being made. At the present date it has a total of about 500, counting new installations. The rates are $2 a month for business phones and $1 a month for residences. The revenue in 1903 was $2,180 for regular services, or including accounts due, about $3,500. After charging interest and all other expenses, there was a loss of $85 on the year. Of course had the service of the Bell been the only one in the town, the net, as well as gross cost, to the people would have been vastly greater, apart from the difference in the quality of the service. It is expected that this year there will be a net surplus of $1,000 for this service.

A waterworks system has been installed during the past year at a cost of about $85,000. The water is taken from Lake Superior, by pumping, the intake being three miles from the town. The system can at any time be converted into a gravity system, by taking water from Six Mile Creek or the Current River. A sewage system is also being put in, at a cost of $62,000, both systems being planned by Willis Chipman, C.E., of Toronto. The sidewalks are of cement, and like the other works, are carried out under the town's own management.

The tax rate of Port Arthur last year was 21 mills, and towards the total sum of $68,050 required for municipal purposes the franchises owned by the town bring in a net income of $38,000. In this estimate due allowance is made for depreciation of plant.

As regards water power, A. L. Russell, a local civil engineer, says that five other dams can be added to the present dam at moderate expense, that 5,000-h.p. can be furnished on the present plans, and that when it is required practically the whole of the water of the Current River, with a drainage basin of 375 sq. miles, can be utilized by reservoirs for power purposes.

It will thus be seen that the franchises now municipally owned by Port Arthur and Fort William have a value that can scarcely be calculated, when their influence on the future development of these lake ports is kept in mind.

MARINE NEWS.

The Reid Wrecking Co., Sarnia, Ont., has received a contract to release the schooner John Kelderhouse, ashore on North Point.

The Canadian Pacific Railway has given a contract to a Glasgow firm for three large steamers of high speed for the Atlantic trade.

The tonnage of coal brought into Montreal from Cape Breton during the season of navigation 1904, amounted to over 1,400,000 tons.

The Hamilton Steamboat Co.'s steamer Macassa has been sent to Collingwood to be remodeled and to have forty feet added to her length.

The Canadian Northern Railway purposes to use a fleet of steam boats on the Upper Lakes to bring down to French River the freight brought by its western branch to Port Arthur. Thence it will go east to the Atlantic, by way of the Intercolonial.

The Government steamer Aberdeen got caught by the ice in one of the locks on the Lachine Canal, while on her way to Toronto to have new boilers installed. The steamer will now have to winter in Montreal, and no work will be done on her until spring.

A contract has been given to Andrew Weir & Co, of Glasgow, Scotland, for two steamers for the Canada-Mexico trade, having capacity of 4,500 tons of freight each, and of 50 first-class and 300 or 400 steerage passengers. The Mexican and Canadian Governments will each give a subsidy of $50,000.

THE VALUES OF WATER POWERS AND DAMAGES CAUSED BY DIVERSION.*

BY CHAS. T. MAIN, BOSTON, MASS.

Definition of Value.

The following definition of market value was given to the witnesses who were to testify on values in a recent important law-suit.

"'Market value' means the fair value of the property, as between one who wants to purchase and one who wants to sell any article, not what could be obtained for it under peculiar circumstances, when a greater than its fair price could be obtained; not its speculative value; not a value obtained from the necessities of another. Nor, on the other hand, is it to be limited to that price which the property would bring when forced off at auction, under the hammer. It is what it would bring at a fair public sale, when one party wanted to sell and the other to buy."

Definition of Damage.

The definition of the damage due to the diversion of water was stated as, "The difference in market value, before and after the diversion."

Method of Determining Value.

The value of an undeveloped water power depends:

First.—Upon its location, the amount and uniformity of flow, head, conditions affecting the cost of construction and transmission, use of exhaust steam and need of water for other purposes than power.

Second.—Upon what the power is to be used for, whether for electric lighting and railway work, through most of the hours in the day with a variable load, for some requiring a fairly steady load for twenty-four hours a day, or for running a textile mill or similar plant with a fairly steady load for about ten hours a day.

Third.—Upon the market, which can be served, whether it is secure and steady or must be built up and is somewhat unreliable.

The value of a privilege should be determined by comparison with the cost of producing power in such quantities and with such regularity as is required for the particular purpose for which it is to be used in a fairly economical manner at any place or places equally convenient for the transaction of the business under consideration. Some times the location is fixed, but oftentimes there can be a choice of locations.

In estimating the value of an undeveloped privilege, the steps followed are as follows:

(1) Determine the flow including the effect of storage and pondage.

(2) Determine the net head.

(3) Determine the horse-power which can be economically developed and used each month in an average year.

(4) Determine the minimum flow and power and from this the size of supplementary steam plant required if the power is to be developed above the minimum flow.

(5) Determine the shortage of water power during such months as there is a deficiency.

(6) Estimate the probable cost of development of the water power.

(7) Estimate the probable cost of the supplementary plant, using steam, gas, oil, or anything which is best for the location under consideration.

(8) Estimate the yearly cost of running the water power and supplementary plants, including the fixed charges on both, to produce a combined power suitable for the purpose for which the power is to be used.

(9) Estimate the cost of a steam, or other kind of plant, necessary to produce the power required.

(10) Estimate the yearly cost of running this plant, including fixed charges, to produce the power required.

(11) Subtract the cost of producing the power by water power and the supplementary plant from the cost of producing it by steam power, or some other method, alone. The difference, if positive, gives the apparent yearly saving by the use of water power. The apparent saving should be modified if necessary for location or any other thing affecting the value.

(12) Capitalize this difference at a rate which seems proper, and the result is the value of the privilege.

There seems to be a great difference of opinion as to the proper rate of capitalization, but in the purchase of water power privileges the buyer of his own free will assumes certain risks, as damages caused by freshets, changes of business, etc., which he will not assume for nothing. He is also basing his comparisons of cost of power upon the present cost of producing power, which cost may be reduced in the future. For these reasons, the yearly saving should be capitalized at a rate not less than 10 per cent.

Where a whole property is taken and the owner is free to move into an equal or more favorable location, the method and rate of capitalization given above should be used.

If the privilege is developed the total value includes the value of the plant.

The value of a plant will be its cost, less depreciation, up to the point where the cost of water power equals that of steam or some other power. Beyond this point, when water power costs more than steam power, the value of the improvements, although new, would not be represented by the cost, but would be something less than the cost. It is the sum which could be paid for it new which would bring the total cost of water power including fixed charges down to the cost of steam power, less depreciation.

Method of Determining Damages.

The damage has been defined as the difference in value of the entire property before and after diversion.

It is usually unnecessary to go through an elaborate estimate of the value of the whole property, before and after the diversion, for the reason that many of the items of value will remain constant. The decrease in value, if there be any, is due to the fact that the running expense is increased by the diversion, and if this increased cost of running be capitalized at the proper rate the capitalized sum will represent the amount which the property is decreased in value, or the damage.

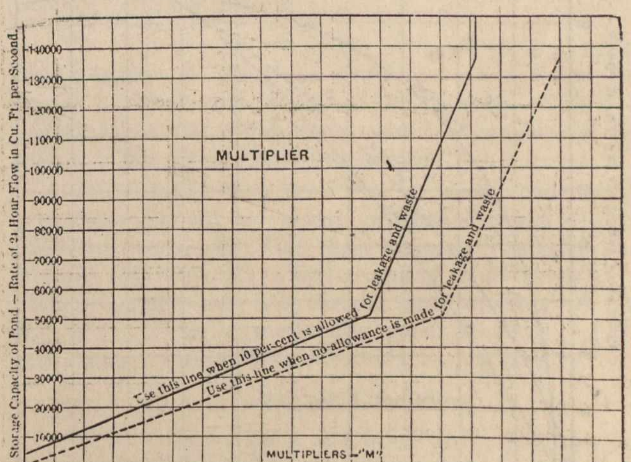


Fig. 1.

f=24 Hour Rate of Flow in c.f.s.
s=Storage in Cu. Ft.
M=9-10 the ratio which the amount of Water which can be used 10 hours per day, 6 days in the week bears to the total amount flowing during the week.

Main, C.T.

When M is less than 2.

$$M=\frac{9}{10}\left(1+\frac{s}{36000f}\right)$$

When M is greater than 2.16 but is less than 2.52.

$$M=\frac{9}{10}\left(2.4+\frac{s-50400f}{216000f}\right)$$

In estimating the damage to an undeveloped or abandoned power, the value before and after diversion should be estimated as described under the previous heading. The difference represents the damage.

If a privilege is developed and used, a valuable business carried on and a plant established which cannot be easily moved, the definition of damage still holds good, but in such case it is customary to capitalize the yearly loss at a smaller rate than 10 per cent., as this damage is done against the owner's wishes, and as he should receive a sufficient sum from which, in his business or in some other way, he can obtain a sufficient income to make good his yearly

*A paper presented at the New York meeting (December, 1904) of the American Society of Mechanical Engineers.

loss. The writer has, unless otherwise instructed, capitalized the yearly loss at 5 per cent.

A privilege which produces a variable power and has no supplementary power is not damaged any more than if it were so supplemented, and it should be treated in the same way as though it were supplemented.

The writer has generally used the following method of determining the damage to an established property, due to the diversion of some of the water.

(1) Determine the flow, including the effect of storage and pondage, before and after the diversion.

(2) Determine the net head.

(3) Determine the horse-power which can be economically developed and used before and after diversion.

(4) The difference between the power used before and after diversion is the power diverted which causes damage.

(5) Estimate the additional yearly cost of running caused by the taking away of this power, of coal, attendance and supplies.

(6) If any permanent power has been taken, that is, power which can be relied upon in the lowest flow of the stream, estimate the cost of a steam plant or portion of plant necessary to make good the amount taken in the dry month.

(7) Estimate the fixed charges on this cost of additional supplementary plant.

(8) Add the extra cost of running and additional fixed charges and the sum represents the extra yearly expense.

(9) This extra expense capitalized at a proper rate represents the damage.

If it is necessary for the mills to maintain a steam plant of sufficient size to run the whole mill under the conditions existing before the taking, it is clearly not necessary for the defendant to furnish or maintain any further addition to the plant, and the damages consist of the increased expense of running the plant, already installed, due to the diversion.

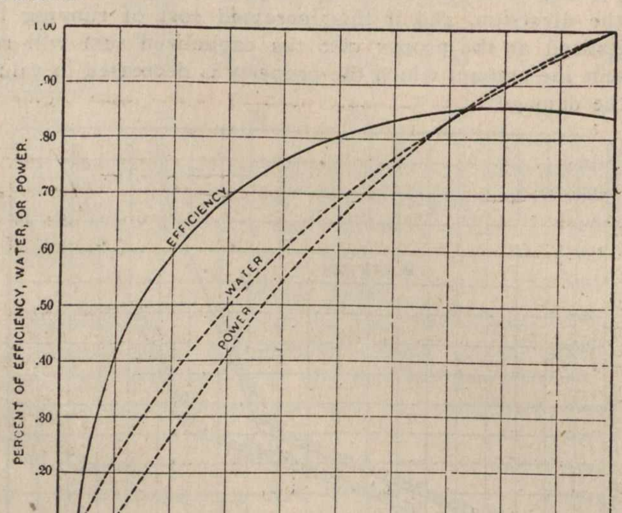


Fig. 2.

Diagram showing relation which gate opening bears to power developed, water used, and efficiency of turbine water wheels.

If the total power required to run the mill is so large that the steam plant must be run all of the time, then there is no extra expense for attendance or supplies due to the diversion.

If the total power required is such that wheel plant can run the whole work for a portion of the year alone, and for the remainder must be supplemented by steam power, the time during which the engine must run may be extended by reason of the diversion, and in such case there is an addition to the expense of running for labor and supplies for such extra time, which should be added to the extra cost of coal, and the total extra expense capitalized at a proper rate will represent the damage.

Water Shed and Run-off.

Too much stress cannot be placed upon the importance of determining the flow of the stream under consideration. If careful gaugings have been made extending over considerable time, they are the most reliable information which can be had. If no gaugings have been made, an examination of the water shed should be made to ascertain its character, all existing rainfall records in the vicinity should be collected, and an estimate made of the run-off. Assistance may be had by comparison of similar rivers, the run-off of which is known.

The amount of data on the flow of streams which is available is increasing each year, as careful records are being kept on many rivers by persons or corporations who are interested in these matters, and by the United States Geological Survey.

The amount and uniformity of the run-off are two items which enter very largely into the value. The uniformity of flow depends largely upon the storage capacity and location of reservoirs on the water shed. The areas and capacities of such reservoirs should be ascertained and the net amount which can be drawn from them.

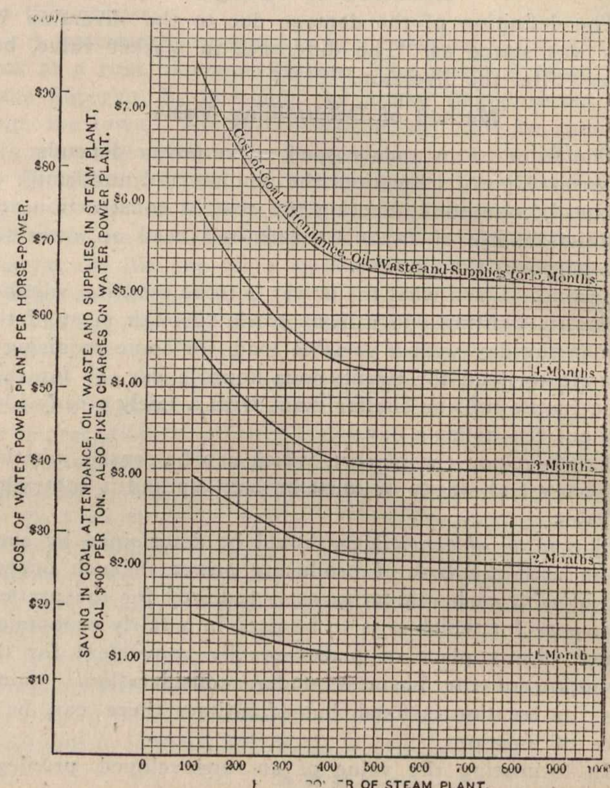


Fig. 3.

Diagram showing number of months when water should be allowed to waste with different sizes of steam plants and different costs of water power.

In estimating the average flow-off the months should be averaged in order of their dryness instead of in calendar order. If the flow is averaged by calendar months a great many irregularities in the flow are smoothed out and some of the flow is averaged in, which could not be held and used. By averaging all the dry months, all the second dryest, and so on, some of this evening up is eliminated, but it cannot be altogether avoided. The average flow by months in the order of their dryness will be less uniform and nearer the truth than when arranged by calendar months.

The average year is the one used in estimating the available power or power diverted, but the effect during the year when the flow is less than the average must not be lost sight of.

Flow Used During Working Hours.

The flow at any given privilege is usually given in cubic feet per second for twenty-four hours a day and seven days a week.

If the power is used twenty-four hours a day and there are no disturbing influences above to break up the uniformity of flow during the whole day, a small mill pond will answer. If, however, there are mills above using all the water in ten hours a day, a large pond would be necessary to store and use it all in twenty-four hours.

In a great majority of cases the water is used during the day for say ten hours a day and six days a week. If there is pondage enough so that it may be drawn down during the ten hours in the day enough to store the whole fourteen hour night flow, and if no water were wasted, the ratio of flow used in ten hours to the 24-hour rate would be 2.4; that is, 2.4 times the 24-hour rate of flow would be used during the ten working hours of the day. If the pond could be drawn down Saturday, so that the night and Sunday flow could be stored, the ratio of 24-hour flow to that used in ten hours a day and six days a week would be 2.8.

A certain amount of water is unavoidably wasted over the dam and by leakage through the various parts of the plant. This allowance of leakage and waste I usually place at 10 per cent. of the flow which could be theoretically stored and used. Using the above allowance for wastage, the maximum ratio of 24-hour flow to that which could be used in ten hours, six days in a week is $2.80 \times .90 = 2.52$.

When the pond cannot hold all of the flow during the time when the mill is not running the ratio will be something less than 2.52, and when no portion can be stored the ratio is 1. These ratios of amount of flow which can be used in ten hours a day to the total flow have sometimes been called "multipliers." They are the figures by which the 24-hour rate of flow is multiplied to get the rate which can be used during the working hours.

The multipliers are computed for an isolated privilege by adding to the cubic feet naturally flowing in ten hours the cubic feet which can be stored each night, and to this adding one-sixth the cubic feet which can be stored during the 24 hours of Sunday, and dividing this sum by the cubic feet naturally flowing in ten hours.

With a series of mills, some with small ponds might be enjoying the benefits of larger ones above, although they might have no rights in them. If the location were directly below the one with the larger pond, so that the lower privilege practically takes the water as it comes from the upper one, it will get the benefit of all or nearly all of the storage above. As the distance increases between the two privileges, the length of time required for the water to get to the lower one would increase, and the benefit of the upper pondage would decrease. If it took one hour for the water to get down the multipliers would be 90 per cent. of those above, two hours, 80 per cent., and so on, plus any storage of water from the water-shed below the upper privilege which can be stored in the lower pond.

Where there is a series of mills the multipliers can be computed in this way until a privilege is reached, where the multipliers, due to its own storage, are greater than those obtained for anything above. This power then becomes the governing one for those below it until another is reached having large enough storage to establish a new set.

The computation of these multipliers is tedious, and in order to facilitate the computation I have worked out the formula for them, and have prepared a diagram which reduces the labor to a comparatively small amount:

Let f = 24-hour rate of flow in c.f.s.

s = storage in cubic feet.

M = 9-10 of the ratio which the amount of water, which can be used in ten hours a day, six days a week, bears to the total amount flowing during the week:

36,000 = number of seconds in ten hours.

50,400 = number of seconds in fourteen hours or one night.

216,000 = number of seconds in sixty hours or one working week.

2.16 = 90 per cent. of 2.4 ratio of 10-hour flow to 24-hour flow.

2.52 = 90 per cent. of 2.8 ratio of 10-hour flow to 24-hour flow + 1-6 of Sunday or four-hour flow.

When M is less than 2.16,

$$M = \frac{9}{10}\left(1 + \frac{s}{36\,000\ f.}\right).$$

When M is greater than 2.16 and less than 2.52,

$$M = \frac{9}{10}\left(2.4 + \frac{s - 50{,}400\ f.}{216{,}000\ f.}\right).$$

Fig. 1 shows the multipliers for various ratios of pondage to rate of 24-hour flow.

Use of the Multipliers.

The use of the multipliers is apparent when the problem is the determination of the amount of power which can be produced at a given place.

In estimating the damages caused by the diversion of a portion of the water shed, the power which can be produced before the diversion and the power which can be produced after diversion should also be estimated in the same manner, the difference between the two representing the amount of power diverted.

Head.

There may be several kinds of heads on the same development. There is the legal head, or the head to which the owner has a right to develop his power. This may or may not have been developed to its full extent. It may be that the expense involved would be too great to warrant further development. In some cases it might be economy to make the expenditure necessary to get the benefit of some unused portion of the head.

The gross head is the head actually used for producing power and getting the water onto and away from the wheel.

The net effective head is the gross head minus the loss in head required to get the water onto and away from the wheel. This loss will vary with the length of the water ways leading to and away from the wheels, the velocity of the flowing water and the construction of such water-ways.

In several manufacturing cities, where the water power is controlled by a company which is separate from the mill owners, there is an allowance of one foot made for the gross head before charging for the water as used on the wheels.

The head should be measured with the wheels running. The only portion of the head which produces power is the difference in level directly above and below the wheel, when the wheel is running.

Some tests of water wheels show a maximum efficiency of about 85 per cent. It is probable that rarely over 80 per cent. is realized in practice after wheels have been installed for a short time, and this is for three-quarters to full-gate opening. When the gate opening is less than about three-quarters, the efficiency begins to drop.

Fig. 2 shows an efficiency curve which has been published by one of the large wheel makers in ~~their~~ catalogue as the result of tests on one of their wheels. This is an excellent curve and represents a wheel of maximum efficiency which is not often found in practice.

After wheels have been run for some time the buckets and guides are not as smooth as when they are new and the efficiency drops off. For these reasons I usually allow an average efficiency for wheels running under ordinary conditions of age, repair and variable gate opening of about 75 per cent. Under exceptionally good conditions and where there are several wheels this could be increased.

Limit of Low Flow.

