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RAILWAY TRANSPORTATION PROBLEMS OF THE FUTURE

PRECEDENTS OF PIONEER RAILROADING OVERTURNED BY NEW FACTORS—THE QUESTION OF GRADES A HANDICAP TO CO-OPERATION—SYSTEM OF GRADE PROFILE ANALYSIS IN NEED OF REVISION—ELECTRIC TRACTION SHOULD NOT BE DELAYED.

By J. GRANT MACGREGOR, C.E., Mem. Can. Soc. C.E.

Chief Engineer, The Alberta Central Railway Company.

THE building of so many transcontinental lines across the Dominion, and the opening up of new inland and ocean waterways for the transportation of the produce of the country may be regarded as the dawn of a new era in the history of railway transportation.

The rapidity of the pace set by competitive lines is in a measure responsible for the state of bewilderment in which the country now finds itself when confronted with the most important railway building and transportation problems of the age. The situation has been the subject of much controversy both among members of the engineering profession and those concerned financially in the economics of present-day railway construction and operation. Precedents based on past experience in pioneer railroading have been disregarded, and the researches and life work of the greatest authorities on railway economics have been found antiquated when compared with the progress of recent events.

There is also a decided lack of harmony between different departments of the various railways in regard to the advantage of the present practice of building railways with long stretches of low ruling grade, all of which tend to unnerve the engineer who may have placed too much faith in the adaptability of old and well-known rules to modern conditions.

The question that now arises is, to what extent are the conditions changed that require a departure from well-known rules and practice in railroad building. The two greatest factors that have entered into, and hold sway in all problems of railway engineering and operation since the invention of steam, are those of "Tractive Power" and "Train Resistance," and as long as the law of gravitation exists we shall have at least one of them to contend with. In considering the other factors, the development of steam tractive power and its application to overcoming train resistance, we find that no great strides have recently been made whereby increased efficiency in the hauling power of locomotives should bring about a change in the conditions affecting grade and alignment. Until closer co-operation is instituted between the operating and engineering departments of the various railways very little will be accomplished in the way of building railways on a basis by which the best results can be obtained in their operation. Too frequently is advantage taken of a new line with low grades as an accessory for the use of old or obsolete engines whereby a saving can be affected to the operating department at the expense of the construction department.

If by constructing railways with lower ruling grades a solution is not obtained to the problem of hauling heavier train loads with present engine efficiency, then a step has been taken in the wrong direction, which is not at all unlikely. The solution, however, will not be found in any further development of the increased weight of the present unit of steam tractive power. More likely it shall be found where a greater number of units are used whether of steam, electrical or oil gas propulsion, whereby the load to be hauled can be increased to a proportion consistent with the proper train unit for minimum cost of operation.

But, to return to the question of the value of lower ruling grades, it should not be necessary at the present time to make a strong plea for their use wherever they can be introduced at a reasonable cost. The fact that millions are being spent annually by the various trunk lines on grade reduction should be sufficient evidence that the movement has got beyond the experimental stage. The wisdom of such a course is apparent from the beneficial results obtained in the way of increased revenue and lower cost of operation. The changes and modifications of grade profile designed to produce the beneficial results obtained have invariably been based on well-known rules in railway location and data obtained from experiments of the actual performance of trains under the conditions sought. If there should be any uncertainty about the continuous performance or endurance of certain classes of locomotives on long stretches of low ruling grades the sooner the value of such a factor is taken into account the better. In the meantime, are we to assume that the defect is of a mechanical nature and that, until such time as it can be removed the grade profile should be modified to provide suitable resting places for the recuperation of the "old horse"?

Under present conditions what is most urgently required is a more definite system of grade profile analysis, by which the proper amount of tractive power can be assigned to the requirements of each division of road to be operated. The analysis referred to once carefully prepared and put in graphic form should show the performance of each class of engine between stations, with a load line adjusted to conform to the requirements of minimum speed over long stretches of ruling grade. To obtain satisfactory results close co-operation is necessary between all departments affected.

The growth of the trade of the Dominion affecting transportation companies is so rapid that greater caution than ever should now be exercised in constructing new arteries of commerce. It would appear that in determining the main arteries of commerce of the future, greater consideration should be given to conditions affecting their future development than to questions of rapid transit and shortest route under present conditions. The fact must not be overlooked, however, that there will always be a limit to the extent to which physical obstacles can be removed from a route, and for this reason it may be necessary to look for developments along other lines. Some of the sources from which relief must be expected are already to some extent receiving attention from the principal transportation companies, such as greater facilities for a more speedy and continuous flow of traffic in both directions along the main arteries, with corresponding facilities for the better handling of freight at distribution and terminal points.

If the demand, however, for increased train loads should continue to find favor a change in the present principle of the application of tractive power to the hauling of trains must be expected. It is to be hoped the day is not far distant when it will be found more economical to combine the power now developed by such a huge fleet of locomotives into stationary engines for the distribution of power in a manner better adapted to modern requirements so that it shall no longer be necessary to have one or two portable power houses attached to each train unduly wasting the products of our mines and diffusing the sparks which destroy the combustible products of the forests and prairie.