With vertical wheels and bevel gears, and belt drive to head lengths of shafting, the friction losses are probably from 5 to 10 per cent. of the total. With horizontal wheels the friction losses are probably from 2 to 5 per cent.

On Fig. 2 there is plotted in addition to the efficiency the percentage of water and power produced for different gate openings. From this it will be seen that with a small flow the efficiency and the amount of power developed will be small, and unless the total drainage area is fairly large, or the low flow is sustained from storage, the power developed in dry months may not be sufficient to run the wheel and overcome the frictional losses.

The flow required to produce 5 per cent. of the power is about 15 per cent. of the total water required to run the wheel full, and for 10 per cent. of power 20 per cent. of water is required. With one wheel only there must, therefore, be a flow of 10 to 20 per cent. of the total used by the wheel to produce any useful power. With several wheels properly arranged this could be reduced somewhat. At such times of low flow the water must either be stored and used for a short time in the day or it will produce no useful work.

Effect of Back Water.

In a great many places there are periods during the year when the flow in the stream is so large that the water backs up below the wheel to a greater extent than the water above the wheel can be raised, thus reducing the effective head and power. Sometimes the effect is so great as to prevent the use of the wheels.

Effect of Low Flow and Back Water.

The effect of low flow is to require an auxiliary power plant to make up the deficiency of water power, if it is necessary to run constantly, and if the flow drops so low as to produce no effective power, the auxiliary power plant must be of a capacity sufficient to run all of the work.

The effect of back water is to reduce the power produced by the water and to make it necessary to maintain a water power plant which has a surplus capacity in times of ordinary flow, or to maintain an auxiliary power plant and to run the same to make good the diminution of power if it is necessary to run full all the time. If the back water lasts for a long time and is so serious as to prevent any production of power from the wheels, the auxiliary plant must then be large enough to run the whole work.

economy to develop the power to use all the water under average conditions.

If the chance size of a wheel should be taken as measuring the length of time over which the damage continues, in a series of adjacent mills, some which had put in a portion of the wheel plant which could be used with economy would receive small damage, while a mill with a much larger wheel than would ordinarily be used would receive larger damages thereby, when in point of fact the damage would be the same, other things being equal, and with a series of mills the damages would not be proportioned properly unless the wheels were installed in each on the same basis of economical development.

Economical Development of Water Power.

In a large number of water power developments, which I have examined, a very large percentage have been developed with wheel capacity sufficient to use all of the water from six to seven months in an average year, and during the remaining months water would go to waste. The economical development has been stated by some engineers to be nine months. No general statement is applicable to all conditions. It is a question of economics which requires solving for each particular case.

TABLE.................. NAME..

Flow and Power before Diversion.								Flow and Power after Diversion.						Power Diverted
Col. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Months in the order of their dryness.	Natural flow in cu. ft. per sec. on one square mile.	Total flow cu. ft. per sec. = Col. 2 × square miles.	Multiplier or ratio of flow which can be used in 10 hours to 24-hour rate.	Total flow which can be used in 10 hours a day = Col. 3 × Col. 4.	H.P. which can be used in 10 hours a day on one foot fall = Col. 5 × .0851.	Total H.P. which can be used in 10 hours a day = Col. 6 × ft. head.	H.P. which present wheels can use or which would ordinarily be developed.	Total flow cu. ft. per sec. = Col. 2 × square miles.	Multiplier or ratio of flow which can be used in 10 hours to 24-hour rate.	Total flow which can be used in 10 hours a day = Col. 9 × Col. 10.	H.P. which can be used in 10 hours on one foot fall = Col. 11 × .0851.	Total H.P. which can be used 10 hours a day = Col. 12 × ft. head.	H.P. which present wheels can use or which would ordinarily be developed.	H.P. diverted which causes damage = Col. 8—Col. 14.
Dryest..														
2nd "														
3nd "														
4th "														
5th "														
6th "														
7th "														
8th "														
9th "														
10th "														
11th "														
Wettest														
Totals and Averages...														

Average H.P. diverted..............................for.....................................months in an average year...................

Length of Time During Which Diversion Causes Damage.

In order to ascertain the difference in running expense due to diversion, it is necessary to know the average amount of power diverted and for how many months the diversion occurs. This latter can usually be ascertained by knowing the capacity of the wheels in use, for in the majority of cases the wheel development will be an economical one.

It is sometimes the case, however, that larger wheels are installed than economy would warrant by overestimating the flow, or some other cause. Wheels are sometimes installed to be used in times of back water, remaining idle at other times. Where the variation of the use of power during the day is large, as for electric light and railway purposes, wheels may be installed for the peak load where pondage will allow this method of running. If the length of time when the diversion causes damage is measured by the capacity of the existing wheels, it may appear to be for the entire twelve months of an average year. This cannot be true, for it would not pay to put in wheels to use all of the water in every month in the year. The diversion should be estimated for as many months as it would be

The factors which enter into the problem are on one side the cost of water power development and the fixed charges on the same, plus the cost of water if anything is paid for it, and on the other side the saving which can be effected by the use of such a plant.

The cost of the dam will be a constant for any size of wheel development, other things being equal. The head gates, canals, racks, feeders, wheels, wheel-pits, and tail-races must be increased in size and cost for the purpose of using a larger amount of water than the flow in the average month or sixth month of an average year, and the fixed charges for such increase in cost, plus the cost of water, represent the annual cost of the corresponding increase in water power.

The saving due to such increase in water power is represented by the saving in coal only on supplementary steam plant, necessarily run with such a varying water power, plus the cost of attendance and supplies on steam plant if it can be shut down entirely during the months of maximum power on the wheels. As the water power is increased in size to use water for a greater number of months, the cost of such increase for each additional month makes a saving for a less number of months, and there comes a time when the saving on steam power is less than the fixed charges on the additional cost of water power plant. Where these two items balance depends upon the following conditions:

(1) Cost of running the water power plant for each increment of power.

(2) Saving effected by the decreased use of steam power.

The variation in the cost of the water power plant per horse-power is very large. The principal causes for this are the variation in head and distance from the source of supply of the water to the point of discharge. The cost of construction will also vary with local conditions.

The saving effected would also vary largely, depending principally upon the number of hours run during the day, the cost of coal, and whether by increasing the size of water power plant the auxiliary power plant could be stopped during the months in which the water power was producing full load.

An example will suffice to make this clear. Supposing the cost for each additional horse-power of water power plant required to use all the water for a longer period was $60 a horse-power. The fixed charges on this, including interest, will be not less than 8 per cent., or $4.80 per year. The cost of coal and attendance on a steam plant of say 500 horse-power, when running ten hours a day, with coal at $4 per ton, is about $13 per year per horse-power, or $1.08 per month. $4.80 ÷ $1.08 = 4.44 months. In other words, it would not pay to develop such a power to use all the water for more than about seven and one-half months.

If the engine or boilers cannot be shut down at all, a less saving could be made and the power could be economically developed for a less period than seven months.

The various conditions and lengths of time required to have the saving equal the fixed charges are shown on Fig. 3. This diagram is figured on coal at $4 per ton, and with a running time of ten hours a day, six days a week. Similar diagrams could be made for any other prices of coal and time of running.

To use the diagram supposing the water power plant cost $50 per horse-power, and the size of steam plant is 200 horse-power. On the ordinates find $50 cost of water power plant. Run along horizontally until this line intersects the vertical line of 200 horse-power of steam plant, and these two lines will be found to intersect about on the curve marked three months.

If the water plant cost $70 and the steam plant were 350 horse-power, the time is five months during which water should waste.

Table Showing Flow and Power.

The following table shows a convenient form for tabulating the flow and power. The first half is useful in estimating the value of a privilege, and the whole table for estimating damages when a portion of the flow is diverted.

The only thing needing explanation is the figure .0851, which appears in the headings of columns 6 and 12. This is the horse-power produced by one cubic foot of water per second on one foot head with an efficiency of 75 per cent. With 80 per cent. efficiency the figure is about .091.

(To be continued)

ESSENTIAL ELEMENTS IN THE DESIGN OF DAMS.

By John S. Fielding.

Although dams are among the very earliest of engineering efforts, more uncertainty still exists as to the proper methods to be pursued for ensuring stability than in the case of almost any other structure.

Present construction fails to utilize all the means now at hand for the building of permanent, economical and absolutely trustworthy structures of this type.

In the case of bridges, buildings, machines, etc., engineers are almost a unit in regard to the manner of estimating their strength, efficiency and factor of safety; and with given loads and conditions of loading, they can check each other's designs, and individual responsibility is largely eliminated, for each engineer feels that he is supported by the general practice in such cases.

If such a condition of intelligent common practice could be brought about in regard to the construction of dams, it would be much better for their builders, and for the community that would be exposed to the consequences of any failure in the judgment of the individual.

In the consideration of all matters pertaining to these structures, search should be made for some hitherto neglected forces or conditions affecting their stability, and for some form of construction that will give a large factor of safety under the most unfavorable conditions that can be assumed.

Assumed Co-efficient of Friction Should Decrease as Height of Dam is Increased.

In building a dam, the first consideration is the nature of the sub-base. If this be ideal, in regard to the probability of remaining tight under pressure, both from its power to prevent the passage of water or moisture, and its likelihood to carry the pressure to be imposed upon it without change, then we may take the known co-efficient of sliding of the materials composing the dam and the sub-base, and take one-third of this for a safety factor of three. Now, if we use this for a fifty-foot dam, and under similar conditions build a two-hundred-foot dam, we should not assume that the two structures have the same factors of safety; for the nature of the sub-base, the material used in the wall, and the cement joints are alike in each case, while the water pressure per sq. foot at the line of sub-base is 3,094 lbs. in the one, and 12,468 lbs. in the other. It would be necessary to have some very exhaustive tests in the laboratory, giving data showing the changes that occur in the co-efficient of friction under different heads of water, before it could be determined what precise theoretical allowance should be made for different heights.

The laboratory co-efficient of friction assumed at the outset would be for materials perfectly dry. There are also co-efficients for materials in a moist condition, and no doubt considerable height of dam could safely be assumed as remaining dry as in the laboratory; but it is equally certain that the greater the head of water, the greater would be the probability of this desirable condition changing for the worse.

Again, a dam is spoken of as having a certain factor of safety, and this safety factor is based upon an ideal condition of the sub-base. This ideal condition would have no inequalities in the nature of the rock deposit, no crevices, springs or imperfections whatever.

When these actual imperfections are encountered, great care is, of course, taken to make these portions come up to the standard; but if the actual case falls below the standard, as it is most likely to do, then the safety factor of 1 1-3, 1½ or 2 has not been secured, but we have sometimes less.

No figures can be given to grade the safety factor upward in proportion as the conditions decrease from the ideal or standard; but it can easily be seen that we would not speak of a dam having a safety factor of two, if at only a certain limited number of parts of its base are ideal conditions encountered; and if a spring be plugged up here, a bad piece of bed doctored there, and an out-cropping of shale met with somewhere else, we should make an estimate of how far these portions fall below the ideal or standard, double the safety factor, where the springs are, and add fifty per cent. to it, where the bad bed is, by actually increasing the section of the dam at such points; and taking everything into consideration, we would then have a uniform safety factor against sliding, or as near to it as any system not providing for unequal loads can give it.

As to the safety factors to be assumed: bridges are given a factor ranging from 5 to 10 including allowance for impact, buildings from 3½ to 6, and machines from 3 to 10, while the safety factor against sliding given gravity dams may be stated as between 1.3 and 1.8, with no allowance for impact, and in exceptional instances only with any allowance made for increase in pressure during floods. In a great many instances even the very small factor of 1.3 is not secured, and in some few instances a better factor than 1.8 is secured. When the comparative disaster that may follow the breaking of a larger dam is considered, this proportioning of the safety factor seems absurd, and if dams were graded in order of the possible destruction following breaking, the factor might probably reach 20 to 30 in some cases.

The table herewith gives a list of forty-eight well-known dams. Of these three are what may be termed ancient construction, having been built previous to A.D. 1600. Nine may be termed as of old construction, having been built previous to year A.D. 1852, which is about the time of the formulation of the French scientific theoretical profiles and formulæ. The remaining 36 sections may be termed of late construction.

Of the ancient dams, given above, all are built curvilinear on plan with safety factor of 2.29, 1.41, and 1.24.

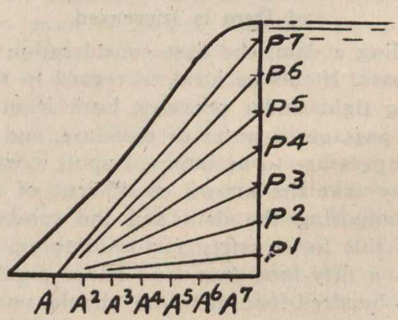


FIG. 1

Of the old dams, four are curvilinear or polygonal, resembling an arc of a circle, and five are straight on plan, with safety factors as follows, viz.: One of 3 or over; one of 2¾; two of 2½; one of 2⅛; this is, five with S.S.F. over 1.5; one of 1½; one of 1⅜; one of 1⅛; one of ¾; making four with S.S.F. 1½ or less.

Of the 34 dams of late construction, two are dependent upon the arched plan; 15 are curvilinear, and 17 are straight, with S.S.F. as follows, viz.: One has a S.S.F. of 2½; one of 2; three of 1¾; three of 1½; six of 1⅜; twenty of less than 1⅜. That is, five have S.S.F. over 1½, and 29 have S.S.F. of 1½ or less.

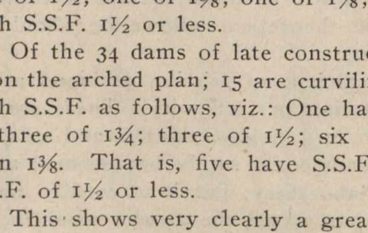
This shows very clearly a great reduction in the S.S.F. since the introduction of the so-called scientific profile, since out of 12 old dams and ancient ones, seven have S.S.F. over 1½, and five have S.S.F. 1½ or less, while out of 34 late designs, five only have over 1½, and 29 have 1½ or less.

Origin of the Scientific Profile.

The whole theory of the scientific profile is based upon some theoretical investigations made by the French engineers, M. De Sazilly and M. Delocre.

Their acceptance by the English-speaking world appears to be based upon endorsation of Prof. N. J. M. Rankine.*

The latter was requested by an English engineer, Captain Tulloch, in a letter dated December 10th, 1870, to give his views upon the above theories, and his reply, practically endorsing them, has been sufficient since then.



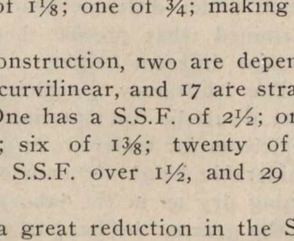


FIG. 2 FIG. 3

The great ability of Prof. Rankine is beyond all question, but that can be no bar to further investigation of any subject which he may have considered. It is not on record that he gave this important subject a second investigation or returned to it in any way subsequently.

The scientific profile is a very pretty mathematical exposition of the probable lines of stress in a dam (see plate 2), but its results, as shown in a design prepared by its aid, are not satisfactory for the following reasons, viz.:

1st. It gives what are claimed to be such close approximations to the actual stresses, that engineers are led to use too low a safety factor against sliding.

2nd. Whilst carefully avoiding tensile stresses in the vertical or inclined faces of the dam, it assumes reliance upon tensile stress in the horizontal fibres.

3rd. The pressure of 15,625 lbs. per square foot upon downstream face, and 20,000 lbs. upon upstream face of masonry, using material capable of sustaining anywhere from 30,000 lbs. to 200,000 lbs., gives a much better safety factor in the material than the structure itself has against sliding.

4th. The system results in a dam with a narrow top, whilst investigation shows that a dam should have considerable top width, and preferably a width in proportion to its length.

5th. It makes no provision for moving loads or unequal loads upon the dam considered as a unit.

The first objection is fully proven in the foregoing, wherein it has been shown that a very great proportion of recent dams have a sliding safety factor of 1½ or less.

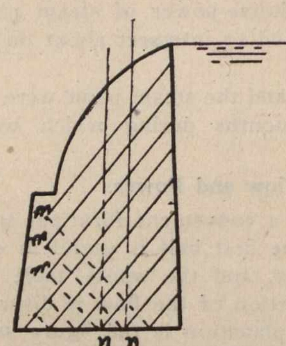
The second objection is set forth more fully below in discussion of horizontal tensile stresses from toe to front of dam.

The third objection is self-evident from recorded tests of strength of material.

The fourth and fifth are set forth more fully in chapters following.

Horizontal Tensile Stresses from Toe to Front of Dam, Assuming that the Pressures Concentrate at the Toe.

If the dam has a safety factor against overturning, i.e., until the overturning moment equals the stability moment, then there is no resultant of forces, but it is the case of direct push from the centre of the pressure at P1, P2, etc., to A1, A2, etc. These lines of pressure, AP1, AP2, etc., will take the most direct route to a point that will absorb the pressure. All of these lines of pressure have horizontal resultants giving horizontal tensile stresses.



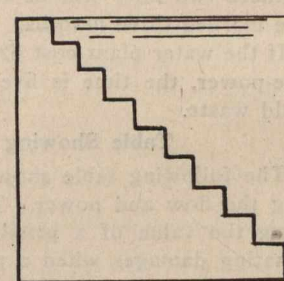


FIG. 4 FIG. 5

Assuming area A as taking up the vertical component, and calling upon all portions of the base to contribute their share of inertia, due to their contact with bed of stream, to aid in taking up the horizontal component, then the area A7, having the greatest height of masonry upon it, will contribute the greatest amount; A6, the next; A5, A4, and so on. This will create great tensile stresses between A and A2, since it will have the pull of A7, A6, A5, A4, and A3.

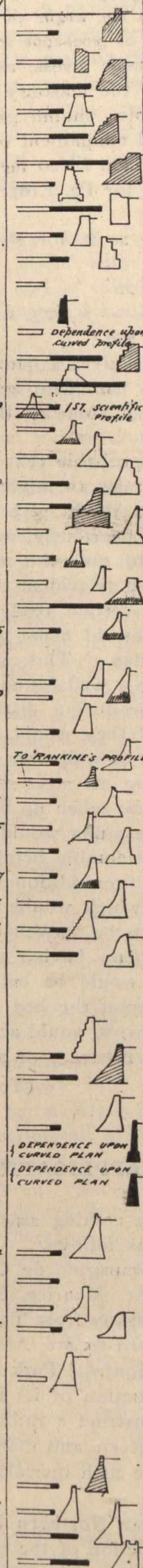
In a lesser degree there will be tensile stress between A2 and A3, between A3 and A4, between A4 and A5, between A5 and A6, and between A6 and A7.

Now we know just where the pressure of the water is, and we know that this pressure will be delivered to the bed of the stream, and we can assume that the portion A will get the most of it, but it cannot take it all, for it is evident that if it did so these tensile stresses would be great enough to tear the dam in two between A and A2. No doubt the pressures P1, P2, etc., would deliver their loads through an angle of 45 deg. so long as they found stability at the ends of these lines of pressure to receive them. Now, in a dam

*See Prof. Rankine's "Miscellaneous Scientific Papers," 1881.

~ SLIDING SAFETY FACTORS &c. ~

	NAME OF DAM	LOCATION	DATE MATERIAL PLAN	AREA	WT PER C FT.	TOTAL WEIGHT	ADHESION = T. WT. x by ·65 COEF.	HEIGHT OF WATER	WATER PRESSURE	SLIDING SAFETY FACTORS S.S.F.	COEF. OF FRICTION	REMARKS
	ALMANZA	SPAIN	AMr	1496	150	224.400	145.860	61·3	117.562	145860/117562 = 1·24	·5238	
	ELCHE	"	AMr	2615	150	392.250	254.963	76·12	180.500	254963/180500 = 1·412	·4601	
	ALICANTE	"	AMr	11839	150	1.775.850	1.154.302	127·0	504.000	1154302/504000 = 2·29	2830	
	LAMPY	FRANCE	OM-	1229	150	184.350	119.828	51·35	82400	119828/82400 = 1·454	·4448	
ø	PUENTES	SPAIN	OMP	16349	150	2.452.350	1.594.027	153·5	740000	1.594027/740000 = 2·154	3075	
	VAL DE INFIERNO	"	OMP	11668	150	1.750.200	1.137.630	116·4	420500	1.137.630/420.500 = 2·705	·2402	
¤	GROS-BOIS	FRANCE	OMS	2503	150	375.450	244.040	83·0	215280	244040/215280 = 1·133	5733	
	VIOREAU	"	OMS	872	150	130.800	85.020	32·8	33620	85020/33620 = 2·529	·2570	
	BOSMELEA	"	OMS	987	150	148.050	96.232	46·9	68900	96232/68900 = 1·396	·4653	
	GLOMEL	"	OMS	774	150	116.100	75.465	39·0	47530	75465/47530 = 1·587	·4093	
	TILLOT	"	-M-	1173	150	175.950	114.367	65·6	134560	114367/134560 = ·8491	7648	
	CHAZILLY	"	-M-	~ THEOR'L PROFILE ~ SEE THEOR'L PROFILE SHEET ~								
	ZOLA	"	OMr	3645	150	546.750	355.387	119·7	447750	355387/447750 = ·7937	8189	dependence upon curved profile
	NIJAR	SPAIN	OMr	5386	150	807.900	525.135	82·0	210.125	525135/210125 = 2·499	·2601	
	LOZOYA	"	OMS	9052	150	1.357.800	882570	94·0	276125	882570/276125 = 3.196	.2033	
	FURENS	FRANCE	LMR	10712	150	1.606.800	1.044.420	164·0	840500	1044420/840500 = 1·242	·5230	1st. scientific profile
	TERNAY	"	LMR	4355	147	640.185	416.120	112·7	396.915	416120/396.915 = 1.048	·620	
✦	HABRA	ALGIERS	LMS	5584	134	748.256	486.366	116·8	427.000	486366/427000 = 1·139	·5706	
	CAGLIARI	ITALY	LM-	2430	150	364.500	236.925	70·5	155.300	236925/155300 = 1·525	·4260	
	VERDON	FRANCE	LMr	863	150	129.450	84.142	41·17	53000	84142/53000 = 1·587	·4097	
	BOYD'S CORNER	UNITED STS	LCS	2039	140	285.460	185.550	78·0	190.125	185550/190125 = ·9759	·6660	
	BAN	FRANCE	LMR	6780	150	1.017.000	661.050	137·9	595.000	661050/595000 = 1·111	·5855	
	TLELAT	ALGIERS	LMS	1560	150	234.000	152.100	68·9	153.000	152.100/153.000 = ·9900	·6538	
	GILEPPE	BELGIUM	LMR	18708	143·5	2.684.598	1.744.990	147·6	684.500	1.744.990/684.500 = 2·549	·2549	
	VILLAR	SPAIN	LMR	11596	143.	1.658.228	1.077.848	162·3	820.125	1077848/820125 = 1·3143	·4945	
	PAS DU RIOT	FRANCE	LMR			PROFILE BASED UPON FUREN'S						
	DJIDIONIA	ALGIERS	LMS	2600	150	390.000	253500	83·67	218750	253500/218750 = 1·158	·5609	
	GEELONG	AUSTRALIA	LCR	1214	143.	173.600	112 840	60·0	112.500	112 840/112500 = 1·003	·6480	
	POONA	INDIA	-M-	3725	150.	558.750	363.188	97·0	294.000	363188/294000 = 1·235	5261	
	TOOLSEE	"	- -	2527	150.	389.050	250.680	79·0	195.000	250680/195000 = 1·285	5063	To Rankine's profile
	HIJAR	SPAIN	LMr	8454	150	1.268.100	824.265	141·0	621.280	824265/621280 = 1·326	·4900	
	GORZENTE	ITALY	LM-	5657	150	848.550	551.560	121·4	460.560	551.560/460560 = 1·197	·5427	
✦	BOUZEY	FRANCE	LMS	1961	150	294.150	191.200	75·4	180.786	191.200/180.786 = 1·057	·6145	
ø	GRAN CHEURFAS	ALGIERS	LMS	6775	150	1.015.250	659.912	131·0	536.280	659912/536280 = 1·23	·5262	
	PONT	FRANCE	LMR	2755	150	413.250	268.612	85·3	227.600	268.612/227600 = 1·180	·5507	
	HAMIZ	ALGIERS	LMS	5629	150	844.350	548.828	114·8	411.800	548.828/411.800 = 1·33	·4877	
	BRIDGEPORT	UNITED STS	LMS	765	150	114.750	74590	40·0	50.000	74590/50.000 = 1·49	·4357	
	VYRNWY	ENGLAND	LMS	8972	160·8	1.441.700	937105	129·0	520 031	937105/520031 = 1·802	·3607	
	VINGEANNE	FRANCE	LM-			Information	Lacking					
	TACHE	"	LMR			"	"					
	COTATAV	"	LM-			"	"					
	TYTAM	CHINA	LC-	3978	150	596.700	387.855	95·0	282.030	387.855/282.030 = 1·375	·4726	
	SAN MATEO	UNITED STS	LCr	16660	150	2.499.000	1.624.350	170·0	903.125	1624.350/903125 = 1·79	·3614	
	SODOM	"	LMS			Information	Lacking					
	TANSA	INDIA	LM-	5790	150	868.500	564.525	118·0	435.125	564525/435125 = 1·29	·5010	
	BEAR VALLEY	UNITED STS	LMr	537	166·7	89.520	58.190	64·0	128.000	58190/128000 = ·454	1·429	Dependence upon curved plan
	SWEATWATER	" "	LMr	2347	164.	150.208	97.635	90·0	253125	97635/253125 = ·3857 o.k.	1·685 o.k.	Dependence upon curved plan
	BHATGUR	INDIA	LM-			Information	Lacking					
	BETWA.	"	LMR			Information	Lacking					
	PERIAR	"	LMS	10772	140.	1.508.080	980.252	153·0	731.531	980.252/731.531 = 1·341	·4844	
	BEETALOO	S. AUSTRALIA	LCR	4610	150	721.500	468.975	110·0	378.125	468975/378125 = 1·24	·5240	
	MOUCHE	FRANCE	LMS	3300	134.	442.200	287.430	95·0	282.030	287430/282030 = 1·02	·6423	
✦	COLORADO	UNITED STS	LMS	2300	—	322.000	209.300	70·0	153.125	209.300/153.125 = 1·366	·4755	
	BUTTE CITY	" "	LCr			Profile	Lacking					
	TITICUS	" "	LMS	5209	150	781.350	507.880	135·0	569.530	507880/569530 = ·891	·7288	
	REMSCHEID	GERMANY	LMr			Profile	Lacking					
	LAGRANGE	UNITED STS	LMr			"	"					
	EINSIEDEL	GERMANY	LMR			"	"					
	HEMMET	UNITED STS	LMr	7500	150	1.125.000	731.250	135·5	583.765	731250/583765 = 1·25	·5197	
	WIGWAM	" "	LMS	2870	150	430500	279825	90	253125	279825/253125 = 1·10	·5877	
	NEW CROTON	" "	LMS	28400	150	4.260.000	2.769.000	224	1.568.000	2.769.000/1.568.000 = 1·76	·3680	
	ASSUAN	EGYPT	LMS	3826	150	573.900	373.000	75·5	178.140	373.000/178.140 = 2·09	·3104	



~ EXPLANATION OF SYMBOLS USED ABOVE ~

A = Ancient or previous date to 1600
O = old " " " 1852
L = modern " since " of 1852

S = straight on Plan
P = Polygonal " "
R = Curved " " to large radius
T = " " " " small "

M = Masonry
C = Concrete

✦ = Failed
¤ = " in part
ø = shewed weakness

THE MARGIN of SAFETY is shown graphically in col. under Remarks.
The total length of the bar equals the safety-factor (S.S.F.)
The Light portion " " " " pressure
The Heavy " " " " " margin of safety, i.e. the excess strength over and above the pressure

IN LAST COLN ARE ALSO GIVEN SECTIONS OF DAMS
THOSE IN BLACK ARE DEPENDENT UPON ARCHED PLAN
" HATCHED " CURVILINEAR TO SHORT RADIUS i.e. T
" SLIGHTLY " " " LARGE " " R
THOSE NOT HATCHED AT ALL ARE STRAIGHT ON PLAN - S

For further explanation of this table, see Canadian Engineer, July, 1904.

such as Figure 2, all of these 45 deg. lines would be taken up by their own co-efficient on the bed of stream, and practically no tensile stresses would accrue as horizontal components; but in a dam such as Figure 3, there would be a change in the angle of the diagonal pressures, and an accumulation of pressure at the toe. This would entail horizontal tensile stress, as before outlined. In Figure 2 the height of the masonry vertically above each area or point, A1, A2, etc., should give a weight to correspond with the horizontal component of each diagonal stress.

In a dam of 20 feet in height, the pressure will be, for P1, 1,250; for P2, 1,187; and for P3, 1,125. The height, then, should be 20 ft. for P1; $\frac{20}{1,250} \times 1,187$, or 18.99, for P2, and for P20, $\frac{20}{1,250} \times 62.5$, or 1 foot; for P10, $\frac{20}{1,250} \times 625$, or 10 feet. This gives a dam with base equal to the height.

For a dam with height greater than its base, it will be evident that some of these diagonal stresses will not be at 45 deg.

It is probable that for P1, P2, P3, P4, P5, P6, and P7, this will take an angle of 45 deg., increasing towards the top. This would give a large horizontal tensile stress, as described previously, and would entail greater height over the toe, to give the necessary inertia required there.

Now, it is evident that if the stresses came, as shown in Figure 3, certain routes of stress would be overcrowded, and this would make greater decrement of length than on other routes. This would not be admissible, because stresses in a wall cannot converge to any point of such wall without producing distortion, and consequently it is unlikely that they would so converge, and the carrying up of the height of wall over the toe would work the cure for this by allowing all stresses to go in 45 deg. lines, and the pressures be taken up by reverse lines in tension m n. This line of reasoning would give a great width to the structure for a considerable height above the base (see Fig. 4), and would require additional weight and height of wall over the points n, which would work out to a line resembling the parabola to be spoken of later.

In a dam having a low tensile strength in the lower planes, it would be better to have the greatest weight or pressure upon the bed of stream, at the point where the greatest thrust would accrue. This would give a section the reverse of Figure 4, or as Figure 5.

(To be continued.)

APPLICATIONS TO PARLIAMENT.

At the coming session of Parliament, applications will be made, as follows:

La Compagnie de Chemin de Fer Electrique de Trois-Rivières, St. Maurice, Maskinongé et Champlain; to construct a railway from Three Rivers westward to Maskinonge, and eastward to Ste. Anne de la Perade.

The Montreal Park and Island Railway Co.; to continue the construction of its railway.

To construct a railway from the coal deposits in townships Eighteen and Nineteen in ranges Seven and Eight, west of the fifth meridian, to Lethbridge. T. Allen for applicants.

Canadian Northern Railway Co.; to extend the time for the construction of the company's uncompleted lines of railway; and authorizing the company to lease or acquire running powers over the lines and leased lines of the Great Northern Railway of Canada, and the Chateauguay and Northern Railway Co., and the Irondale, Bancroft and Ottawa Railway Co., and the Quebec, New Brunswick and Nova Scotia Railway Co., and the James Bay Railway Co., or any of them, or to purchase such lines or amalgamate with the companies or any of them. Also authorizing the company to construct the following lines: 1 From Regina northwesterly and westerly to a point on the Red Deer River, in Alberta, with a branch line west of the Saskatchewan River and running northerly to a point in Township 45, Range 4, west of the third Meridian, in or near Carlton on the North Saskatchewan River. 2. From Regina northerly to or near Humboldt; thence northeasterly down the valley of the Carrot River to a point at or near the Pas Mission on the Saskatchewan River. 3. From a point on the main line of the Canadian Northern Railway between Humboldt and the South Saskatchewan River, northeasterly to a point at or near the crossing of the South Saskatchewan River by the Prince Albert branch of the Canadian Northern Railway. 4. From a point on the main line of the Canadian Northern Railway west of Battleford into Battleford.

Montreal Terminal Railway Co.; to construct electrically-operated branch lines in the Counties of Hochelaga, Maisonneuve, Jacques Cartier, Chambly, Vercheres, La Prairie, St. Johns, Iberville, Rouville, and St. Hyacinthe, and to sell electric power for all purposes.

Montreal Bridge Co.; for authority to purchase and amalgamate with the Montreal and Longueuil Bridge Co., and to change the proposed site of the bridge.

Alberta Railway and Irrigation Co.; for authority to amalgamate with the Western Alberta Railway Co.

Vancouver and Coast-Kootenay Railway Co.; to extend its line from Nicola Lake via Kamloops to Pine River Pass; and to build branch lines from its main line to Penticon, on Okanagan Lake.

Regina and Hudson's Bay Railway Co.; to extend the time for the commencement and completion of its railway and branches.

Ottawa River Railway Co. to amalgamate with the Ottawa River Railway Co (Ontario), to build branches and to extend the time for completion of main line and branches.

Vancouver and Northern British Columbia Railway Co.; to build a railway from Vancouver to the Squamish Valley and through Pemberton Meadows to the northern boundary of the province.

St. Mary's and Western Ontario Railway; for incorporation with power to build a line of railway from a point on the C.P.R., between Woodstock and London, northerly through Oxford, Middlesex, and Perth counties to St. Mary's, and thence westerly through Perth, Huron, Middlesex and Lambton or any of them to a point on Lake Huron or St. Clair river, between Grand Bend and Sarnia.

To construct a railway from a point on either the James Bay Railway or the C.P.R. in the Township of Wood, Muskoka, to a point on the Lake of Bays. F. Hornsby, Gravenhurst, solicitor.

Calgary, Red Deer and Battleford Railway; for incorporation with power to build a railway from Calgary to Battleford.

Central Counties Railway Co.; to build a bridge from Point Fortune, on the south side of the Ottawa river, to Carillon, on the north side; to build a railway from Carillon to Montreal; to extend the time for the completion of the railway, and other powers.

London and St Clair Railway; for incorporation with power to build a railway from a point on the Ontario and Quebec Railway, west of London, to Sarnia or a point on the St. Clair River between Sarnia and Lake St. Clair.

Canada-Middlesex Railway; for incorporation with power to build a railway from some point on the Niagara River to London.

Niagara-Welland Power Co.; for power to use its canal for navigation purposes, to build a tramway along its right of way, and to extend the time for completion on its works.

James Bay Railway Co.; to change its name; to acquire the lines of the Quebec, New Brunswick and Nova Scotia Railway Co.; to lease its lines and leased lines to the Canadian Northern Railway Co.; and to construct the following lines: (1) From a point on the company's line south of Lake Muskoka, easterly to Montreal passing through or near Ottawa with branches to Ottawa and Hawkesbury. (2) From a point on the French River, easterly to Montreal, passing through or near Ottawa with branches to Ottawa and Hawkesbury. (3) From Sudbury westerly and south of Lake Nepigon to a point on the Canadian Northern Railway west of Port Arthur passing through or near Port Arthur or with a branch to Port Arthur.

Canadian Pacific Railway Co.; for extension of time in which to construct the following lines: From Deloraine southwesterly to a point in township one or two, and thence westerly for a distance of one hundred miles. From Napinka, on the Souris branch, westerly to a junction with the northwest extension of the Souris branch. From a point on the Manitoba Southwestern Colonization Railway between Manitou and Pilot Mound; thence in a general southerly direction to a point at or near the international boundary. From a point on the Souris branch between Lauder and Menteith; thence easterly and northeasterly to a point between Glenboro and Treesbank on the Glenboro extension of the said Souris branch. From Osborne, on the Pembina Mountain branch, westerly and southwesterly to some point on the line of the Manitoba Southwestern Colonization Railway between Cartwright and Boissevain. From West Selkirk in a northerly direction about sixty miles through ranges three or four east to some point on the west shore of Lake Winnipeg; thence in a direct line northwesterly to a point on the Little Saskatchewan river distant not more than six miles from Lake Winnipeg.

Great Northern Railway of Canada; to acquire the lines of the Chateauguay and Northern Railway Co., and the Quebec, New Brunswick and Nova Scotia Railway Co., and for power to lease its lines and leased lines to the Canadian Northern Railway Co. or the James Bay Railway Co.; also to build a line from a point near Grand Mere to its terminals in Quebec City, with a branch to the Quebec bridge.

Vancouver, Westminster and Yukon Railway Co.; to increase the capital from $2,000,000 to $12,000,000, and to extend the time for completion by five years.

Nicola, Kamloops, and Similkameen Coal and Railway Co.; to construct, in extension of the railway now authorized, a railway from Osoyoos Lake to Grand Forks, with power to connect with the Vancouver, Victoria and Eastern Railway, at Grand Forks, and with the Columbia and Western Railway at Midway; and extending the time for the commencement and completion of its undertaking.

The Walkerton and Lucknow Railway Co.; to build an extension of its authorized line from Hanover via Durham easterly to a point of connection with the Toronto, Grey and Bruce Railway between Flesherton and Dundalk, and southerly from Lucknow to Wingham, and a branch line from Teeswater northwesterly to Kincardine.

Georgian Bay and Seaboard Railway. For incorporation with power to construct a railway from a point on Georgian Bay, between Point Severn and Penetanguishene in a southeasterly direction through the counties of Simcoe, Ontario, Victoria, Peterboro, Hastings, Lennox and Addington, Frontenac and Lanark, or any of them, to a point of connection with the Ontario and Quebec Railway between Cavanville and Maberly.

The following companies will apply to Parliament for extension of times in which to complete their various undertakings:

Calgary and Edmonton Railway Co., construction of branches.

Canada Southern Railway Co., construction of lines and branches.

Canada and Michigan Bridge and Tunnel Co.

Canada Southern Bridge Co.

Red Deer Valley Railway and Coal Co.

The Ottawa, Northern and Western Railway Co.

The Columbia and Western Railway Co.

DIAMOND TOOLS.*

BY G. C. HENNING, NEW YORK, N.Y.

Steel is, of course, the one material in almost universal use for cutting and working stone, metal, wood and other materials, because of its great strength and the degree to which it can be hardened. There are some materials, however, which, because of their hardness, structure or non-conductivity of heat, cannot be worked economically by means of steel tools. The latter become worn rapidly, losing their shape and dimensions to such degree and extent that the work produced becomes inaccurate, causing constant interruption of operation, loss of time, and the use of new tools or frequent regrinding or shaping of the old ones. This causes great expense and delay in production.

The great friction produced by cutting materials in some cases draws the temper of steel tools, making them useless.

Hard rubber, paper and hardened steel cannot be readily worked by use of steel tools, as is also the case with hard stone. In these cases a much harder material is required, and for this reason diamond is used. The diamond which is used is of two kinds, totally different in appearance and quality.

Black Diamond.—This has a very dark purple brown color, is an amorphorus, granular stone with rarely any crystallization visible or traceable, and is called carbon or black diamond. It is the hardest material known and has great strength.

Bort.—This is entirely crystalline, and generally transparent and of all colors of the rainbow, as well as clear and transparent as glass. The latter is considered of greater hardness than all other bort except some which is almost black. Bort is extremely brittle and is readily fractured or "cleaved" in the three directions of its cleavage planes parallel to the sides of the octahedral crystal, in which shape it is most commonly found. The dodecahedral crystals are also readily cleaved in a similar manner.

In spite of the very great hardness of all kinds of diamonds, they are readily sawn, drilled, cut and polished; carbon (black diamond), cannot, however, be polished, as is the case with bort. Diamond cuts diamond, while steel saws and drills and cast iron discs, charged with diamond dust, are used for the other operations. All kinds of grinding wheels, being made of extremely hard materials, are most readily kept free from filling or glazing and in perfect shape by diamond tools.

In certain classes of work, where great accuracy and precision are primary requirements, or extremely fine lines are essential, the diamond is the only material that answers the purpose. Thus lithographers, engravers and scalemakers use them for fine work. There is another very important field of production in which diamond is all but imperative to obtain satisfactory results at reasonable cost, viz., that of wire drawing.

Formerly all small wire was drawn through holes in hardened steel plates, but these wear so rapidly that the wire soon loses its calibre and becomes unround. As it is all-important, especially in electric work, that the wire be of absolutely uniform size, so as to maintain constant resistance and permit symmetrical distribution of weight about spindles and shafts, it became necessary to use a material harder than steel, and hence diamond was again resorted to. This made it possible to avoid delays in replacing worn dies, and because of the great permanence of accuracy of the calibres of the holes in the diamonds, materially reduced the cost of producing fine wire of copper, brass, steel, iron, nickel, and of other metals. It is of course well known that stone is drilled and sawed by use of diamonds, these having been used in core drills, which, in an extreme case, have cut solid cores of about 21 inches diameter. In diamond drills, stone saws and grinding wheel dressers, the rough diamond is used in appropriate holders, set either by staking, brazing, soldering, or by casting molten steel around the diamonds.