THE USE OF EXPLOSIVES.

The mining engineering profession is accustomed to consider the use of high explosives as its especial field. It is probably not generally realized how widely explosives are used otherwise. Disregarding the strictly engineering work of excavation in rock or compact material on a considerable scale, explosives are finding an increased application in more varied lines. Dynamite seems to be not only available, but highly efficient for such purposes as extracting stumps; breaking subsoils to assist drainage and the entrance of plant roots; digging post holes; ditching, especially for drainage purposes; blowing out holes for planting trees; breaking up unwieldly boulders and excavating in connection with road work.

The National Paving Brick Manufacturer's Association will hold its tenth annual meeting at Cleveland, Ohio, on September 17 and 18. This is the first summer convention the association has held, the former custom of holding winter meetings having recently been altered to afford opportunity for investigating actual work on brick street and road construction. Officers of the National Paving Brick Manufacturers' Association are:—Charles J. Deckman, Cleveland, president; Will P. Blair, Cleveland, secretary.

INSULATION OF JOINTS IN PIPE LINES.*

By William R. Conard,
Inspecting Engineer, Burlington, N.J.

SOME years ago it was the writer's privilege to secure pipe for carrying high-pressure gas, or rather that was the term used in speaking of it, and the thought was that it might be of interest to the New England Waterworks Association to have a short description of the manner in which these pipes were laid in an endeavor to get a line as nearly proof against electrolytic action as possible.

The pipe were of the ordinary bell and spigot type with the bell made 5 in. deep and with no lead groove (see Fig. 1), and were tested to 50 lb. of air per sq. in. at the foundry in addition to the regular hydrostatic test. In all there were about 15 miles of 6-in. pipe.

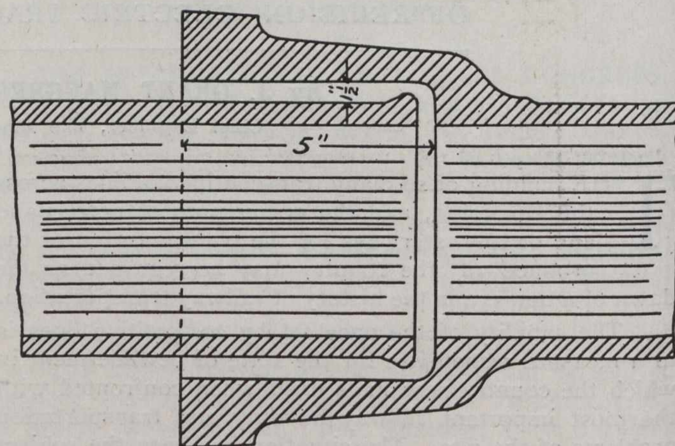


Fig. 1.—Cross-Section of Bell and Spigot.

In laying these pipe the joints were made up by placing at the base of the bell ¼-in. wooden ring, oil-soaked; the spigot of the pipe next to be used was then encircled with a rubber band about 1/16 in. thick and 2½ in. wide placed about 5½ in. from the spigot end of the pipe to prevent an iron ring, afterwards put on, coming in contact with the pipe; the pipes were then put together, the spigot going home against the wooden ring, and about 1½ in. of untarred jute packing calked tight; instead of lead being poured in to make the rest of the joint, an insulating compound about 3 in. deep, black in appearance, which melts readily at 200° F., was poured, after which a square rubber packing was put on, and then a No. 4½ Dresser coupling was applied to the joint and clamped tight (see Fig. 2).

To those unfamiliar with the Dresser coupling, it may be described as consisting of two split clamp rings; one split clamp ring fitting around the outside of the base of the bell, the other around the outside of the spigot end of the pipe, entering the bell, with a 1-inch square rubber packing ring between it and the bell. The two rings are connected and drawn towards one another by four bolts, one ring pressing against the square rubber packing.

The line, after laying and in sections, was tested with 20 lb. per sq. in. air pressure, and all the joints found tight.

Joints made up in this manner are as flexible as poured lead joints, acting just as readily as expansion joints,

*Read before the New England Waterworks Association, February 12, 1913.

and electric tests made shortly after installation indicated no flow of electricity at all, although, the entire pipe line parallels an electric car line.

The expense of a line like this figured about three times greater than for an ordinary lead joint, but for a gas line it was considered very desirable that it should be no conductor of electricity.

It is probably true that the rubber used in these joints will in time disintegrate, but it is also true that it will last for quite a number of years, for the moisture in the earth and the absence of exposure to the atmosphere should keep the volatile particles of the rubber alive for a long while.

As an insulated joint to prevent pipe lines from carrying stray currents of electricity it would appear that it would be fully as serviceable for water as for gas lines.