A peculiar property of the diamond is that it can be plated like any metal; this property is made use of in the galvanoplastic setting. This method of setting consists in first plating the diamonds and then casting other molten metal around them, which alloys with the deposited metal. Thus an absolutely firm and rigid setting is produced.

Very high temperature does not affect the diamonds either in their hardness or, when sound, in their solidity, and does not produce checks or other flaws. A temperature higher than that sufficient to melt steel will, however, burn the diamond, and that of the electric arc will do so readily.

The diamonds in tools used for doing accurate work are, however, all "shaped" by cutting and polishing, so as to imitate the customary shapes of steel tools. Glass and

*Presented at the New York meeting, December, 1904, of the American Society of Mechanical Engineers.

china are drilled by shaped diamonds, in which case a triangular splint is generally provided with a flat triangular pyramidal point, which, when using turpentine as a lubricant, penetrates glass and china more readily than any other tool, and lasts for from one to two years, unless broken by carelessness or accident.

Diamond tools are commonly used for turning hard rubber, because the diamond lasts a very long time without wear and produces absolutely smooth and accurate work, while steel tools wear off in a few minutes at most and get very hot. One other reason why it is economically advantageous to use diamond tools for turning hard rubber is that very high speeds can be used, 450 to 500 feet per minute being common.

It may here be added that diamond tools are most suitable for working carbon used for electrical purposes.

Diamond dies are used for drawing wire. The die is a bronze block in which is set a diamond perforated by a tapering, polished hole through which the wire is drawn. The holes in these diamonds are rarely made larger than .064 inches diameter, because steel draw plates or dies are considered sufficiently accurate and economical for larger sizes, and because of the great cost of diamond dies. The smallest dies which have come to the notice of the writer had holes of .001 in. diameter although clients have called for calibres as small as .00045, .00055 and .00065. It is common practice to make the holes in diamond dies accurate to a .0001 inch, which to many engineers may seem almost impossible, and is therefore here mentioned.

In drawing copper wire, it is customary to draw a .064 wire in one pass from a rough wire of .072 diameter. Smaller sizes are then produced by the following consecutive reductions: to .053, .045, .040, .036, .032, .028, .025, .022, .020, .019 then by 1-1000 down to .0075 and by half-thousandths down to .001.

It may be mentioned that diamonds wear increasingly when drawing the following metals in the order stated, viz.: gold, silver, copper, brass, bronze, platinum, soft steel, nickel, iron and crucible steel (piano wire).

In order to show why such expensive material as diamond can be used economically, it may be stated that diamond dies wear up to eight years under constant use. One die of .004 calibre has, according to the record, drawn over 550,000 pounds of soft copper wire.

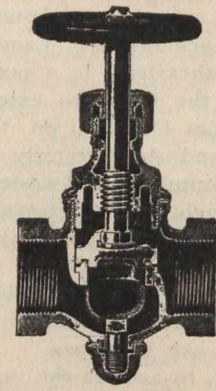
Diamond drills for drilling glass wear from one and one-half to two years before requiring recutting. As is well known, diamonds are also used for spindle bearings in watches, and most recently have been introduced as cupped bearings for the pivots of electric meters, because they produce the minimum of friction, and do not wear out in many years. Another purpose for which diamonds are used is that of drilling teeth, especially artificial teeth. In these drills minute chips of diamonds soldered into steel shanks are used. These diamonds are not prepared in any manner, as their points and edges when properly selected are sufficiently hard and sharp to penetrate bone and porcelain. The shapes of chips generally used are flat, triangular points and three-sided pyramids. The most perfect drills for this purpose have diamonds of the triangular sections with a pyramidal polished point.

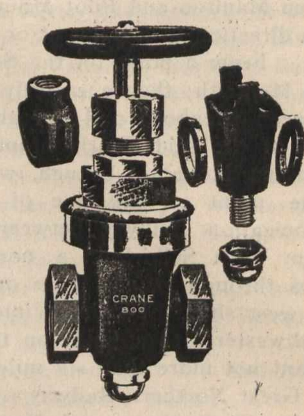
IMPROVED CRANE VALVES.

Fifty years' practical experience in the manufacture of steam and engineering appliances of all kinds and the degree of perfection which has attended all their efforts in developing and placing at the disposal of their patrons many articles of recognized merit and of superior design and construction, have established for the Crane Co., Chicago, a reputation of which they may be justly proud.

They have recently brought out and have applied for patents on Improved Renewable Seat and Disc Globe and Angle Valves. These valves are suitable for working pressures up to 250 pounds, and are tested to 700 pounds' pressure per square inch.

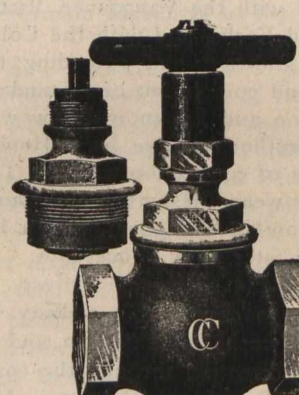
As the accompanying cuts will show, they are an improvement over anything heretofore made, and embody several new and valuable features, which will be readily appreciated. The renewable parts are made of hard and superior composition, far better than the usual composition put into valves, and last many times longer than those in the ordinary valves. They are especially suitable for any hard work where extreme pressure is used and where the wear and tear on the valve is most severe.





By unscrewing the nut on bottom of valve all parts are accessible and removable from the top, thus making it convenient to substitute a new seat or new disc when required, or to replace any worn part. The disc being attached to the stem by a slot, is easily removed and replaced. The seat and disc can be removed and the two ground together if necessary. In putting valve together, replace the seat, then tighten the nut on bottom of valve, which holds the seat in place; then screw on the bonnet and close the valve.

The construction of these valves is such that they may be packed when open without steam escaping.



The Crane Patent Renewable Seats and Wedge Straightway Valves also illustrated in this article, are made with copper seats and hard metal wedge; they are suitable for working pressures up to 250 pounds and are tested to 800 pounds' pressure per square inch.

The ready method of inserting these renewable parts and the wide range in the use of these valves, on all kinds of severe service will recommend them to all users who require thoroughly first-class and reliable goods. Soft metal rings or seats will be furnished for water or air, when so specified.

The Crane "Self-Packing" Globe and Angle and Radiator Valves (patent applied for), are made with Jenkins disc and non-rising stem, and satisfactorily supply a demand for valves embodying this very desirable self-packing feature.

All consumers of radiator valves know that leaky stuffing boxes are a source of a great deal of annoyance, caused by the escape of steam and water, soiling the trimmings of valves, also the carpets, walls and ceilings and necessitating the annoyance of the engineer going through apartments, looking after and repacking leaky valves. The Crane Self-Packing Radiator Valves, illustrated above, have been thoroughly tested, both as to efficiency and durability, and fully obviate this trouble and annoyance.

Many attempts have been made in the past to produce a self-packing valve, but with unsatisfactory results, because they have been made with two metallic parts, which, grinding together, soon become leaky. In the Crane Self-Packing Valve, a piece of vulcanized rubber is introduced between these two metallic parts, which makes a perfect seat; and in large experience with these valves in actual service, this device has completely overcome the tendency to leak; in fact, where used under the most severe conditions, entirely satisfactory results have been obtained. In any event, should these valves become leaky, a new vulcanized rubber disc can readily be inserted.

The application of this device, when applied to globe and gate valves, will be appreciated by all users of steam and water, as it obviates the constant attention of the engineer, or other persons in charge of the plant, in looking after leaky valves.

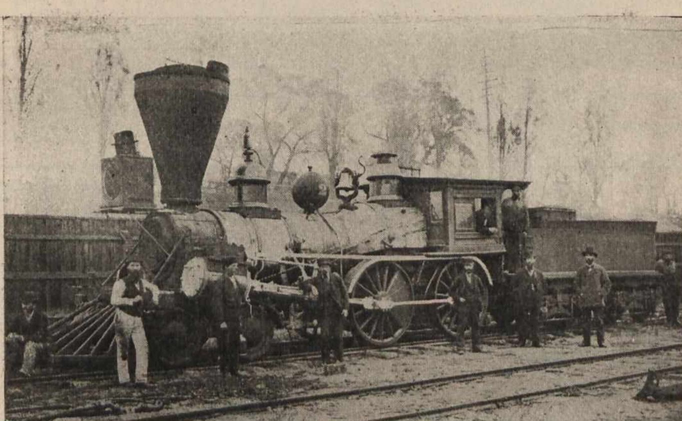
The threads on the bonnet of these self-packing valves are the same size as those in the Jenkins' disc valves, made by the Crane Co., and any one wishing to replace the old style trimmings with this new self-packing device, can do so without removing the valve.

This self-packing device, if desired, can also be applied to any of the Crane Co. brass wedge gate valves, with non-rising stem.

So confident are the Crane Co. that these valves will meet all the requirements, that they do not hesitate to guarantee entire satisfaction to all their customers.

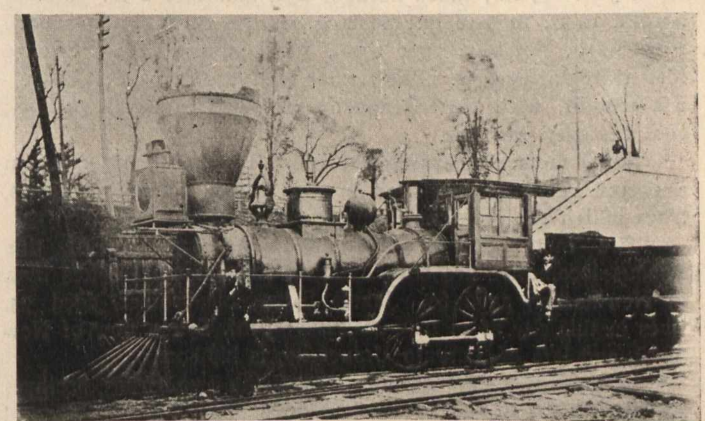
PROGRESS IN CANADIAN RAILWAY ENGINE BUILDING.

The first railway in Canada, the St. Lawrence and Champlain, was opened in 1836. The rails were made of wood with straps or bars of iron spiked on them, and the



The "Toronto," the First Locomotive Built in Canada, 1853.

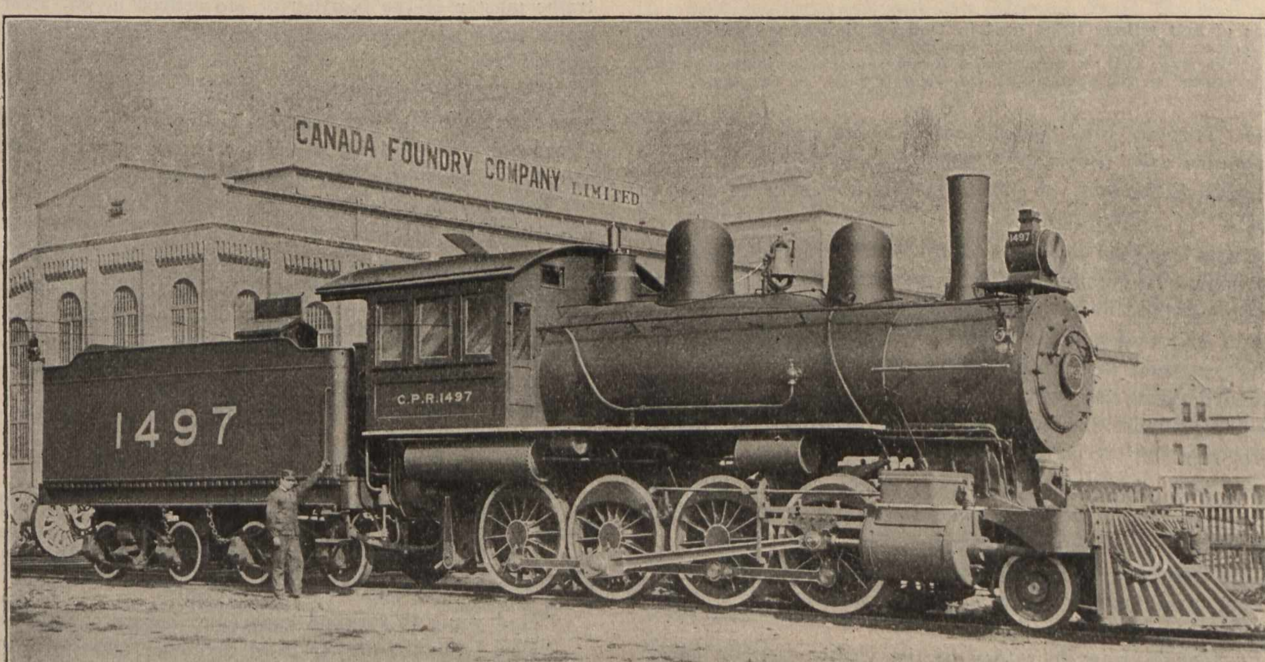
first locomotive was one of the primitive kind, like the "Rocket," sent out from England. It was caged up and secreted from view, and the trial trip was made by moonlight in charge of the Old Country engineer sent out with it. At first "the Kitten" could not be got to run, but afterwards made a speed of 20 miles an hour. The next locomotives were the "James Ferrier," and the "John Molson," made by Kinmond & Co., Dundee, Scotland, and shipped to Montreal in 1848. These were used on the Montreal & Lachine Railway. The first Canadian-built locomotive was



"Lady Elgin," First Engine on Ontario, Simcoe & Huron Railway.

the "Toronto," made in the shop of James Good, Toronto. She was finished and went into service in 1853 on the Ontario, Huron & Simcoe Railway, (afterwards the Northern), running at first from Toronto to Bradford and Barrie. The first engine actually used on this road, however, was the "Lady Elgin," built at Portland, Me., and used as a construction engine in laying out the road in 1852-3. The "Toronto" made her first trip to Machell's Corners (now Aurora), on the 16th May, 1853, with John Harvie, now secretary of the Upper Canada Bible Society, as the conductor of the train. To him we are indebted for the accompanying photos of these early locomotives, and for the reproductions of the first railway tickets and first tariff of passenger rates. Mr. Harvie is shown standing on the ground at the front corner of the tender in the picture of the Toronto.

To show the progress made in the half-century that has elapsed since the beginning of locomotive building in Ontario we give herewith an illustration of the first modern locomotive turned out at the close of 1904, by the Canada Foundry Co., of Davenport, Toronto, whose new shops would take in forty of that of the pioneer railway engine builder. For purposes of comparison, the magnificent specimen of modern engine building turned out by the Canada Foundry Co. for the Canadian Pacific Railway, will be of interest. She is what is known as the C.P.R. 10-compound consolidation locomotive. Total weight in working order, 164,000 lbs.;



First New Locomotive from Shops of Canada Foundry Co.

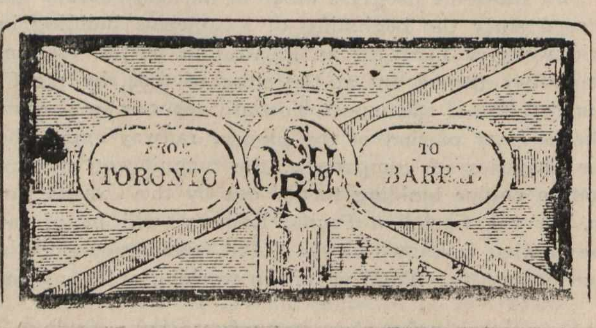
on drivers, 144,800 lbs.; diameter of cast steel drivers, 57 in.; diameter high pressure cylinder, 22 inches; low pressure, 35 inches by 26 inches stroke. Boiler type, radial stayed, with working pressure of 200 lbs., diameter of smallest ring, 5 ft. 0¾ in. Fire box, length, 9 ft. 1⅞in.; width, 3 ft. 6⅝ in., at mud ring; depth, front, 5 ft. 6¼ in.; back, 5 ft. 1¼ in.; tubes number 254, diameter 2 in. outside; length, 12 ft. 10 9-16 in.; heating surface of tubes in square feet, 1,710; fire-box, 166; total, 1,876 square feet. Square feet grate surface, 32. The tender is styled the C.P.R. standard freight, with water capacity of 5,000 imperial gallons; coal capacity, 10 tons.

Some facts concerning the old "Toronto" are given in a sketch recently published in the Toronto Evening News, from which the following extracts are made:

The men who superintended the building of this famous locomotive are both living to-day. Samuel Sykes lives in Newmarket, aged 84. James Sykes, his brother, aged 75, lives in this city at 14 Augusta Ave. Prof. Sykes, now of New York, and late of Toronto University, is his son.

In the latter part of April, 1853, the two Sykes brothers finished their job, neither of them dreaming of the C.P.R. and the G.T.P. The "Toronto" was ready to leave the shop of James Good, Esq. Into her sturdy frame had gone twenty-five tons of iron. The engine built by the Canada Foundry Company contains 104 tons. The gauge of the old Ontario, Huron and Simcoe Railway was five feet, so that the wheels of the old "Toronto" were 3½ inches further apart than those of the new engine built by the Canada Foundry. The diameter of the two drive-wheels on each side was 5½ feet. The Canada Foundry's engine wheels are 4 feet 9 inches. The tender of the new engine carries eleven tons of coal. The old "Toronto's" tender carried cordwood, as may be inferred from the shape of her funnel. The cordwood was picked up along the road, beech and maple—and the best of bird's-eye maple at that.

But the first trip of the "Toronto" was made without either wood or water. The motive power was "elbow grease," and the trip was made up Queen street to Yonge, and down Yonge to the corner of Front, where now stands the Customs House, but where in '53 was the switch of the new Ontario, Huron & Simcoe, built by the "Lady Elgin."



Form of first railway ticket used in Ontario. It was printed from a crude woodcut, in black and white, showing the Union Jack, with the initials of the road, O.H. & S.R., in the centre and the destination of the passenger printed in the panels over the horizontal bar of the flag.

The "Toronto" was "pinch barred" every inch of the way on temporary rails which were taken up and relaid at every rail's length of the way. A "pinch bar" is a close relation to a crow bar.

The trip occupied five or six days—an average of about 40 feet an hour. This daily "run" was witnessed by a daily small army of spectators, many of whom were just getting their first glimpse of railroading. The horses shied and the dogs barked those balmy April days, while the first Canada-made locomotive crawled down the railway. It was a notable week. For in a few days more the citizens of Toronto would be taking their first ride "on the cars."

Some days were occupied by Mr. Sykes and his men in getting the new iron wonder rigged for the journey. And it was the 16th day of May, 'mid singing birds, bursting leaves and piping frogs, when the "Toronto" got up steam, real Canadian steam, manufactured from Lake Ontario water and bird's-eye maple.

John Harvie, now secretary of the Upper Canada Bible Society, was the first actual conductor that ever ran a train in Toronto. He was then freight conductor, but owing to the delayed arrival of Mr. Jones, the regular passenger conductor, Mr. Harvie took charge of the "Toronto" on her trial trip. He sold the first railway tickets ever issued in Canada that May morning of '53. The fare was slightly over two cents a mile. The journey to "Machell's Corners," now Aurora, occupied two hours, an average of 15 miles an hour. About fifty people went. There were two cars, a baggage car combined with a smoker, and one flat-topped passenger car. And all that day the dogs barked, and the York County horses snorted in the farmers' fields.

The "Toronto" returned to the city the same day, having burned several cords of wood and "scared the daylights" out of most of the live stock in York County. Toronto was no longer a country town, but a railway centre. And the old 25-ton, five-foot gauge, "outside-rigged," wood-eating "Toronto," with its two big drive-wheels on each side was the biggest thing that ever tooted a whistle or rang a bell in Canada up to that time.

Mr. Good afterward made other locomotives in his Queen

ONTARIO, SIMCOE AND HURON RAILROAD.

PASSENGER TARIFF,-JUNE, 1853.

FROM	Davenport Road.	Thornhill.	Richmond Hill	King.	Machell's Corners.	Newmarket.	Holland Landing.	Bradford.
Toronto	0 7½	1 0	1 3	1 10½	3 1½	3 9	4 0	4 4½
Davenport Road	.....	1 3	1 10½	3 1½	3 9	4 4½	4 4½	4 4½
Thornhill	.....	.....	7½	1 3	2 6	3 1½	3 9	4 4½
Richmond Hill	.....	.....	....	1 0	1 10½	2 6	3 1½	3 9
King	.....	.....	....	..	1 0	1 3	1 10½	2 6
Machell's Corners	.....	.....	....	...	....	7½	1 3	1 10½
Newmarket	.....	.....	....	...	....	....	7½	1 3
Holland Landing	.....	.....	....	...	....	....	...	7½

A. BRUNEL. Superintendent.

First Card of Passenger Rates in Ontario.

street shop for both the old Northern and the Grand Trunk. Some of these were "Simcoe, No. 6," "Samson, No. 9," and "Hercules, No. 10." These two latter were baptized with the strenuous names, because of their size. Each had six drive-wheels on a side, and were used for heavy freight.