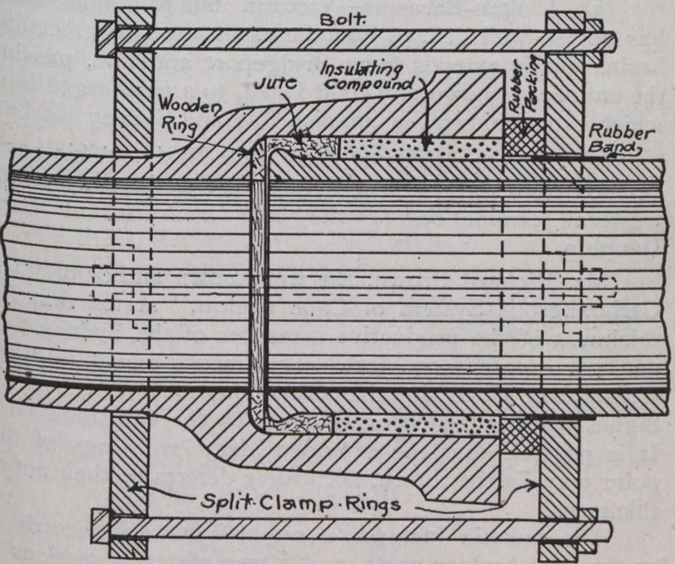


Fig. 2.—The Joint Constructed.

Since writing the above I learn from Mr. Brackett, chief engineer of the Metropolitan Waterworks, that rubber insulated joints have been used by them and were successful when installed, but due to a large amount of current charging the pipe from a heavy electric storm, the rubber was in part carbonized and thereby became a conductor rather than an insulator. It would appear, therefore, that so long as electricity can be prevented from collecting in large volume, the joint described is an efficient insulator, but one can never tell what is going to happen during an electric storm. If the rubber once becomes carbonized or loses volatile properties, it fails as an insulator.

The Lincoln Highway Association, formed to secure the establishment of an ocean-to-ocean highway, to be a memorial to Abraham Lincoln, has established headquarters at Detroit. The highway, plans for which are nearing completion, is to cost approximately $10,000,000, of which $4,200,000 has already been subscribed. The association proposes to co-operate with local communities in procuring the establishment of the highway, to be engaged in the improvement or reconstruction of existing highways, which will constitute a part of the route. Several States along the line have already taken steps towards the construction of improved highways from east to west to connect with the coast-to-coast route. Mr. H. B. Joy is president of the association.

THE SYDNEY COAL FIELDS.

By Joseph G. S. Hudson.

THE mines branch, Department of Mines, Ottawa, in a bulletin specially prepared for the International Geological Congress, by Mr. J. G. S. Hudson, gives some interesting historic facts concerning the Sydney coal fields of Cape Breton, Nova Scotia. The sketch is as follows:—

The maritime provinces of Canada, owing to their geological position on the Atlantic seaboard, were the first in Canada to have their mineral resources explored. Among these resources coal is one which stands pre-eminent, and Nova Scotia has for over 200 years had an enviable reputation as a producer of bituminous coal.

The first printed notice of the existence of coal in these areas appeared in 1672, when Nicholas Denys published in Paris, "La Description Geographique et Historique des Costes de l'Amerique Septentrionale." Eighteen years before, in 1654, Denys had obtained from Louis XIV., a concession granting the right to explore and work mines of gold and other minerals; for this privilege he agreed to pay the King a royalty of one-tenth. In 1677, M. Duchesneau, the Intendant of New France, issued a proclamation, exacting a royalty of 20 sous per ton, from all persons taking coal from Cape Breton. In 1711, Admiral Walker—who commanded an expedition to reduce Quebec—mentions in his journal, that he procured a supply of coal from the cliffs, with no other appliances than crowbars.

The initial attempt at systematic mining was made in 1720, when it was found necessary to procure a supply of fuel for the men who came from France to lay the foundations of the fortress of Louisburg. The pit openings then made, can be seen even at the present day, at Port Morien, Table Head, and other places. During the next 100 years, very little work was done, the coal mined being used almost exclusively by the garrison at Halifax. In 1820, however, when Cape Breton Island became part of the province of Nova Scotia, a considerable tonnage of coal was being mined. In 1827 all the mines were transferred to the company known as the General Mining Association by the London firm of goldsmiths (Rundle, Bridge, and Rundle) who had secured the mines and minerals concession for the entire island province of Cape Breton, from the Duke of York. The new owners immediately organized, opened out, and systematically operated, mines in Cape Breton, Pictou, and Cumberland counties. A formidable agitation had been started in the province for some years previous to 1858, claiming that the monopoly of the coal lands by the General Mining Association was seriously retarding the legitimate expansion of the coal trade; this agitation eventually resulted in the whole subject being referred to the privy council of Great Britain for equitable adjustment. In 1858, the Mining Association surrendered its claims to the provincial government of Nova Scotia. The government, in return, agreed to abolish the fixed rental of £3,000 per annum, together with the royalty on slack coal; to reduce the royalty on all screened coal up to 250,000 tons, to 4.80 pence per ton; and to reduce the royalty on all coal sold over 250,000 tons to 3.20 pence per ton. To the association, however, was reserved the exclusive right to 20 square miles in Cape Breton, and to 4 square miles each in Pictou, Joggins, and Springhill counties respectively. Under this new regime, mining developed to such magnitude that, in 1865, the provincial government appointed an inspector of mines (John Rutherford, M.E.)—the first on this continent.