Other nameless "bullgines" turned out by Mr. Good were, Nos. 11, 12, 13, 16 and 17. No. 13 was baptized "George Beatty," after the secretary-treasurer of the road; No. 16, "J. C. Morrison," after the president; and No. 17 "Cumberland," out of courtesy to the managing director. This was on the occasion of the future Emperor King Edward's trip from Toronto to Collingwood on September 10th, 1860. Mr. Harvie was the conductor on that occasion. Afterwards, in 1869, he became traffic master of the Northern. He retired in '81, after twenty-eight years of railroading unmarred by a single collision or loss of life.

"The Lady Elgin" being too light for heavy trains, was used for shunting purposes at Collingwood until 1882. The "Toronto" was used for a shunter at the terminal. Both were afterwards broken up and sold for scrap iron.

Nos. 19, 20, 21 and 22 were erected in the Northern Railway shops, all before 1870.

"Well, it was quite a job building the 'Toronto,'" said Jas. Sykes, reminiscently. "We had no end of experimenting, fitting on this part there, that part somewhere else. My brother, Samuel, was really the mechanical superintendent."

"Was there any steel in the 'Toronto?'"

"No. She was all iron, but the bell, the whistle and the lamp."

"What were your particular duties?"

"I had charge of all the engines after they left the shop. Many a locomotive I've 'pinch barred' down Yonge street. Yes, I took the 'Toronto' down in April, '53. We had a turntable at the corner of Yonge and Queen."

"Had you any railroad experience before coming here."

"Yes, I ran the first train of cars ever taken over the Delaware & Lackawanna, and I sent out the first trainload of coal that ever went out of Pennsylvania. My brother Samuel had a longer experience. My wife's father, Mr. Earp, made the first iron rails ever made in America, and my wife's sister's husband made the first steel rails ever made in America."

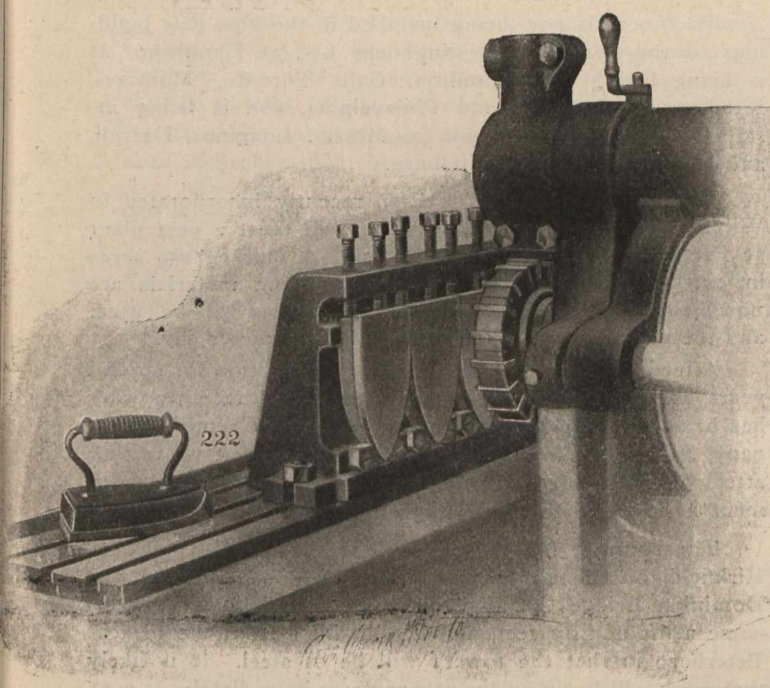
"Yes," he continued, "we used all iron rails on the first railroads here. They were very light—not more than 25 pounds to the yard."

MACHINE SHOP NOTES FROM THE STATES.

By Charles S. Gingrich, M.E.

XI.

The illustration herewith will be of interest to manufacturers of hardware, as it shows the latest development in finishing flat surfaces, and is a solution of the vexing problem of finishing sad irons. There are in use a great many methods of doing this work and up to the present time most of it is done on disk grinders, but this has been found objectionable because it is slow and in some localities it is



difficult to obtain workmen to carry it on continuously because it is exceedingly unpleasant on account of the dirt and dust caused both by the ground particles of iron and the disengaged particles from the grinding wheels.

The illustration shows a quick and clean, and easy way of doing the work, by holding the sad irons in a fixture and facing off the surfaces with a face mill on a No. 2 Plain Cincinnati Geared-Feed Miller. The fixture is arranged so that the irons can be quickly clamped in position. The cutter is made of high speed steel, permitting of rapid cutting, runs at a surface speed of about 77 feet per minute, and feeding .2 inches per turn, which means that the irons are fed past the cutter at the rate of 7½ inches per minute. This leaves the surfaces in a nicely finished condition, and very little polishing is required afterward to smooth them up ready for the market. Any intelligent boy can be taught to run the machine in a short time, and the results obtained are very much more satisfactory than any of the other methods used to-day.

THE TEST OF A GENERATOR.

Editor, Canadian Engineer:—

Sir,—The only true measure of the normal capacity of a properly designed generator is the current it will develop safely under short circuit with normal (fully excited), field within a stated temperature for a given period of time, the maximum capacity being the current at safe temperature under fully saturated field, short circuit to be applied when the generator is giving out its standard voltage and the same test should be made on all direct current motors and synchronous alternating motors, by operating them as generators.

Purchasers of electrical machines should insist on these requirements if they want an absolute test.

The United Electric Co., Limited, of Toronto, are ready to tender to above requirements, as their "Johnson" generators and motors are built and all machines tested at full load current under these conditions. If any engineer takes exception to the above, the Editor will no doubt be glad to print his reply. Yours truly,

THE UNITED ELECTRIC CO., LIMITED,

Toronto, Dec. 28th. W. H. Johnson,

President and Mgr. Director.

CANADIAN TIDAL INVESTIGATIONS APPRECIATED.

Dr. W. Bell Dawson, the engineer in charge of the Tidal and Current Survey of Canada, has just been awarded the Gay prize of 1,500 francs by the Academy of Sciences of France; a prize offered for the best determinations of mean sea level on the coasts of the North Atlantic Ocean.

The importance of such determinations is evident; either to detect any gradual change of the land elevation relatively to the ocean, or as a plane of reference for all levels throughout the country. Dr. Dawson has given special attention to this, in addition to the direct work of the Tidal and Current Survey as a marine undertaking. As there is as yet no general datum of reference for levels throughout Canada, he has established independent bench-marks at all the more important localities and harbors, where tidal observations have been obtained. These are at widely separated points in the area extending from Labrador to Nova Scotia, and from the St. Lawrence to Newfoundland. The resulting tide levels are described in his recent paper in the Transactions of the Canadian Society of Civil Engineers, entitled: "Tide Levels and Datum Planes in Eastern Canada." It is the work there detailed, and explained in his other reports and papers on tidal subjects, that formed the basis of the award of the prize referred to. It should be encouraging to Canadian engineers to find work of this character meeting with appreciation in other countries.

INDUSTRIAL NOTES.

The A. D. Gall Petroleum and Chemical Co. of Montreal, purpose erecting an oil refinery in Toronto, to be one of the largest refineries in the country.

It is understood that the Algoma Steel Co. has a contract from the C.P.R. for 25,000 tons of steel rails to be manufactured and delivered at once.

The Canada Car Co. has a contract from the Grand Trunk Pacific Railway Co. for fifteen cars per day for five years, or a total of 23,475 cars, delivery to commence as soon as the plant is completed.

The Canada Foundry Co. has completed arrangements for the manufacture of steam shovels, pile drivers, wrecking appliances and other machinery necessary for railway and general construction work. This new department will employ several hundred additional hands.

In spite of the rise in price of manilla and sisal, the International Harvester Co. has fixed the price of binder twine for next season at a lower figure than last. The Canadian manufacturers will ask the Government for protection as they cannot stand this competition. The duty on twine was removed in 1895.

Application is being made for the incorporation of the New Brunswick Iron Co., Limited, with a capital of $1,000,000, to work iron deposits found in the vicinity of Lepreaux, N.B., which are said to be of excellent quality and in abundant supply. The applicants are: John S. McLennan and Charles V. Wetmore, Sydney; L. B. Knight, St. John; Chas. W. Young, St. Stephen, and A. D. Wetmore, Truro.

Magann & Phin, of Toronto, have been awarded the contract for the removal of the central pier in the Welland Canal at Allanburg and Marlatt.

A fish plant, costing $75,000, is to be erected at Port Angeles, B.C., for packing and shipping purposes and for the manufacture of various products, such as glue, etc.

The Montreal Rolling Mills have purchased a strip of land from St. Cunegonde for the purpose of extending their works. Their plans necessitate the closing of a street and a by-law to permit this is being submitted to the Lieutenant-Governor for approval.

The Peterboro Shovel Co. have accepted terms offered by the town council, and will immediately commence the erection of buildings on what is known as the town lot. Tenders for the buildings have been received, but the plans are being altered, and it is expected that new tenders will be called for.

The suit of the Cramp Steel Co., Ltd., vs. Currie, et al. has been dismissed by consent, which means the end of the litigation over the reorganization of the company. The Northern Iron & Steel Co., Ltd., has now full possession of the property, and will commence operations at an early date.

About 3,900 men are now on the pay-roll of the reorganized Lake Superior Corporation. The steel rail mill, blast furnaces, iron works, pulp mill, and the Helen mine are all working. The company recently paid out of its earnings $50,000 as the first half-year's interest on the loan guaranteed by the Ontario Government, and $25,000 interest on the mortgage bonds.

The McAdamite Metal Co., which is operating a large factory at Staten Island, N.Y., will begin manufacturing at St. John, N.B. They own a factory which was built and partially equipped at the time of the organization of the company, and it has now been decided to complete the equipment of the mill and start operations. The company has recently been somewhat reorganized, and it is now under the control of the New Brunswick interest.

The Dominion Brass Works, Limited, of Port Colborne, has gone into liquidation, Osler Wade being permanent liquidator. The company established a factory last summer and operated with 52 hands, expert machinists from Detroit, Toronto, and elsewhere, from September till December 2nd. Warrants have been issued against certain officers and shareholders charging them with obtaining money from the village under false pretences. The village granted a loan of $10,000, and it is claimed that the first instalment was obtained by fraud. Mr. Wade's report to the judges attributes the failure to lack of capital and lack of system in conducting the business. The shareholders are: F. N. Cullen, president; H. E. Johnstone, vice-president and general manager; Wm. H. Thomas, secretary-treasurer; H. Meen, Wm. Meen, and J. A. Flynn, all Toronto men.

The Canada Car Company has elected the following board of directors: Sir H. Montagu Allan, of the Allan Steamship Company; H. S. Holt, president of the Montreal Light, Heat and Power Company; E. L. Pease, general manager of the Royal Bank of Canada; Frederic Nicholls, general manager of the Canadian General Electric Company; F. N. Hoffstot, president, and J. N. Friend, vice-president, of the Pressed Steel Car Company, and W. P. Coleman, ex-vice-president of the American Car and Foundry Company. The capital is to be three million dollars, and half of this sum has been subscribed in Canada. It is understood that by next August the company will be ready for business, employing at least one thousand men at the start. During the last few weeks the company has let about $300,000 worth of contracts in connection with the buildings at Cote St. Paul (near Montreal), where forty acres of land has been acquired. It is understood that if satisfactory arrangements can be made with either Fort William or Port Arthur, the company may establish a car manufactory at either of these places, to supply cars required west of the Great Lakes by the Grand Trunk Pacific, Canadian Pacific, and Canadian Northern.

The Canadian Corundum Wheel Co., Hamilton, is doubling the size of its plant, and will manufacture vitrified emery wheels. At present these goods are not made in Canada.

The New Brunswick Department of Public Works will receive tenders until January 16th, for the rebuilding of the Wm. Fitzsimmons Bridge over the Shediac River, Parish of Moncton, N.B.

It is stated that an arrangement is being entered into between the C.N.R. and the town of Fort Saskatchewan to build a joint traffic and railway bridge over the Saskatchewan river at that place, the company to receive a free site for a station for the consideration of helping to pay the cost of building a bridge.

The American Cereal Co. has closed its Peterboro mills in consequence of the advance of freight rates. As the product of these mills was nearly all exported to foreign countries they could not, under the increased rates, compete with the company's mills in the United States. About 400 hands are thrown out of employment.

Machinery is now being installed in the nine new buildings of the Canadian Westinghouse Co., at Hamilton. It is being bought in Hamilton, Galt, Toronto, Montreal, Pittsburg, New York, and Philadelphia, and is being installed under the supervision of Messrs. Longinus, Darrell, and Reid, experts from Pittsburg.

The Manitoba Peat Co., Ltd., recently incorporated in Winnipeg with a capital of $200,000, will erect a peat plant at Fort Frances, Ont., in the spring. A muskeg 250 acres in extent has been purchased, and building materials are now being got ready. The Dobson process will be used. and the plant is to have a capacity of 50 tons per day.

After battling with United States competition for several years, the manufacture of caustic soda and bleaching powder has been given up by the Canadian Electro Chemical Company, Sault Ste. Marie, Ont. It is probable that no further attempt will be made to operate, as the Dominion Government has refused to place duty on such products.

The contract for the erection of the new lift lock, at Kirkfield, on the Trent Canal, has been awarded to the Dominion Bridge Co., of Montreal. The lock is to overcome a lift of fifty feet, and it will differ from the lock at Peterboro in that the towers will be of steel. It is likely that work will begin on the new contract immediately. It is to be completed by a year from next spring.

At a meeting of the shareholders of the Canada Cycle and Motor Co., Toronto, which was held on December 15th, a final effort was made to get the shareholders who had not deposited their share certificates to do so, and thereby secure the benefit to be distributed pro rata by the cancellation of the $900,000 preference stock. It was decided to start a branch company in New Zealand with a capitalization of $50,000. The following directors were re-elected: Jos. N. Shenstone, J. W. Flavelle, E. B. Ryckman, Hon. George A. Cox, Hon. L. M. Jones, Warren Y. Soper, and T. A. Russell.

J. C. Hunter, of Duluth, who controls the Atikokan Iron Range, is approaching the town of Fort William asking it to assume $200,000 worth of bonds of the company, which will then erect a blast furnace. The co-operation of the Canadian Northern Railway is expected, as the ore will be shipped in along their line to Fort William, only a short spur being required to reach the mines from the main line.

The Laurie Engine Co., of Montreal, are putting on the market a line of machinery new to Canada. This is a new type of triplex power pump, carefully designed by engineers who have had twelve years' experience with one of the largest pump manufacturers in the United States. They are building a full line of power and electric pumps for general water supply, municipal waterworks, hydraulic elevators, and boiler feeding, also special power pumps for paper and pulp mills. The ordinary duplex steam pump is a very extravagant machine, both in regard to steam consumption and repairs, and the triplex power pump is superceding it at a rapid pace.

United States capitalists are starting a tar factory at Barry Bay, Renfrew County, Ont.

An industry for the manufacture of cement blocks will shortly be opened in Prince Albert, Sask.

The contract for a new immigration shed at Halifax has been awarded to John McInnes, of Halifax, for $75,000.

The Windermere Lumber Company has been organized by Capt. Armstrong with a capital of $20,000 to operate a mill at Windermere, B.C.

The Dominion Government has awarded the contract for the new Post-Office building at Winnipeg to Thomas Kelly, of that city, the price being $529,000.

The Keewatin Flour Mills Company will shortly build another large mill, with elevators, barrel factory, railway siding and every facility for operating a concern of 5,000 barrels' capacity.

It is announced that the Kingston Locomotive Works have received from the Canadian Pacific Railway an order for ten more mogul engines, to be completed within the next ten months.

The plant of the Imperial Steel and Wire Company, of Collingwood, Ont., has been put into commission. The company has enough orders on its books to keep the machinery running till the end of May.

The Manitoba Pressed Brick Company, Limited, has been incorporated in Manitoba with a capital stock of $60,000. Winnipeg parties are the incorporators, and Winnipeg will be the chief place of business.

The D. L. Burrell Company, dairy supplies, of Little Falls, N.Y., will locate a branch of their business in Brockville if granted a free site and exemption from taxation for ten years. A committee of the town council will at once take the matter up.

La Valle, Ont., is to have a new sawmill, which will be erected at once. The new mill will be erected by a Port Arthur man, and will have a capacity of 25,000 feet per day. It will be located about two miles north of the town, and it is expected will be sawing timber in less than three months.

It is proposed to wind up the Ottawa Milling Co., Limited, a concern which was incorporated in 1900 with a capital of $40,000, an amount which was subsequently increased to $99,000. It is understood this decision was arrived at by the shareholders owing to the difficulty in securing a suitable manager.

The William Davies Company, packers and provision merchants, of Toronto, are making plans to establish an extensive branch of their business in Montreal. They are leasing from the Montreal Stock Yards Company, three and a half acres of land, and propose to build a packing house on this property. They also purpose to operate stores in the city of Montreal. It is their intention to kill both cattle and hogs there.

The Mundy Lumber Co., of Bradford, Pa., will establish a mill at Lhee Valley Lake, B.C., with a capacity of 15,000,000 feet annually, at an expenditure of $50,000 to $60,000. A representative of the Mundy Company states: "We are erecting a small mill for the reason that we wish to hold the timber for a few years. The value of it now is nothing compared to what it will be, and in those days there will not be the reckless waste there is at present, both in the logging and at the mill."

NEW INCORPORATIONS.

Charters have been issued as below:

Dominion.—Electrical Flour Patents Co., Montreal; $250,000. To deal in patents of all kinds. Incorporators: E. S. Clouston, banker; Sir Geo. A. Drummond, Senator; C. R. Hosmer, capitalist; Sir Hugh M. Allan, steamship owner; Frederick W. Thompson, miller, and Herbert S. Holt, capitalist; all of Montreal.

National Construction Co., Montreal; $250,000. Joseph Hobson, engineer; Robert S. Logan, gentleman; Henry W. Walker, auditor; Frank Scott, treasurer, and Henry Phillips, secretary; all of Montreal.

The Hood Rubber Co., of Canada, Montreal; $5,000. Robert D. McGibbon, K.C.; Douglas Armour, advocate; Stephen J. Le Huray, accountant; K. J. Beardwood, stenographer, and L. L. Legault, student; all of Montreal.

The Railway Specialty Co, of Canada, Montreal; $20,000. Norman J. Holden, merchant, of Montreal; Chas. F. Quincy, merchant, of Oconomowoc, Wis.; Edgar M. Smith, civil engineer, of New York; Joseph N. Rattey, accountant, of Ottawa, and Mary I. Hickson, stenographer, of Ottawa.

Automatic Railway Signal Co., Montreal; $500,000. Joseph Lemire, mechanic, and Rev. Frederic Tetreau, of Drummondville; M. Langlois, agent; Oscar Hebert, notary, and Henri Sauriol, gentleman, of Montreal.

Canada Saw Co., Ottawa. $125,000. Frederick Bacon, metal agent, of Montreal; George H. Bindon, machinist; Patrick M. Feeny, saw manufacturer; John I. McCracken, barrister; Charles McGee, banker; Walter S. O'Dell, brick manufacturer, all of Ottawa, and John M. H. Robertson, manufacturer, of Montreal. To acquire the business of the Ottawa Saw Co., and the business, relating to saws, of the James Robertson Co., at Montreal, St. John, and Ottawa.

The capital of the Verity Plow Co. is increased from $300,000 to $600,000.

Ontario.—Steel Radiator Co., Toronto; $500,000. Clarence E. Safford, of Buffalo; James G. Smith, Neil Sinclair, and Frank Morrison, barristers, and Strafford Watson, of Toronto.

Wahnapitæ Power Co., Sudbury; $50,000. To generate and distribute electricity. Frank Cochran and William McVittie, of Sudbury, and C. R. Masten, of Toronto.