In, 1854 the government of the United States removed the duty on coal. This "open door" policy greatly increased the trade with the New England States; in 1866, the exportation of coal thereto amounted to 404,252 tons. In 1867, however, (year of Confederation) the United States once again discriminated against Canadian coal, imposing a duty of $1.25 per ton. This duty was maintained at this rate until 1872, when it was reduced to 75 cents per ton; at which figure it remained until 1894. During this latter period, the exports fluctuated from 228,132 tons to 13,883 tons. During the period 1894-97, the tariff was reduced to 40 cents, but in 1897 it was advanced to 67 cents, at which figure it still remains. Notwithstanding the tariff barriers, the exportation of Nova Scotia bituminous coal to the New England States continued to increase, and in 1903 the shipments reached a maximum of 968,832 tons. There has been a gradual decrease since that date, and in 1912 the shipments were 412,531 tons. The total production has, however, increased enormously; in 1912 it was 6,802,997 tons (of 2,240 pounds). Of this production 5,197,601 tons are to be credited to the coal fields of Cape Breton.

This marked increase in the production is due in part to the increased market offered by St. Lawrence ports. In 1877 a select committee of the Dominion parliament, appointed to inquire into the condition of the coal trade, recommended the imposition of a duty on United States coals; this duty has had the desired effect of opening up the markets of the St. Lawrence to the Nova Scotia coal trade, and in 1912 the St. Lawrence market alone purchased 2,159,005 tons, most of which came from Cape Breton.

On February 1, 1903, the Dominion Coal Company was organized with a capital of $18,000,000 by a special Act of the Legislature of Nova Scotia. This corporation amalgamated the principal interests in the coal areas on the south side of Sydney harbor, Cape Breton. These included the Caledonia, International, Gardiner, Old Bridgeport, Glace Bay, Reserve, Gowrie, Victoria, and Ontario mines, also the Sword areas, in all comprising 70 square miles; the areas controlled have now been extended to 142 square miles. With the advent of this great industrial organization, a new era in Nova Scotia coal mining began; new mine workings, railway extensions, new shipping and discharging facilities were developed, old coal markets were expanded, and new ones opened out, so that the whole coal trade was revolutionized. In the first year of its operations (1893) the coal mined was 834,019 tons; in 1912, the production amounted to 4,332,320 tons; or an increase of nearly 520 per cent. in 20 years.

In 1900, the Nova Scotia Steel and Coal Company acquired all the mining rights still held by the General Mining Association. In addition to operating the existing collieries, they have opened out new mines, erected iron and steel works, and built a modern coke oven plant, all in close proximity to the working collieries. Their Princess Pit—now known as Sydney No. 1—was, in 1873, the first submarine mine in North America, the coal being won from workings under the sea. The shafts are of unique construction, consisting of metal cribbing or tubbing. The total length of metal tubbing is 842 ft. 9 ins., weighing some 776 tons. Here, also, was erected the first Guibal ventilating fan in Cape Breton.

The most important of the Cape Breton coal fields is that known as the Sydney field. It is an extraordinarily rich tract of coal bearing rocks, having an area of approximately 250 square miles. It extends along the northern coast of Cape Breton island for a distance of about 35 miles. Geologically the coal bearing strata are bounded by the outcrops of the Millstone Grit, as seen at Mira Bay, and they terminate at Cape Dauphin, where the intrusive syenites of the Ste. Anne hills form the northern boundary of the Great Bras d'Or Lakes. The Sydney field is divided into four main basins, as follows:

(1) Cow Bay or Morien Basin, defined on the east by the Millstone Grit and on the west by an anticlinal fault that dips seaward at Cape Percy.

(2) Glace Bay Basin, bounded by the Cape Percy anticline on the east, and by the Bridgeport anticline on the west.

(3) Lingan-Barasois—Victoria Basin. This basin has not so well defined boundaries as the two preceding basins but it extends from Bridgeport anticline, passing the eminence known as David Head, to a submerged fault which exists midway in Spanish Bay and Sydney Harbor.

(4) Sydney Mines or Bras d'Or Basin. This basin extends from the submerged fault in Spanish Bay to the western termination of the coal measures at Cape Dauphin.

Mr. Richard Brown, the well-known author of "The Carboniferous System of Cape Breton," states that the thickness of the productive measures of the Sydney field will not exceed 6,000 feet. This measurement is taken from Burnt Head in the Glace Bay Basin, where the highest known bed occurs, down to the Millstone Grit. It is possible that the extended deep workings at this point may, in the future, accurately determine their actual thickness.

The bulletin includes a set of summary records of analyses of Sydney coals, and fifteen plates of sections of coal seams and strata, some of them representing a depth of over 1,500 feet. An index map of the fields is appended.

Logan Waller Page, Director of the United States Office of Public Roads, will read a paper at the Road Congress at Detroit on the "Selection of Road Materials." Before he was appointed to his present post Mr. Page assembled at Harvard University the first road material testing laboratory in America, following his studies at the French School of Roads and Bridges, and his name is now identified with some of the best-known apparatus for road material tests. The selection of road materials is an exceedingly important factor in the building of a road, and it is certain that Mr. Page's paper will receive the closest attention.