B. and T. Roller-Bearing Window Co., Toronto; $30,000. Arthur J. Jackson, Edgar A. Badenach, Arthur B. Lee, Edwin J. H. Pauley, and Wm. Bentley, all of Toronto.

Brooks-Smith Hardware, Limited, Toronto; $75,000. Ewart J. Creeper, John Brooks, Wm. H. Carrie, and Harry Symons, K.C., all of Toronto.

Reading Mining Co., Toronto; $250,000. Isaac Hollenbach, Thomas C. Seidle, Henry Kramer, and Percival Geistwite, of Reading, Pa., and Henry J. Tharle, of Buffalo, N.Y.

Erie Iron Works, St. Thomas; $40,000. Mary Risdon, William G. Rogers, and William Risdon, all of St. Thomas.

Henry Disston & Sons, Toronto; $100,000. To manufacture saws, files, etc. Henry Disston, William Disston, Jacob Disston, Samuel Disston, and Henry C. Disston, sawmakers, of Philadelphia, Pa.

Dorion Lead and Zinc Co., Port Arthur; $50,000. Michael Jacoby, miner; Herman J. Achenbach, and Wm. H. Salter, all of Duluth, Minn.

Condensed Peat Fuel Co., Peterboro; $40,000. Ernest V. Moore, mining engineer; Alfred L. Davis, insurance agent; David H. Moore, Crown timber agent; George M. Roger, barrister, of Peterboro, and Walter A. Sadler, barrister, of Toronto.

The Stratford Carriage Co. have changed their name to the Borland Carriage Co.

British Columbia.—Mt. Angel Gold Mines, Limited; $90,000.

Bannockburn Mines, Limited; $500,000.

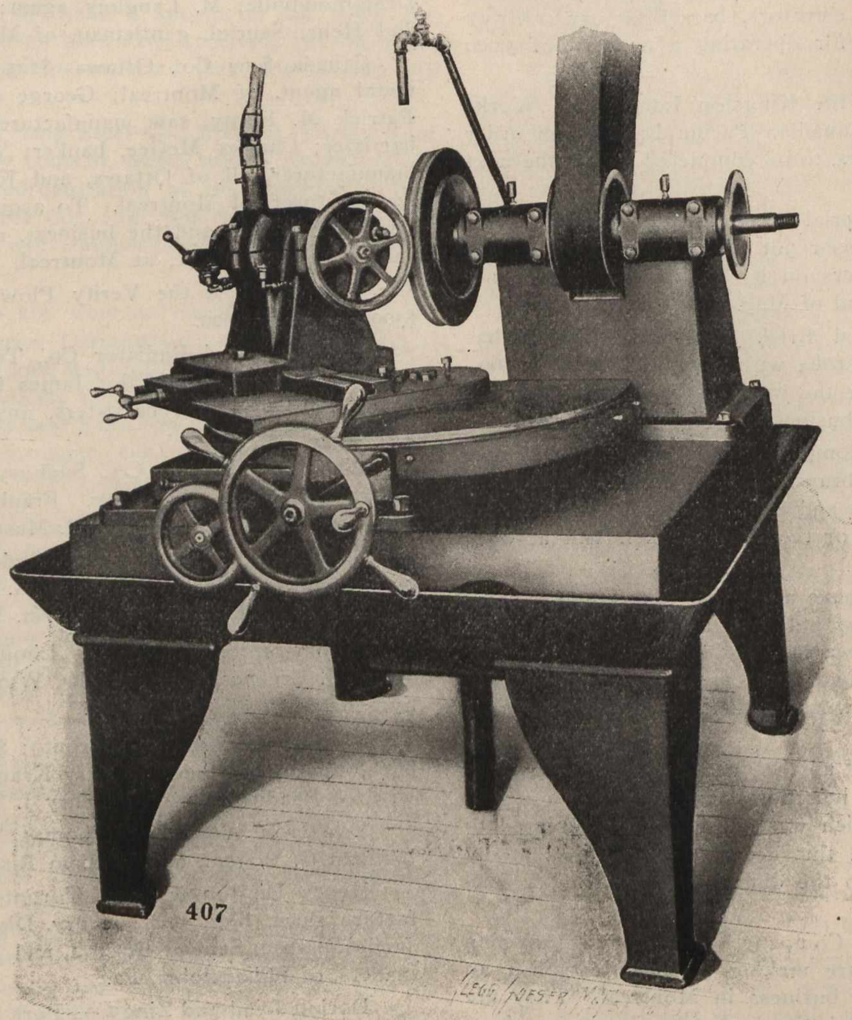
Alexander B. Carson, of Rexton, Richard O'Leary, of Richibucto, and other residents of Kent County, N.B., are seeking incorporation as the Richibucto & Rexton Telephone Company, Limited. The capital stock is to be $20,000.

Representatives of the Bell Telephone Co. have met a number of the farmers interested in the proposed rural telephone system in Waterloo County, and have offered phones at $15 a year for rural connections, or $25 for connection to Berlin and Waterloo, or $15 a year and ten cents per call for communication with the towns. Neither offer was accepted, but another conference will be held this month.

HAND WHEEL GRINDING MACHINE.

The object of this machine is to finish the rim of the hand wheel from the rough at one operation, ready for the buffer, without machining it with a tool.

The bed consists of a planed casting 3 feet 7 inches by 3 feet 5 inches, mounted upon a cast iron pan on legs. On the bed plate is fixed the grinder head at the back. In front is a dove-tailed slide, having 17½ inches of bearing for the swivel slide. This swivel slide has a cross-feed to and from the grinder head of 13 inches; upon this swivel slide is mounted a second slide with its centre fixed upon the swivel slide in line with the grinding wheel so as to centre all



diameters. A rotary movement is provided for the second slide by the pilot wheel shown in front.

A cross adjustment is also provided for the head block carrying the hand wheel to be ground, and the spindle holding the hand wheel is also adjustable so as to bring different diameters of hand wheels directly over the swivel centre.

The speed of the hand wheel to be ground is controlled through a universal joint driven from a variable speed countershaft. On certain hand wheels the time was reduced from one hour to nine minutes. The machine is manufactured by the Lodge & Shipley Machine Tool Co., Cincinnati, O.

ANNEALING PROCESS FOR IRON AND STEEL SHEETS.

A patent has been taken out at Ottawa for a process of annealing and oxidizing sheets of iron and steel. It is described by Fetherstonhaugh & Co., patent solicitors, as follows: The sheets are conducted through a furnace by means of a plurality of revoluble shafts situated a few inches apart. At one point these shafts lead down underneath the surface of the tank of boiling water. The furnace is divided into three compartments, the first one being filled with steam, which is superheated, the steam at the front of the chamber being heated at a higher temperature than at the rear. The second chamber contains a tank of boiling water, and the third is a hot air drying chamber. The temperature of the superheated steam in the first chamber varies from nine hundred degrees at the front to two hundred and twelve degrees at the rear. The steel sheets being let in, first encounter the high temperature at 900 degrees. They are then gradually cooled down until they reach the boiling point of water 212 degrees Fahrenheit. At this point they dip below the surface of the water. They then pass into the drying chamber and are dried. The theory of the operation is as follows: The metal coming suddenly in contact with the steam at a high temperature expands and opens its pores which admits the subtle steam, which is an oxidizing agent of a high order; so the steam enters into the pores and oxidizes the metal to a considerable depth. Dipping below the water cools off the metal and prevents further oxidization, as the metal when brought to the drying chamber is below 212 degrees, too low a temperature for oxidization. It will be noticed that at the same time as the steel is being oxidized, it is also being annealed as the temperature is gradually reduced from 900 degrees to 212 degrees which constitutes the process of annealing. The great advantage of this method is that any polish the metal may have at beginning of process remains at the end, thus avoiding the necessity of a second rolling.

The town council of New Liskeard is discussing the advisability of installing modern municipal electric light and waterworks systems.

A by-law will be submitted to the rate-payers of Ottawa to provide for the purchase of the Ottawa Electric Railway for $3,000,000. The by-law provides that the railway shall be run by an unpaid commission to which aldermen are ineligible.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.

Since the last annual convention of the American Railway Engineering and Maintenance of Way Association, the board of direction has constituted a new standing committee, to be known as No. 16, on The Economics of Railway Location.

The province of this committee, as outlined by the board, is: The consideration of all questions connected with railway location, grades, lines and improvements of grades and line affecting the economic operation with relation to traffic, tonnage ratings, speed, density of traffic and financial considerations. Its special aim is to establish uniform methods and unit values for investigating and analyzing the relative advantages and costs of comparative routes or proposed grade reductions and line corrections.

It will be observed that the subject-matter allotted to this committee is vast in its scope, and one of the most important in the sphere of work undertaken by the Association. In order, therefore, to assist the committee in ultimately laying before the Association the best principles and practice in regard to this subject, together with suggestions tending towards improvement, it has issued the list of questions following, and to which the close personal attention of the members of the Association has been invited.

Each member of the Association, as well as every railway official, is, more or less, directly interested in this work and will benefit from the result of the committee's enquiries. Communications will be addressed to the chairman, W. McNab, Engineering Department, Grand Trunk Railway System, Montreal.

1. On new lines or changes of any magnitude in operated lines, are reconnaissance surveys made, results put upon small scale map and profile form and approximate estimate obtained, before regular survey force commences work?

2. Enumerate in general the field force and outfit of a complete reconnaissance survey party, also that of regular preliminary and location surveys.

3. Furnish copy of instructions to engineers on preliminary surveys and locations.

4. Are engineers instructed definitely as to limiting grades to be used in each direction, and is the development of future traffic taken into substantial account in considering the present economic value of such grades?

5. If future traffic is taken into account, for how many years in advance should the estimated traffic be adapted?

6. If the outlook for immediate traffic is only moderate, but ultimate future increase probable, is the use of temporary steep grades over heavy sections advocated, and to what extent if same are to be ultimately used as pusher grades or modified when traffic warrants?

7. Is a temporary line ever built in order to avoid heavy work until the traffic develops sufficiently to warrant the construction of the permanent line?

8. What consideration is given to making a grade somewhat less in rate than the limiting grade, where it can be done without much increased cost in the line, the object being to allow freight trains to make better time than they can do on limiting grades?

9. On new lines, or on work of grade revision, is the use of "momentum" grades advocated, and to what extent? If so, what is the method of determining the rate and the length of the "momentum" or steepest actual grade used?

10. Are there diagrams or tables used in arriving at such "momentum" grades? (Please furnish a sample of such, or reference thereto.)

11. When reductions in grades on an operated line are contemplated, is the existing traffic taken as a basis on which to figure the number of train miles with a certain weight of locomotive, or how is the number of trains determined?

12. Is it customary to reduce grades at stations, passing points, water stations or tunnels, in order to compensate for starting, and if so, what is the nature of the decrease?

13. At what rate of grade between stations is it considered that tonnage is limited by resistance due to starting or to the necessity of making time?

14. In instructions to engineers, what principles are taken into account in fixing the maximum degree of curvature?

15. Are all grades compensated for curves, or only limiting grades? Is it considered that compensation should be directly proportional to the degree of curve, or should it vary, depending upon the degree of curve? What compensation is considered suitable, and what are the underlying reasons therefor?

16. Is the compensation of a main line grade advocated in the turnout to a siding?

17. Are any instructions given relative to fixing the degree or length of curve with reference to the total deflection?

18. Are engineers given definite instructions in regard to values for different increases or decreases in distance, grades, curvature per degree, rise and fall, as well as total elimination of curves and time saved for both passenger and freight trains?

19. What is the nature of such values, and how based?

20. What rate of change in grade per 100 feet is allowed for vertical curves at intersections in sags and in summits, and what change in rate of intersection is considered necessary before vertical curves are used? Please furnish copy of tables used or reference thereto.

21. What theoretical methods are used for fixing the tonnage rating of locomotives?

22. What is the nature of actual experimental tests? (It is desirable to know in as much detail as possible how the experiments are made, and what observations are taken.)

23. At what speed is it considered that the traction of locomotives should be figured? Is this varied in view of the amount and length of limiting grade in an engine run?

24. What methods are used in finding the equivalent values for empty and loaded cars for the purpose of tonnage rating?

25. What is the train resistance, at ten (10) miles per hour, for empty box cars and for loading in box cars for long trains after having run several miles? Does this resistance increase with speed?

These questions cover a great deal of ground, and no doubt the committee will be able to clear up a great many uncertainties. It will be observed that the personnel of the committee is a strong one, composed of the following:

W. McNab, assistant engineer, Grand Trunk Railway System, chairman.

J. B. Berry, chief engineer, Union Pacific Railway, vice-chairman.

C. Frank Allen, Professor of R. R. Engineering, Mass. Inst. of Technology.

V. G. Bogue, civil engineer, New York.

Lewis Kingman, chief engineer, Mexican Central Railway.

E. H. McHenry, fourth vice-president, N.Y., N.H. & H.R.R.

W. B. Storey, Jr., chief engineer, Atchison, Topeka & Santa Fe Railway.

W. E. Dauchy, Chicago, Ill.

A. C. Dennis, civil engineer, Clarksburg, W. Va.

O. E. Selby, assistant engineer, C., C., C. & St. L. Railway.

W. D. Taylor, Professor of R. R. Engineering, University of Wisconsin.

W. F. Tye, chief engineer, Canadian Pacific Railway.

J. H. Wallace, engineer, M. of W., Pacific System, Southern Pacific Co.

It will be observed that two of our Canadian engineers, Mr. McNab, of the Grand Trunk Railway System, and Mr. Tye, of the Canadian Pacific, occupy honorable positions in the work of this, probably the greatest and most useful organization of its kind in the world.

—The Labor Temple at Toronto was officially opened last month, when Prof. Goldwin Smith delivered an address. He strongly favored labor organization and co-operation.

BOILER SCALE AND BOILER FEED.

BY HARRY SPURRIER, DAVENPORT, TORONTO.

Water is a compound body and the elements entering into its composition are hydrogen and oxygen in the proportion of two parts by weight of hydrogen and sixteen parts by weight of oxygen, or two parts by volume of hydrogen and one part by volume of oxygen, oxygen being sixteen times as heavy as hydrogen. These two bodies are elementary gases and have so far never been made to produce from themselves anything but oxygen and hydrogen. The chief characters of hydrogen are, first, its extreme lightness. It is the lightest substance known, being about 14½ times lighter than dry air. Hydrogen is a colorless, odorless, combustible gas, but not a supporter of combustion. It is a necessary constituent of all acids; it occurs in the steam from fumarolles, in volcanic gases, and constitutes one-ninth of all the water on the globe, but this vast quantity is probably eclipsed by the enormous quantity contained in the sun's atmosphere. Hydrogen may be prepared by reacting on dilute, sulphuric acid with metallic zinc. The reproduction of water may be demonstrated by the combustion of the hydrogen so formed. This gas can also be produced by the action of sodium upon water. The other constituent of water, oxygen, is also a colorless, odorless gas, non-inflammable, but the main supporter of combustion and respiration, which is in fact slow combustion. Oxygen constitutes eight-ninths of all water and one-fifth of all the earth's atmosphere, is contained in all oxides, carbonates and many other salts. The gas may be artificially prepared by heating chlorate of potash with manganese dioxide.

Pure water is perhaps the most powerful material in the world and is remarkable as possessing the greatest latent heat of liquefaction(80 B.T.U. nearly). The greatest latent heat of vaporization (234 B.T.U.); the greatest cohesion of particles of any liquid; the greatest specific heat of any known substance; the least compressibility of all liquids, except mercury which is a metal. Water is used to establish standard weights and duplicates, as a standard for thermometric reference points and also a standard in calorimetry.

Water is known to assume all the three states of matter, as solid ice, as liquid water, as gas steam, but in the change of physical condition there is no change in composition whatever. At all temperatures below 32 deg. F., and at normal atmospheric pressures, water exhibits the solid form but if the pressure be much increased, the freezing point is sensibly lowered. For each increase in pressure of one atmosphere (14.7 lbs. per sq. in.), there is a lowering of the freezing point 0.0135 deg. F. equal to .0075 deg. C. At a pressure of 13,000 atmospheres, water may be kept liquid at a temperature of 18 deg. F.

A familiar instance of the effect of pressure is found in the possibility of making snowballs when snow is not much below its freezing point. The squeezing of the snow lowers the melting point, to which the snow is very near already—this causes some of the snow to melt; on releasing the pressure, the liquid so formed is re-frozen and cements the whole ball together. Another and very striking instance of this "regelation," as it is called, may be shown. Take a bar of ice on a mild day and support it at each end, then pass over it a fine steel wire heavily weighted at each end. The much increased pressure under the wire will cause the ice to melt, and the wire will gradually sink, the liquified water flowing over it and re-freezing; this will go on until the wire has passed completely through the ice, leaving only a milky trail of air bubbles, but the ice bar will not be parted. When water freezes into ice there is an expansion of volume amounting to a trifle more than 9 per cent., one volume of water becoming 1.09082 volumes of ice. If this expansion can be successfully resisted, solidification is delayed in the ratio previously stated. On the liquefaction of ice to water there is an absorption of heat equal to 80 B.T.U. This absorption of heat is not associated with any rise in temperature, but is rendered latent or stored up (not lost), so to speak, in doing the work of liquefaction, and this 80 B.T.U. is known as the "latent heat of liquefaction." After liquefaction and upon an increase in temperature, water decreases in volume until it reaches a temperature of 39 deg. F. = 4 deg. C. This temperature is known as the "Temperature of Maximum Density," and is used as the standard of physical constants. As the temperature of water increases beyond 39 deg. F., it begins to expand and continues to do so until a temperature of 212 deg. F. is reached, which if maintained long enough will dissipate the water by evaporation and its history as boiler feed will be finished.

Between the temperatures of liquefaction and boiling of water are ranged a vast number of phenomena of solution and dissolution, which taken together constitute the vexed problems of boiler feed. Of all neutral solvents, water is by far the most powerful and most general. Absolutely pure water is both unusual and undesirable as a boiler feed, because it has been found that when incrustation is completely stopped corrosion usually begins.

We will first consider water as a solvent of gases because it is mainly in consequence of the gases dissolved in a water that it is capable of dissolving those materials that make up for the greater part of "boiler scale." The solvent action of water upon gases is very variable both in regard to the kind of gas and the amount dissolved, as the following table shows. 100 volumes of water will dissolve:

Gas.	At 32° F. Vols.	At 82° F. Vols.
Carbon dioxide	179.7	
Nitrogen	2.03	
Oxygen	4.1	2.8
Nitrous oxide	130.52	
Sulphuretted hydrogen	437.06	
Sulphurous acid	7978.9	
Ammonia	114900.0	69060.0

An increase of temperature generally causes a diminution in the amount of gas dissolved, except in the case of hydrogen which is constant between 0 deg. C. and 25 deg. C. The amount of any gas taken up by water depends, 1st—On the specific nature of the gas. 2nd—On the temperature of the water. 3rd—On the pressure under which solution is effected.

If a mixture of soluble gases be acted upon by water at a given pressure, the water will dissolve of a given constituent only so much as corresponds to the pressure exerted upon the water by that particular gas, and so on for each gas in the mixture. If we have a mixture containing equal volumes of A and B, the effect of A's molecules will be equal to ½ A + B. But since the amount of gas absorbed varies with the effect exerted by the molecules—or which is the same thing—varies with the pressure under which the solution is effected, it follows that the amount of A dissolved would be only half what it would have been if the entire pressure were due to A instead of A + B. This law of partial pressures, as it is called, is of enormous importance and explains at once why water introduced into a boiler which has practically an atmosphere of steam alone loses at once all its dissolved carbonic acid gas, and is then unable to hold in solution the scale-forming materials.

We will now devote a little time to the solvent action of water on solids and then consider the solvent action of water containing carbonic acid gas in solution.

There is no known substance which dissolves as freely as water such a multitude of bodies, and it may be stated that the stronger the solution the higher the boiling point. This is clearly shown by the table below:

Salt.	Boiling Point.	Per Cent. Salt Dissolved.
Carbonate of soda	220	48.5
Salt (sodium chloride)	227	41.2
Nitrate of potash	240.6	335.1
Nitrate of soda	249.8	224.8
Carbonate of potash	271	205
Calcium chloride	365	325

In some cases the solvent power of water may be exhausted for a particular substance, but still be unimpaired or even increased for another.

The solvent power of water is usually increased by an increase in temperature, but not always, for instance, one part of sulphate of lime (gypsum) is dissolved at 0 deg. C. by 488 parts of water; at 35 deg. C. by 393 parts of water; at 100 deg. C. by 460 parts of water.

As before stated, water dissolves carbonic acid gas; although the amount is not large, still it is sufficient to be of very grave import in regard to boiler feed. All natural waters contain some carbonic acid gas in solution, which may be taken up from the air which usually contains four parts of carbonic gas in 10,000 parts of air and sometimes much more. Now when water contains this carbonic gas in solution, it is capable of dissolving quite notable quantities of mineral matters that are almost wholly insoluble in pure water. These minerals are principally carbonates of lime and magnesia. Now this question of solubility of carbonates of lime and magnesia in carbonated water is of such vital importance that I shall—to emphasize it— quote an extract from an old book, published in 1776, which made known to the world for the first time the cardinal fact of the solubility of earthy carbonates, as they are called in carbonated water. "Mr. Cavendish farther shows that water is capable of absorbing a volume of air more than equal to itself; that this quantity is proportionately greater as the water is colder, and is compressed by a heavier atmosphere, that water thus impregnated with fixed air (carbonic acid gas is the modern name), has an acidulous, spirituous, and not disagreeable taste, and, lastly, that it has the property of dissolving calcareous earth and magnesia. It follows as a consequence of this property of water impregnated with fixed air that if after precipitating lime, from lime-water, by throwing fixed air into it, still more of the same air be added, the water becomes capable of dissolving a part of the earth which had been precipitated. Water impregnated with fixed air has also the property of dissolving almost all the metals, especially iron and lime; a very small quantity of these metals is sufficient to communicate to water their taste and virtues."

Passing carbonic acid gas into lime water, one sees a copious precipitate of carbonate of lime. As the introduction of the gas is continued, all the lime is precipitated as carbonate of lime, and on further addition of the gas the solution begins to clear, owing to the conversion of the carbonate of lime—in the presence of an excess of carbonic gas—into bicarbonate of lime, and it is this salt bicarbonate of lime which is the great enemy of firemen and engineers. (Magnesia acts similarly). Now if this solution of bicarbonate of lime is boiled, it is easily split up into normal carbonate of lime and carbonic acid gas. This, then, is what nature does, in part, the remainder being accomplished in the boiler.

Natural water being charged with carbonic acid gas from the atmosphere, drains and percolates from the high lands over the soil and through rock fissures gradually taking into solution the lime and magnesia salts, which impart to the water the well known property of hardness. Only in the state of bi-carbonate are these materials soluble in water, and upon boiling the water the soluble bicarbonates are converted into the insoluble normal carbonate and are deposited as mud or scale as the case may be. The following table of solubilities is instructive:

Substance	Soluble in parts pure Water at 32° F.	Soluble in parts Carbonic Acid Water cold	Soluble in parts pure Water at 212° F.	Insoluble at
Carbonate of lime	62,500	150	62,500	302
Sulphate of lime.......	500	...	460	302
Carbonate of magnesia .	5,500	150	9,600	...
Phosphate of lime	....	1,333	....	212

The above table tells us that slightly above 300 deg. F. carbonate of lime and sulphate and phosphate are entirely insoluble. Now a boiler at 70 lbs. absolute or 85 lbs. gauge pressure will have an internal temperature of over 302 deg. F., and is consequently in a condition to separate the whole of the lime salts. The deprivation of the water of the carbonic acid gas owing to the high temperature and the law of partial pressures will cause the magnesia carbonates to separate, and the high degree of concentration causes the other and more soluble salts to separate in part. These causes, taken together, are the root of boiler feed and scale troubles.

There are some waters that contain so much organic matter in solution that the mineral matters are deposited as a mud and not as scale at all. In the use of these waters corrosion or pitting is liable to occur, and the tubes and shell of such boilers should be examined very carefully to detect such action. This may be easily corrected by the contact of a large surface of clean iron by which the organic matter is precipitated and the much improved water may be filtered or drained away. The following analyses are of a water that caused corrosion, but after treatment proved excellent—expressed as grains per gallon:

	Natural.	48 Hours in Contact with Iron.
Sulphate of lime	3.7	3.68
Salt	4.1	4.01
Carbonate of lime	5.60	3.20
Carbonate of magnesia	3.97	1.30
Silica	.16	Trace.
Phosphate of iron and aluminum..	.95	Trace.
Organic matter	2.10	Trace.
	20.58	12.19

This iron treatment showed a reduction of solid residue equal to 40.7 per cent., and entirely stopped the corrosion.

Many methods have been devised to rid natural waters of part of their dissolved impurities; one of the oldest and also one of the best is Clark's process, which aims at converting the bicarbonate of lime in solution into the insoluble carbonate of lime by adding lime itself in sufficient quantity to take up all excess of carbonic acid. This process is theoretically excellent but offers practical difficulties in the way of needing large settling tanks, but this should not be unsurmountable. Alum has been used to improve the water, but while it clears it, it also increases the hardness and is dangerous in boiler feed. Carbonate of soda (sal soda, soda ash), has been used, and is very beneficial in waters containing sulphate of lime, which it converts into carbonate of lime and is converted itself into sulphate of soda, the carbonate of lime being deposited as mud. It is the mistake of most "purges" that they contain a great excess of carbonate of soda and cutch (gambia or japonica). Caustic soda is also largely used and in the presence of much carbonate does excellent service if 1¾ oz. per 1,000 gal. is used for each grain per gallon. E.g., for Toronto water containing carbonate of lime, 5.77 gr., carbonate of magnesia, 1.13 gr., and sulphate of magnesia, 99 gr., per gallon, we should use $(5.77 + 1.13 + .99) \times 1.75 = 13{,}807$ oz. of caustic soda per thousand gallons. This will convert the scale-forming material into mud, which may be sludged out. Water may be very successfully treated to change scale-forming material into mud-forming material, and at the same time remove completely all oil from exhaust and drip by forming a gelatinous precipitate, which occludes the oil, and which can then be filtered out completely. Apparatus is now built to effect this, and in my own experience I can vouch for its perfect operation. I made the following experiment upon water supplied to Toronto Junction which gave a mineral residue of 9.2 gr. per gallon. One-half a per cent. of a 1 per cent. solution of caustic soda was added, and one-tenth of a per cent. of milk of lime. The insoluble residue left amounted to only 2.44 gr., being a reduction of 72.72 per cent.

There is one other agent that sometimes gets into boiler feed, and is sometimes put there deliberately—I mean oil. This should never be tolerated. It may do some good, but it is always likely to do untold harm if the scale be heavy. I cannot now go into the chemical effects of such practices, but be assured that there are valid objections to it.

We now come to the question of boiler scale. Scales usually consist of carbonates and sulphates of lime and magnesia, and occasionally quite a lot of silica. Sulphate of lime can always be taken care of by carbonate of soda

(soda ash). It is best when carbonates and sulphates are both present to attack them separately, first with caustic soda, and then with soda ash. This treatment will have far better effect than the joint action of the two together. Sulphate of lime may be very successfully attacked by common salt. While salt does not in any way effect iron, it should only be used just prior to cleaning out, and the boiler should be thoroughly washed as a saline atmosphere tends to rust the plates above the water line; this fact may be of great use in case of obstinate sulphate of lime scales.

While an engineer can certainly help his boiler by soda, salts, etc., it is certainly best both for owner and engineer to have expert chemical supervision.

THE UNITED STATES MERCHANT MARINE.

The Marine Review, of Cleveland, recently published a folder designed to call attention to the present condition of the United States merchant marine. The folder is got up in a most striking way, being printed in red and blue, so arranged as to emphasize and "clinch" every point made. The front page contains a cut of the United States flag over the legend: "The flag that is about to become extinct upon the ocean highways of the world." Following are some interesting statements culled from the circular:

In 1861 American ships carried 65 per cent. of our foreign commerce. In 1903 we carried less than 8 per cent. of it. Figure out what it will be in 1910.

In January, of this year, 292 steamships passed through the Suez Canal. These were divided according to nationality, as follows: British, 173; German, 42; French, 16; Dutch, 14; Russian, 11; Austrian, 8; Italian, 7; Japanese, 6; Turkish, 6; Norwegian, 4; Spanish, 2; Egyptian, 1; Danish, 1; American, 1.

Notice where the Stars and Stripes appear in this table.

The American tonnage of the Great Lakes alone exceeds in capacity the merchant marine of any other nation except Germany and Great Britain. Thanks to wise coasting laws and to the "protection" of the rapids and channels below Niagara.

On the question of "protection," we are inconsistent to the limit. Nearly all free trade countries make an exception in favor of their merchant marine, and support them to a greater or less degree, while the United States with its high tariff likewise makes an exception and practically refuses all sort of support or recognition. Strange how we reverse ourselves.

We have the largest seacoast line in the world. And get the least benefit.

We have the greatest number of navigable rivers leading into the sea on earth. They carry our commerce to the foreign ships in wait for it.

We have more harbors than any other two or three countries in the world. And those on the coast display more foreign than American flags.

We have more railroads connecting our seaports with the interior than all the other countries in the world combined. And they carry freight cheaper and faster than elsewhere.

We have more timber, coal, ore, mines, farms, iron and steel plants, and manufacturing establishments of all kinds than any other three nations on earth. And if accorded the same treatment we would quickly have the largest merchant marine.

We raise more corn, wheat, cattle, farm products, than any other three countries. And should retain the benefits of doing our own marketing.

In a year recently 55,764,000 bushels of American grain were shipped from New York alone, and not a bushel in an American vessel. Isn't that a shameful condition?

During 1903, not an American ship entered or cleared from a single port in Austria-Hungary, Denmark, Germany, Greece, Italy, Netherlands, Norway, Russia, Sweden or Turkey. Are we such a wonderful nation after all?

If a great European war should arise and the transportation facilities upon which we depend should be withdrawn by their owners entirely, what would happen to the foreign trade of $1,500,000,000 yearly? It would cease to exist, and the war would cost the American people more than it would cost the combatants.

Of all the steamships in the world of 14 knots speed and upwards, 80 per cent. are assisted by their respective governments, and of those capable of going 16 knots, all but six are assisted by the country whose flag they carry. Are all the other nations fools?

Great Britain aids its shipping interests by annual payments of over $6,000,000. Result: John Bull controls the shipping of the world.

American capitalists hold over $200,000,000 worth of stock in foreign steamship companies. Why not encourage the investment of this money in America?

A very trifling expenditure, comparatively speaking, by our Government will warrant the expenditure each year of from $50,000,000 to $100,000,000 for new ships, and this money would be expended in shipyards, engine shops, boiler shops, factories, mills and mines of our whole country, and as a nation and as individuals we would all be better off.

Our navy is supposed to be built largely to protect our shipping, but as a matter of fact, there are more officers and sailors on our naval vessels than on the merchant ships carrying the Stars and Stripes.

We have spent in improving our rivers and harbors since 1879 over $321,000,000.

In many cases these improvements were to benefit foreign ships principally. Patriotism is supposed to commence at home.

During seven years past we have spent over $437,000,000 upon our navy. Then our army for seven years past has cost over $526,000,000. Millions and millions for anything but the flag upon the sea.

Ought we not to be able to spare out of all this just two or three millions for a merchant marine that, unlike our army and navy, would bring us a profit many, many times over what it cost? All other leading countries of the world look at it in this way.

The amount paid in freight annually to vessels in the foreign trade of the United States is $200,000,000, of which $184,000,000 is earned by foreign bottoms. No bill to aid shipping has ever been introduced in Congress which calculated to expend in ten years out of the treasury one-quarter of what would be annually earned by American ships under its provisions. Isn't that buying a business for American citizens mighty cheap compared with our expenditures in Cuba, Philippines, Panama, etc.?

France helps in various ways to the extent of over $7,000,000 a year. And is coming to the front fast.

Germany pays over $2,000,000 and has only just started. Keep your eye on Germany.

Austria-Hungary to aid its little commerce pays the trifle of $1,724,000. And can shame the United States.

Spain paid last year $1,629,000 to one line alone. Spain may be without a navy, but they are doing business.

Little Japan expended $3,492,000 in this way. What nation is more progressive than Japan?

And the United States pays altogether $988,000. At the foot of the class in every way.

Other countries do this to facilitate the carrying of the mails and to open up trade to the foreign countries. Each package of mail is a commercial traveller.

For the first time in a hundred years not a ship is under contract in the United States or being built for American commerce on the seas. What are we coming to?

When those now built are worn out, the American flag will disappear from the oceans of the world. Wake up!

Following are the number of vessels and tonnage which passed through the Suez Canal during June, 1904:

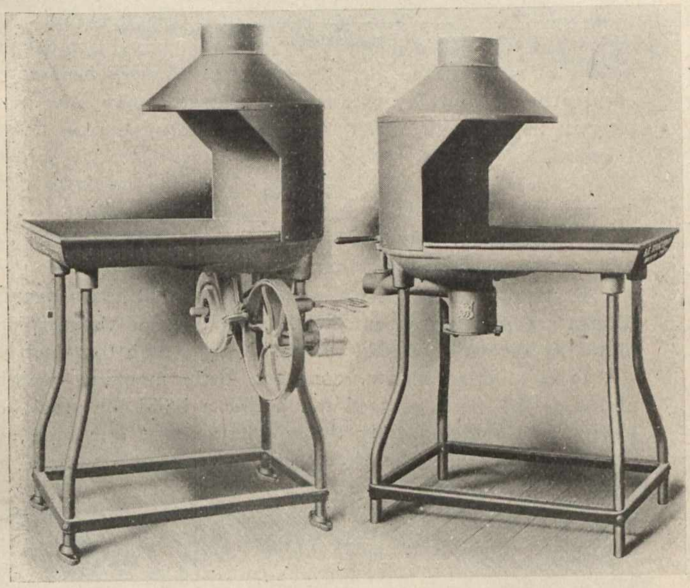
Austrian, eight of 28,527 tons; Belgian, one of 2,414 tons; British, 187 of 633,476 tons; Danish, two of 7,713 tons; Dutch, 18 of 46,536 tons; French, 20 of 63,242; German, 32 of 120,119; Italian, 10 of 28,876; Norwegian, one of 671; Spanish, two of 7,556; Turkish, one of 1,383.

Puzzle: Find the American flag.

THE STURTEVANT PORTABLE FORGES.

The adaptability of the Sturtevant Portable Forges to all light forge work, their endurance and ease of running, have for many years given them a high character with blacksmiths, wagon and carriage smiths, tool-makers, locksmiths, tinsmiths, jewellers, prospectors and miners, bridge and tank builders, sheet-iron workers and riveters in general. In shops and mills, on shipboard, in manual training schools and mechanical laboratories of technical schools, they meet alike the requirements of a small and medium-sized forge for heating and tempering and for small repairs.

These forges have stood the test for years not only in this country but abroad. From time to time new sizes have been added to the list to meet new applications and conditions, and now, with no less than thirty-one sizes, the applications may be widely variable. Not only have new sizes been made, but the designs have been perfected in every little detail. The sheet metal work is of heavy steel plate, the running gear is heavy, strong and easy of operation. The tuyeres are made extra strong to resist the action of the fire and the fire pan is of a double metal plate with asbestus between to prevent the heat from cracking the main pan or affecting the running gear. The blower is of the well known Sturtevant steel pressure type, has babbitted journal boxes and has been redesigned to give increased capacity.



C-5. B-5.

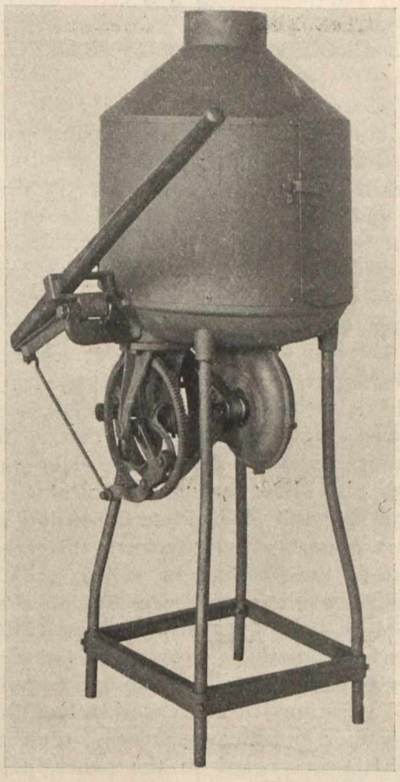
There are seven distinct types represented respectively by the A, B, C, D, E, F, and G forges. Types A, B and C are alike except in the means of producing the blast. The blast for the type A forges is provided by an attached blower driven by hand power. The B forges are arranged for pipe connection and receive blast from an independent blower, which may also supply a number of forges. Forges of the C type are fitted with a blower driven by a pulley on the forge, belt connected to a line shaft or other drive.

The A forge is built in five sizes adaptable to all light work, and is extensively used by wagon and carriage smiths, tool-makers and blacksmiths. On the farm and plantation, in the shop and mill, on shipboard, and in manual training schools, or wherever small repairs are necessary, this forge is much demanded. Sizes A-1, A-2, and A-3 differ only in the hoods. The A-1 is provided with a wind-guard, A-2 has an open hood, and A-3 a closed hood. Sizes A-4, A-5, A-6, and A-7 have larger pans and are provided with a water tank. A-8 is heavier in construction, has a Sturtevant hand blower attached for supplying the blast and is used extensively for stationary work.

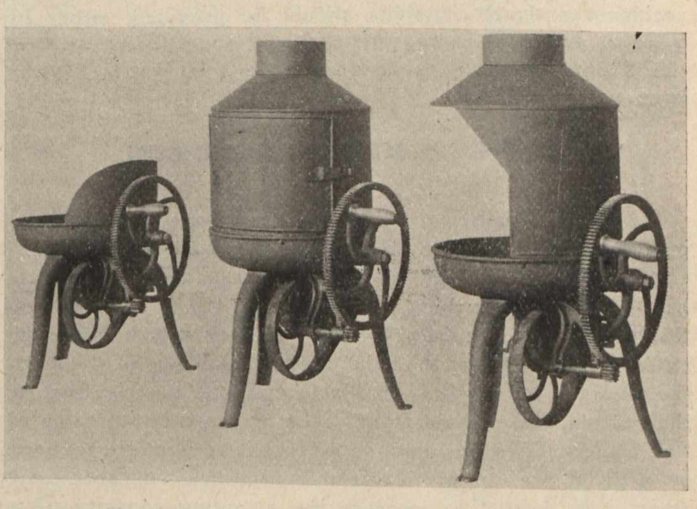
The B type is made in eight sizes particularly adaptable to mechanical laboratories of technical schools. As before stated, they are similar to the corresponding numbers of the A forges, except in the manner of producing the blast.

The C forges are made in four sizes, C-4, C-5, C-6 and C-7, corresponding to forges A-4, A-5, A-6 and A-7, and are fitted with a tight and loose pulley for belt connection; a continuous blast may be thus provided which can readily be regulated by means of a blast gate underneath the fire-pan.

For the lightest forge work, forges D-1, D-2, D-3, E-1, E-2, and E-3 are peculiarly suitable. Sizes D-1, D-2 and D-3 are like A-1, A-2, and A-3, but have shorter legs for bench work, and are arranged for blast connection to an independent blower. The pan, tuyere and blower of the E-1, E-2 and E-3 forges are exactly similar to but smaller than those on the A-1, A-2 and A-3 forges, but the hand power attachment is arranged for bench work. With these forges strong wooden box is furnished sufficiently large to hold a complement of tools together with the forge itself. This equipment is, therefore, extensively used by repair and set-up men on account of its ease and convenience of transportation. As in the A forges, the three sizes differ only in the hoods. E-1, like A-1, is provided with a wind-guard only, E-2 has an open front hood, and E-3 a closed hood. For the light work of jewellers, locksmiths, tinsmiths, and farmers, and for all small repairs this type of forge is best adapted.



A-3.



E-1. E-3. E-2.

The F forge is made in three sizes, F-1, F-2 and F-3, exactly like the A-1, A-2 and A-3 forges, except that they have much shorter legs; in fact, they are short enough to give the correct height for operation when the forge sets on the box. This type meets the requirements of the prospector and miner, but is not as readily portable as style E.

The G forge, built in two types with hand or stationary blast, is extensively used for stationary work on account of its durability. The body is of heavy steel plate rigidly braced and provided with wind-guard. It is extensively used by bridge and tank builders, sheet-iron workers and riveters in general.

These forges are manufactured by the B. F. Sturtevant Co., of Hyde Park, Mass., who furnish complete forge equipments including portable and stationary forges, blowers and hand blowers, for producing the blast, exhaust fans for the removal of the smoke, blast and exhaust piping systems, hoods and blast gates.