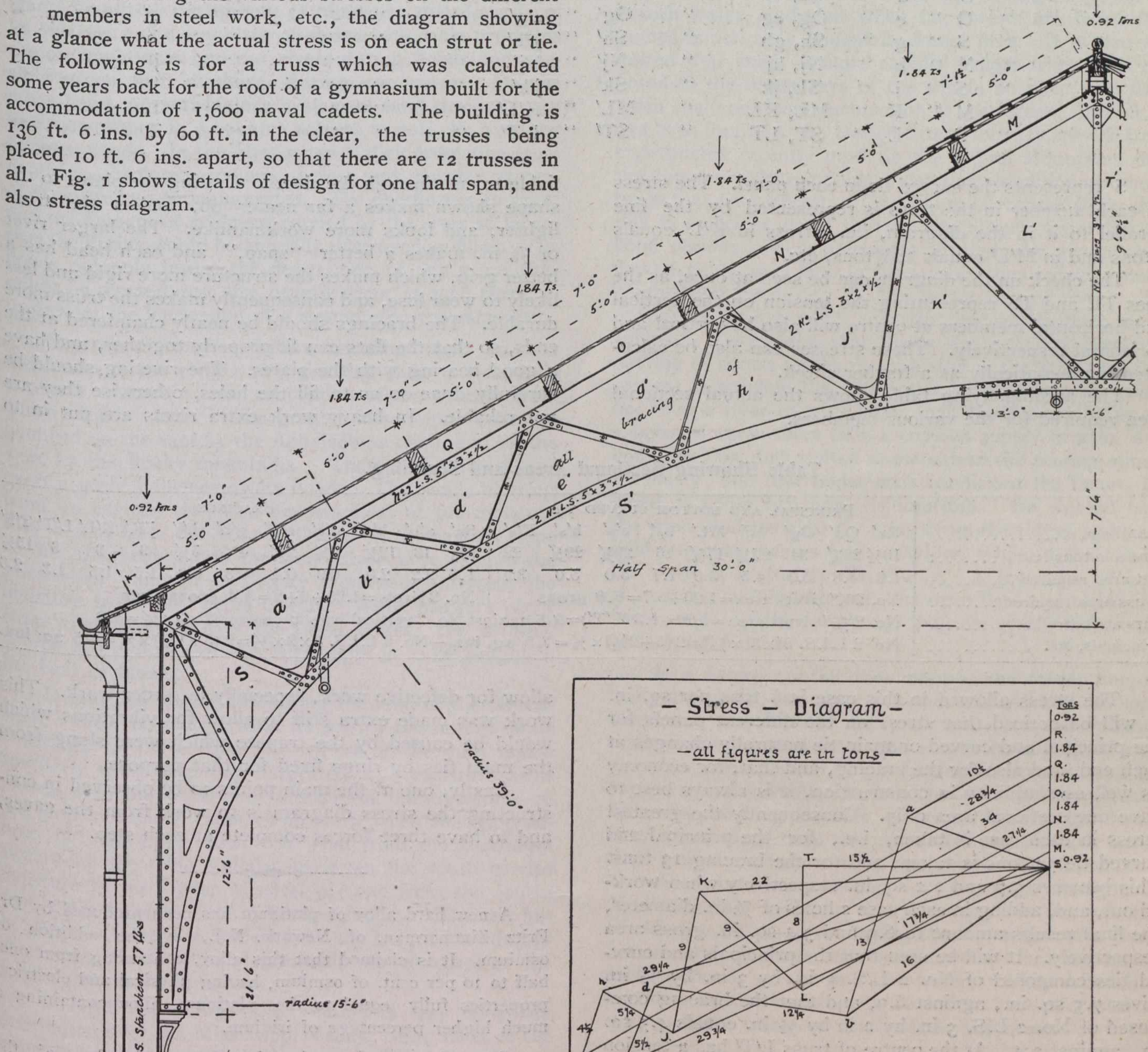
The world's largest power plant is projected to be located at Big Eddy, on the Columbia River, a few miles above the Dalles. The gorge at this point is of such a character that comparatively little work will be required to impound a great quantity of water, sufficient to develop 300,000 horse-power. The river can be entirely closed by the construction of a dam only 300 feet long and 180 feet above its foundations, and the construction of a canal 300 feet wide, 20 feet deep and a mile and a half in length. The head of water is 73 feet at low tide and 42 feet at high water, and the mean flow of the river throughout the year is 235,000 cubic feet per second. The hydro-electric units would be each of 32,000 horse-power. The total cost of the scheme would be about $23,000,000.

DESIGN AND GRAPHIC METHOD FOR CALCULATING A STEEL TRUSS.

By Leonard Goodday, C.E., M.E.,
Late of the British Admiralty.

It is very well known by engineers that the graphic method is the best, quickest and most practical way for calculating the various stresses on the different members in steel work, etc., the diagram showing at a glance what the actual stress is on each strut or tie. The following is for a truss which was calculated some years back for the roof of a gymnasium built for the accommodation of 1,600 naval cadets. The building is 136 ft. 6 ins. by 60 ft. in the clear, the trusses being placed 10 ft. 6 ins. apart, so that there are 12 trusses in all. Fig. 1 shows details of design for one half span, and also stress diagram.

Starting with the weight on the truss, and taking the wind into account, dead weight, when worked out, equals 55.8172 lbs. per sq. ft. Superficial area equals 10.5 × 35.125, or 368.85 sq. ft., from which the total weight is found to be 9.20 tons. The truss is of the Warren type, and the distributed weight equals 0.92 tons at each end of half span, and 1.84 tons on each apex.



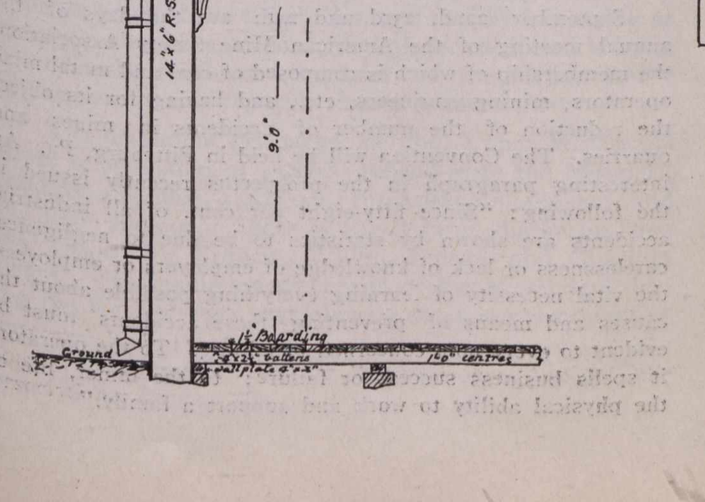


Fig. 1.—Design of Roof for a Gymnasium (Half Span) and Stress Diagram Applied to it.

It must be remembered that the diagram should be lettered similarly to the truss, so that no mistake is made in respect to the stress on any one member, for from whatever point that occurs the diagram will be entirely wrong to the end.

Now draw the vertical line R.S. (see diagram) to any convenient scale, representing the total weight on the half truss, less that portion taken directly by the end support, and divided into the lengths RQ, QO, ON, NM, MS, representing the various weights in tons, as shown. It will be noticed that the lettering of the panels, and the naming of a member by the letters on either side simplifies the process throughout.

From	R	and	S	draw	Ra, Sa,	parallel to	Ra′	and	Sa′	on sketch	until	they	intersect at	a
"	a′	"	S	"	ab, Sb	"	a′b′	"	Sb′	"	"	"	"	b
"	Q	"	b	"	Qd, bd	"	Qd′	"	b′d′	"	"	"	"	d
"	S	"	d	"	Se, de	"	Se′	"	d′e′	"	"	"	"	e
"	O	"	e	"	Og, eg	"	Og′	"	e′g′	"	"	"	"	g
"	S	"	g	"	Sh, gh	"	Sh′	"	g′h′	"	"	"	"	h
"	N	"	h	"	Nj, hj	"	Nj′	"	h′j′	"	"	"	"	j
"	S	"	j	"	Sk, jk	"	Sk′	"	j′k′	"	"	"	"	k
"	M	"	K	"	ML, KL	"	ML′	"	K′L′	"	"	"	"	L
"	S	"	L	"	ST, LT	"	ST′	"	L′T′	"	"	"	"	T

S′ represents the curved tie in each panel. The stress on each member in the truss is represented by the line parallel to it in the diagram, i.e., stress in K′L′ equals 9 tons and in M′L′ equals 17¾ tons, etc.

The check on the diagram can be seen at once, as the lines TL and TS representing the tension on the vertical and horizontal members at centre will also be vertical and horizontal respectively. These stresses can also be calculated mathematically as a further check.

The accompanying table shows the actual sectional area required for the various members.

Table Showing Sectional Areas and Scantling.

	Principal and bottom curved tie									Bracings										
Scantling	Ra′	Qd′	Og′	Nj′	ML′	bs′	e′s′	h′s′	K′s′	Sa′	a′b′	b′d′	d′e′	e′g′	g′h′	h′j′	j′K′	K′L′	L′T′	T′S′
Stress in tons	10½	28¾	34	27¼	17¾	16	29¾	29¼	22	9½	13	12¼	5½	2½	4½	5¼	9	9	8	15½
Net area required	1.8	4.8	5.7	4.5	3.0	1.7	5.0	5.0	3.7	1.6	2.2	2.0	0.9	0.4	0.8	0.9	1.5	1.5	1.3	2.6
Gross area required	No. 2⅞″ rivets area=1.20+5.7=**6.9 gross**									No. 2 rivets=1.20+2+2=**3.4 gross area**										
Bars at centre	No. 2 ⅞″ rivets area=1.20+1.3 (L′T′)=**2.5** against No. 2 vertical bars at centre=2×3×½=**3.0**																			
Principals, &c.	No. 2 L.I.S. 5″×3″×½″=2 (5+2½)×½=**7.5 sq. ins.**—No. 2 L.I.S. 3×2×½=2 (3+1½)×½=**4.5 sq. ins.**																			