WIRE CLOTH AND PERFORATED METAL.

The B. Greening Wire Co., of Hamilton, Ont., are publishing in January a series of catalogues, one for each separate department. The first deals with wire cloth and perforated metal. They have spent a great deal of labor on this book, and it is the most complete catalogue in these two lines of business we have yet seen. It is not only complete, but convenient in form. The mesh in wire cloth is measured from the centre to centre of wire and this frequently leads to confusion owing to customers and others measuring between the wires, so the Greening Wire Co. publish a half-tone with rule on it (page 21), showing how cloth should be measured, and on page 10, a half-tone showing how screening is measured. One is from centre to centre of wire, and the other in the clear or between the wires. They also show through the catalogue a great many cuts showing the full size of the screening and wire cloth, but the most important improvement this year is giving the decimal size of the opening as well as the decimal size of the wire, thus enabling anyone at a glance to see what to order should he have been using a wire cloth and want to replace it with something heavier or lighter, which would give exactly the same size of opening. In perforated metals they give illustrations of the exact size of the dies, besides the trade number and measurement of the holes. The general appearance in regard to the paper, printing, etc., is highly creditable. A cut shows the latest additions to the company's works. The company will be pleased to forward copies of these catalogues to any readers interested.

The jury investigating the Toronto level crossing fatality of November 17th, have found that neither the motorman of the trolley nor the Grand Trunk Railway are to blame, but that the Toronto Railway Co. are culpably negligent in not equipping the car with efficient brakes, and that the system of inspection is very inefficient. The jury also recommended that some more effective method of preventing accidents at level crossings should be provided, either by a spring switch placed against the cars, or by the removal of the Scotch blocks to a distance of at least 50 feet away from the gates.

CHIMNEY vs. MECHANICAL DRAFT.

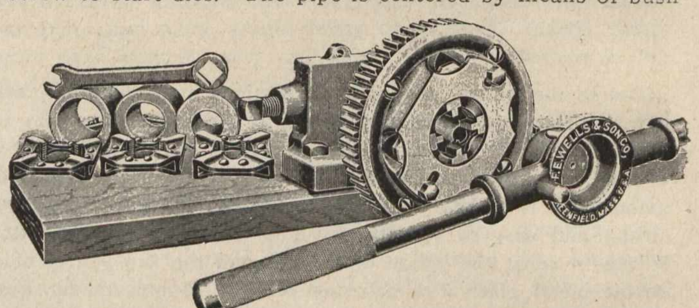
A chimney with natural draught will have a draught dependent upon its height, the power of which will not vary, except upon the rise or fall of the internal temperature. It has therefore, no sucking power; in fact, the term suction in this connection is a fallacy. The chimney acts because the external air is heavier than the internal, and thus presses into the chimney by the only available opening, namely, that at the bottom, the furnace front. The pressure or intensity of the draught fixes the amount of fuel it is possible to burn on a given area of grate. It therefore becomes necessary, when it is desired to increase the steaming capacity of a boiler by increasing its coal consumption, to increase the intensity of the draught, and the only way in chimney draught is to increase the temperature of the gases passing up it, or increase the height of the chimney. The first method, of course, means a large amount of waste, and is a very uneconomical arrangement; the second is expensive and unusual. A chimney stack 150 feet high will burn from 15 lbs. to 20 lbs. of coal per square foot of grate area per hour under normal conditions, but in wet or foggy weather it will be very much less than this, as the wet air is lighter than the dry, and thus produces less pressure at the furnace (the weight of water vapor is about half that of air). A fair average of temperature in the furnace is 2,400° F., and that of the escaping gases at the chimney, without economizers, 600° F. This means that one-quarter of the total heat generated is sent up the chimney to waste. Thus, on a 2,000-h.p. plant, almost 500-h.p. is going up the chimney per hour, and the coal bill necessary to sustain this will come to a big figure in the year. It is cheaper and better to provide the necessary supply of air for burning fuel in steam boilers by mechanical means, and to take as much heat out of the hot gases after they have ceased to be in contact with the boiler itself before they are turned out into the atmosphere, than to do it in the older way by utilizing a portion of the heat generated to create the necessary supply of air. This is the primary reason for using a mechanical means of moving the air. The heat previously necessary to create the draught by means of a chimney may now be employed usefully in other directions.—Engineering Review, London.

"WELLS" PIPE THREADING MACHINE.

F. E. Wells & Son Co., of 31 Riddell St., Greenfield, Mass., are putting on the market a new pipe threading machine, as shown herewith, for threading 1-inch to 2-inch pipe.

It is a very simple, compact little machine weighing about 45 lbs., that is used much like a hand die stock, only having gears to multiply the power so that one man alone can easily thread pipe that usually takes two with a hand stock.

The die is held in the large gear, which has a threaded shank that screws into the main frame and acts as a load screw to start dies. The pipe is centered by means of bush-



ings the same as in an ordinary die stock, and is held from turning by two vise jaws on the back of machine operated by set screws. The gears are all machine cut, and all castings are of malleable iron to save weight and give strength even for the hardest usage. It can be bolted to either a bench or post, and the vise, which is a part of the machine can be used in place of an ordinary pipe vise. The "Economy" dies made by F. E. Wells & Son Co. are furnished with the machine, but any standard solid square pipe die will fit.

The moderate weight and the simplicity of the machine permit its being sold at a low price.

SIXTY-INCH ROLL TURNING LATHE.

The accompanying illustrations show in a comprehensive way a heavy 60-inch motor driven roll-turning lathe, built by the American Tool Works Co., of Cincinnati. In view of the extra heavy duty for which this lathe is intended, it is built extremely substantial throughout, which renders it capable of standing up under the heaviest strains. The lathe is driven by a 25-h.p. variable speed motor, which is mounted on a substantial stand at the rear of the headstock and is connected to the driving shaft in the headstock by silent chain, as shown in Fig 3. Primary speed variation is obtained electrically through manipulation of the hand wheel at right hand end of carriage, which starts, stops and reverses the machine. Variations of speed by mechanical changes are obtained through the all-gear headstock, by means of the two levers shown on the front of the hood. This headstock contains an assemblage of gears oppositely disposed on the upper and lower shafts, engaged and disengaged by throwing the levers to right or left. The proper combination of the levers for any desired speed is indicated by prominently placed index plates. The range of speeds thus obtained through both the headstock and the motor

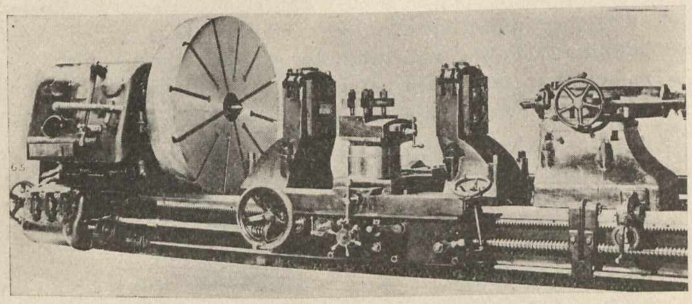


Fig. 1.

is very wide, varying by minute gradations, and far superior to the machine driven by belt through cone pulley. The levers operating the gears in the headstock are readily thrown as the operator desires by simply releasing a knob, and all danger and liability to error are eliminated—a very important consideration in the operation of these heavy lathes. The compactness and neatness of the entire arrangement of the headstock and motor driven are well shown up in Fig. 3.

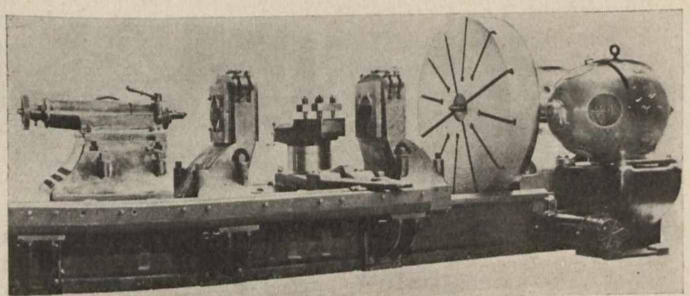


Fig. 2.

Below the all-gear headstock, on the head end of the bed, is located the geared feed changing device. Through the three levers, shown at the front of the box, seven distinct and positive feeds are obtainable without removing a single gear. The gears are mounted on two shafts, and are

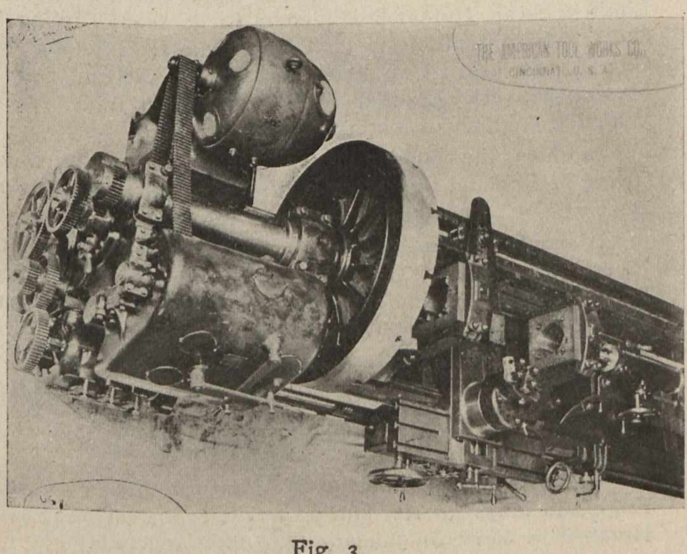


Fig. 3.

completely housed in. Simple index plates show clearly the various combinations for obtaining any desired pitch or thread.

Aside from the motor drive, the features of especial interest, on this particular lathe, are the roll-turning attachments. The heavy housings shown are for the purpose of holding heavy pipe roll castings. At the rear of the machine, mounted on the rear of the bed, is shown an interesting roll-forming attachment, well conveyed in Figs. 2 and 3; the purpose of which is to impart curved surface to long pipe straightening rolls. It operates on the principle of a taper attachment; a shoe, provided with anti-friction rollers, slides in a trough following master bars, thus generating the same curve on the rolls being turned. Straight work can be turned by simply disengaging the nut which holds the shoe and by tightening cross feed nut.

The concaving rest, shown in Fig. 3, is interchangeable with the compound rest, and is used for grooving out pipe welding rolls, with capacity for rolls for pipe from 2 to 20 inches diameter; a limiting gauge, which is provided, being of great value to the operator in getting the tool to any desired diameter. This rest operates with rotary motion, through worm and worm wheel, with either hand or power feed, the latter being derived through the feed rod and carriage with all the advantages of the regular feeds.

Otherwise the lathe contains all the features of excellence peculiar to "American" lathes, including the heavy drop V bed, making the actual swing 62 inches. All gears throughout are coarse pitch and wide face, cut from the solid.

Further information will be cheerfully furnished by the makers.

SEWAGE DISPOSAL WORKS IN GLOUCESTERSHIRE, ENG.

By W. Hollingworth, C.E., Toronto.

The Septic Tank system of sewage treatment, which has found great favor in England as the most economical solution of the problem of the disposal of all descriptions of sewage and trade wastes, is now being accepted in Canada as the most satisfactory method of dealing with the waste products of towns and cities.

The following is a description of works on this system carried out by me for the rural districts of Stroud, Gloucestershire:—The sewage is received at the outfall works direct into the grit chamber which is designed to arrest all road detritus and other non-oxidizable matter. From thence it passes into the Septic Tank through submerged openings, the outlets also are placed below water-level, this excludes all light, and to a certain extent air, and prevents any disturbance of the upper contents of the tank. The tanks are in duplicate and covered over with concrete arches having air-tight manhole covers and ventilators fitted with fine copper gauze. The solid matter contained in the sewage on entering the tank is broken up, some of which descends to the bottom, other floats to the surface according to the specific gravity. This floating matter undergoing decomposition forms a scum on the top of the sewage in the tank. During the winter this scum attains a thickness of two or three inches, forming a rough and coherent layer of considerable toughness, the surface of which becomes covered with a variety of fungoid growths; during the summer, however, this reduces to about half this thickness.

Light and air being excluded from the tank the anaërobic bacteria originally present in the sewage increases to an enormous extent, and attacks all organic substances, the more complex of which are converted into simpler compounds by their action, the ultimate result of the decomposition being the production of ammonia, carbonic acid gas, considerable quantities of hydrogen and methane; these two being highly inflammable have been used in some cases for illuminating the works at night. The sewage now in its semi-clarified state, through the action of the anaërobic bacteria, flows through a circulating chamber, which automatically precipitates any suspended matter which may find its way through the tank outlets during times of abnormal flow, into an aërating trough, flowing over the sides of which in thin sheets into the pipe leading to the alternating distributing gear, and from thence on to the filters which are open tanks 5 feet in depth, filled with crushed furnace clinker, and having collecting drains at the bottom joining main collectors and terminating in discharging wells. The filters are arranged in groups of four and are filled and emptied automatically. As the filter fills, the semi-clarified liquid at the same time rises in the discharge well of that filter, from these discharge wells small pipes are led to discharge over two sets of buckets hung on rocking levers. On the same levers are also the valves controlling the delivery and discharge. The filter which has just filled discharges the one standing full, at the same time closing the discharge and opening the delivery valve of the filter next to be filled, which at the same time is aërating preparatory to receiving the sewage. In this way each filter in turn receives its sewage which is retained till the one next is filled, when it is discharged, it then stands empty to aërate whilst awaiting the next cycle when it will again fill, stand full, empty, remain empty to aërate, and so on.

The bacterial action which takes place in the filters is directly opposite to that which takes place in the Septic Tank; in case the aërobic bacteria perform their work. The presence of oxygen being absolutely necessary for their life and work.

This action consists of the oxidation of the ammonia formed in the tank. This is converted into nitric acid which at once combines with the bases present to form nitrates. This completes the process of purification the resulting effluent being perfectly clear, sparkling and agreeable to the palate and has undergone no putrefaction on being kept in stoppered bottles up till now.

One filter in each set of four is cut out of work each week and given a week's rest. This is necessary in order that the bacteria may exercise their full powers of purification. In conclusion I might add that this system of sewage treatment has been found efficacious at all temperatures experienced in England. In no case has the activity of the bacteria ceased through the formation of ice, the temperature of the sewage being at all times sufficient to prevent any stoppage through this cause in the filters exposed to the air.

METRIC MEASURES.

Editor, Canadian Engineer;—

Sir,—May I be allowed space in your columns to call the attention of your readers to the Weights and Measures Bill which passed the House of Lords on May 17th, of this year,

The outside support which the Bill received is some indication of the favor with which the movement for a reform of our weights and measures is meeting on all sides. Petitions in its favor have been presented either to the Board of Trade or to the House of Lords by various bodies including 92 Town, City and County Councils, 49 Chambers of Commerce, 29 Retail Traders' Associations, 39 Trade Unions, 59 Teachers' Associations, the Inspectors of Weights and Measures in 91 districts, and several Chambers of Agriculture.

In addition to the support already quoted, 333 members of the British House of Commons have signified their approval of the reform, most of them being in favor of a compulsory measure.

The chief objection to the proposed change on the part of engineers is on the score of expense. Prophecies of total ruin to the engineering industry have been made as a consequence of the scrapping of machinery which would be necessitated by the change. That, of course, is a legitimate objection, but we must remember that in many works a scrapping process is more or less continuous, and the most enterprising manufacturers do not hesitate now to scrap machinery when they see any ultimate advantage.

While, therefore, it is unwise on the part of supporters of the reform to ignore this difficulty, it is very easy for their opponents to exaggerate the expense involved; and, further, the advantages of a uniform system of weights and measures are so great and so obvious that we have to decide whether the gain would not outweigh the sacrifice.

German engineers in 1870 were confronted with a similar position, with like difficulties, but we do not hear of universal ruin as a consequence to them of the change which took place at that time.

In a paper read by Alexander Siemens (President of the Institute of Electrical Engineers), on this subject before the Royal Statistical Society on December 15th, 1903, he refers to the question of screw threads.

"As regards screw-cutting machinery," he says, "it should be known by this time that English threads can be cut with metric leading screws just as accurately as metric threads on English leading screws; all that is necessary is to buy suitable exchange wheels."

As an indication of how this reform is regarded in England by scientific men and by manufacturing firms, it is sufficient to quote the names of the following who strongly advocate the adoption of the Metric System:

Lord Alverstone, F.R.S.; Lord Avebury, F.R.S.; Sir Benjamin Baker, K.C.B., etc.; Sir Lowthian Bell, F.R.S.; Sir J. T. Brunner, Sir Wm. Farrer, F.R.G.S.; Sir Michael Foster, K.C.B., etc.; Earl Grey, K.C.M.G.; Sir William Huggins, O.M., F.R.S.; Mr. W. Henry Hunter, M.I.C.E.; Lord Kelvin, O.M., F.R.S., etc.; Lord Lister, O.M., F.R.S.; Sir Oliver Lodge, F.R.S., Sir Hiram Maxim; Sir Guilford Molesworth (Pres. of Inst. C.E.); Sir Andrew Noble, K.C.B., etc.; Sir William Preece, K.C.B., etc.; Sir William Ramsay, K.C.B., F.R.S.; Lord Rayleigh, O.M., F.R.S.; Sir Henry Roscoe, F.R.S.; Mr. Alexander Siemens (Pres. I.E.E.); Armstrong, Whitworth & Co; Babcock & Wilcox; Birch, J. & Co.; Birmingham Small Arms Co.; Boake, Roberts & Co.; Bovril, Limited; Briggs, Thomas (Manchester) Limited; British Mannesmann Tube Co.; Broughton Copper Co.; Brunner, Mond & Co.; Egerton, Burnett, Limited; Burroughs, Wellcome & Co.; Central Marine Engine Works; Clarke, Nickolls & Coombs; Clayton & Shuttleworth; Cleveland Bridge and Engineering Co.; Colville, David, & Sons; Crosfield, Joseph, & Sons, Limited; Debenham & Freebody; Deloitte, Dever, Griffiths & Co.; Elliman, Sons & Co.; Fleming, Birkby & Goodall; Sir Douglas Fox & Partners; Fraser & Chalmers; Gosnell, John, & Co.; Gossage, William, & Sons; Guthrie, Edwin & Co.; Harland & Wolff; Harrods Stores, Limited; Hollins Mill Co.; Horrockses, Crewdson & Co.; Imperial Tobacco Co.; Jaegers Sanitary Woolen Co.; Jenson & Nicholson; Johnson Mattey & Co.; Jonas & Colver; Johannesburg Cons. Investment Co.; Kayser, Ellison & Co.; Lancashires Explosives Co.; Liberty & Co.; Main, A. & J. Co.; Mather & Platt; Maw, S., & Sons; N. F. Marine Engineering Co.; North British Locomotive Co.; Pears, A. & F., Limited; Perfecta Seamless Steel Tube Co.; Ransomes, Sims & Jefferies; Rudge-Whitworth, Limited; Ruston, Proctor & Co.; Salt, Sir Titus, Bt., Sons, & Co.; Salt Union, Limited; Salter, George, & Co.; Sandycroft Foundry Co.; Sassoon, D., & Co.; Siemens, Alexander, & Co.; Simpson, James, & Co.; Smith's Dock Co.; Summerscales & Son, Limited; Swan, Hunter & Wingham Richardson; Tapling, T., & Co.; Thornycroft, John I., & Co.; Tyne Iron Shipbuilding Co.; United Alkali Co.; Venesta, Limited; Vickers, Sons & Maxim; Waverley Iron & Steel Co.; White, J. G., & Co.; Whiteley, William, Limited; Whitwell & Co.

In short, the popular demand for the change is now so strong in England that there is little doubt that the Government will be compelled to grant the reform.

It should be remembered, moreover, in the event of the Liberal party coming into power, that the Lords Spencer, Rosebery and Tweedmouth warmly advocated the reform when the Bill was under discussion in the House of Lords.

E. Johnson, Secretary Decimal Association,
London, England.

—The American Society of Heating and Ventilating Engineers holds its eleventh annual meeting at the Astor Hotel, New York, on January 17th, 18th, and 19th.

—The Kerr Engine Co., Walkerville, are to be congratulated on the tasty calendar which they are issuing for 1905. The heavy dark board with its wide margins enhances the beauty of the picture which it supports, and the printing, while perfectly legible, is not so intrusive as to mar the general effect.