The stress allowed in this case is 6 tons per sq. in. It will be noticed that stress on the different panels for the principal and curved or main tie naturally changes at each end, and also for the bracing, and that, for economy as well as simplicity in construction, it is always best to have one sectional area only. Consequently the greatest stress in each case is taken, i.e., for the principal and curved tie 34 tons is taken, and for the bracing 13 tons. This becomes 5.7 and 2.2 sq. in. respectively when worked out, and, adding in each case 2 holes of ⅞ in. diameter, the final results amount to 6.9 and 3.4 sq. in. gross area respectively. It will be seen that the principals and curved ties composed of No. 2 L.S. 5 in. by 3 in. by ½ in. gives 7.5 sq. in., against 6.9, and that the bracing composed of No. 2 L.S. 3 in. by 2 in by ½ in. equals 4.5 sq. in., against 3.4. At the centre of truss L′T′ has a tension of 1.3 tons and for two rivet holes 1.20, so that the total amounts to 2.5 sq. in., and No. 2 vertical tension bars having 3.0 sq. in. will be about right. The rivets should never be less than ⅞ in. for this span of 60 ft., although ¾ in. diameter rivets are sometimes used, but then more rivets are needed at the joints, and consequently the plates are much larger and therefore clumsy. In work of this kind it is not always wise to consider the rivets in double shear where this occurs, as practically no rivet is ever sheared in two places at once. It must be remembered that at the joints there must be enough rivets in the end of each bracing or tie to take the thrust or pull in either case. The pitch of rivets for the principals and curved or main tie equals 3½ ins., and for the bracing 2⅝ ins. The holes for rivets are generally made ⅛ in. larger in diameter than the rivets.

The plates at joints are ½ in. in thickness. In no cases should they be less than ⅜ in., otherwise they are liable to cut through the rivets. Cutting the plates to the shape shown makes a far neater job, makes the truss lighter, and looks more workmanlike. The larger rivet of ⅞ in. makes a better "snap," and each head has a better grip, which makes the structure more rigid and less likely to wear lose, and consequently makes the truss more durable. The bracings should be neatly chamfered at the ends, so that the flats can fit properly together, and have a good bearing with the plates. The riveting should be carefully done so as to fill the holes, otherwise they are not reliable. In heavy work extra rivets are put in to allow for defective work, especially in girder work. This work was made extra stiff to allow for vibrations which would be caused by the trapeze which were slung from the main ties by rings fixed for that purpose.

Lastly, one of the main points to be observed in constructing the stress diagram is to work from the eaves, and to have three forces complete at each step.

A new hard alloy of platinum has been produced by Dr. Fritz Zimmerman, of Newark, N.J., by the addition of osmium. It is claimed that this alloy, containing from one-half to 10 per cent. of osmium, having physical and electrical properties fully equal to the platinum alloy containing a much higher percentage of iridium.

September 22nd, 23rd and 24th are the days of the annual meeting of the American Mine Safety Association, the membership of which is composed of coal and metal mine operators, mining engineers, etc., and having for its object the reduction of the number of accidents in mines and quarries. The Convention will be held in Pittsburg, Pa. An interesting paragraph in the prospectus recently issued is the following: "Since fifty-eight per cent. of all industrial accidents are shown by statistics to be due to negligence, carelessness or lack of knowledge of employers or employees, the vital necessity of learning everything possible about the causes and means of preventing these accidents must be evident to every man concerned in mining. To the operators it spells business success or failure; to the miner, life or the physical ability to work and support a family."

THE CONTROL OF RIVER FLOODS.*

By Col. C. McD. Townsend, M.Am.Soc.C.E.
United States Corps of Engineers.

THE subject of land drainage is intimately associated with that of river improvement. The cultivation of the soil largely increases the amount of sediment entering our streams; the direction of the furrow markedly affects the amount of rainwater that flows from its surface, and every ditch or subsurface drain promotes a more rapid flow into our rivers during floods and possibly affects their discharge during low water. On the other hand, no satisfactory system of land drainage can be accomplished in a country subject to periodic overflow by river floods. In the Mississippi Valley protection from floods is absolutely required before any regular system of drainage can be inaugurated. The overflow is so great and the amount of sediment carried by the river so large, that the drains would be annually destroyed or filled. The floods not only insure the destruction of any crops that might be planted, but also usually occur at such times as to prevent the harvesting of a second crop the same year.

Sources of Floods.—Before entering upon such a discussion of the means of preventing these floods, it is desirable to have a clear conception of the sources from which floods arise. The greater Mississippi Valley is bounded on the east by the Appalachian chain and on the west by the Rocky mountains. These mountain ranges exert a great influence on its floods. The winds blowing from an easterly direction deposit most of the moisture they absorb from the Atlantic Ocean on the eastern slope of the Alleghenies, and therefore cause little rain in the Mississippi Valley; the Rocky Mountains intercept the moisture from the Pacific Ocean. While showers occur from winds blowing over the Great Lakes, the original source of the floods of the Mississippi is to be sought in the Gulf of Mexico.

During the winter and spring the land of the Mississippi Valley, no matter what its soil or the nature of its covering, is cooler than the waters of the gulf, and a southerly wind becoming saturated with moisture as it passes over the water will precipitate that moisture on the land in copious rains, or in snow when the temperature is sufficiently low. A wind from the southwest sweeps up the Ohio Valley; one from the south carries moisture to the Upper Mississippi; one from the southeast to the valleys of the Arkansas and the Missouri; but in all cases there is a tendency for the greatest rainfall to occur near the coast, and gradually to decrease as the wind currents travel inland.

Generally speaking, the rainfall is very unequally distributed over the Mississippi Valley, being least at the upper sources of the tributaries, and rapidly increasing as the main stream is reached, though an exception is to be noted in the southern tributaries of the Ohio, whose sources are nearer the gulf than are their outlets.

The maximum discharge of the Upper Mississippi River is estimated at 450,000 second-feet; the Missouri, 900,000; the Ohio, 1,400,000; the Arkansas, 450,000; and the Red, 220,000. There is also a large discharge from the Yazoo, St. Francis, White, Tensas, and Ouachita rivers. The maximum discharge of the Mississippi during the flood of 1912 was about 2,000,000 second-feet at Cairo, and 2,300,000 at the mouth of the Red River. It overflows its natural banks when the flow exceeds 1,000,000 second-feet.

While the influence of forests on stream flow has received little attention in this country until recently, the scientists of Europe have discussed the subject pro and con during the past forty years. It is generally accepted by both sides that the leaves falling from forest trees as they decay form a humus which has a large capacity to absorb water, and that when the forests are felled this humus is seriously injured by forest fires. It is also admitted that snow is more rapidly melted when it is exposed to the direct rays of the sun in an open field than when sheltered from such action in the forest. In fact, it has been found by the United States forestry service from experiments recently made in the White Mountains that the flow from cleared fields under such conditions is about twice that from forests. The forest advocates claim that this is sufficient proof that forests absorb water during flood periods, which percolates through the ground and flows from springs later in the season, thus reducing flood heights and increasing the low water flow of rivers. Its opponents do not admit that the problem is thus easily solved. They claim that floods do not arise from the melting of snows by the direct action of the sun; that this process is so slow that the water which flows off would not raise a river to mid-stage; that floods occur when on a layer of snow there falls a copious supply of rain, and both the rain and melted snow enters the stream simultaneously; and that under such conditions the forest, instead of being beneficial, is injurious. On cleared land the wind tends to blow the snow from the ridges and piles it in immense masses in the ravines, while in the forests the snow is uniformly distributed. A few days of sunshine dries out the ridges in the open field and melts sufficient snow in the forest to saturate with water the underlying humus.

If a heavy rainfall then occurs, the forest humus, being saturated, can absorb no more water, and the combined rain and snow of the forest flows into the streams, while in the cleared land, the ridges having dried out, absorb a large portion of the rainfall, and the snowdrifts expose a much smaller surface to the action of rain. Moreover, during periods of great drouth the forest humus and long, deep tree roots also absorb more water than grass and farm crops, and retard the run-off at a time when it is most needed for low water navigation. They therefore maintain that a forest is a fair-weather friend of some use in regulating the mid-stages of a river, but an utter failure when most needed—that is, during extreme floods or extreme low water. While I consider this discussion valuable, my objections to reforestation are not based solely on a scholastic argument.

It requires from twenty to fifty years to produce a good forest growth, and over a century for the leaves of that forest to decay in sufficient quantities to produce the humus which will be satisfactory as an absorbent of rainfall. We can not afford to delay the drainage of the Mississippi Valley even to produce the forest growth, without taking into consideration the time required for the humus to form. We are more vitally interested in the height that the river will attain in the next few weeks than in what will occur in the year 2013.

It is also pertinent to this discussion to determine what would be the extent of the forest reservation which would be required to reduce the flood heights on the Mississippi River a given amount. To solve this problem

*Paper read at a recent meeting of Drainage Congress in St. Louis.

it is necessary to make certain assumptions, and for purposes of argument we will take it for granted that reforestation will reduce the flood discharge of a stream one-half. The Mississippi flood of 1912 attained the greatest height of any then recorded at all gauge stations, except at Vicksburg. That of January and February, 1913, while 5 feet lower at Cairo, was the next highest flood at Memphis, and for a considerable distance along the river. We will endeavor by reforestation to reduce the flood of 1912 to the heights attained in the winter of 1913. For this purpose it will be necessary to reduce the maximum discharge of the river 500,000 second feet. It will also be necessary to distribute this reduction among the tributaries, reducing the maximum discharge of the Missouri River from 900,000 to 700,000 second-feet, that of the Upper Mississippi from 450,000 to 350,000, and that of the Ohio River from 1,400,000 to 1,200,000.

As stated in the introductory remarks, the flood discharge of the Missouri River at its headwaters is about 1 cubic foot per second per square mile of drainage area, and if the reduction in discharge of one-half is to be secured by reforestation 2 square miles of forest would be necessary for every second-foot of reduction of flood discharge, or 400,000 square miles of forests to reduce the discharge of the Missouri River 200,000 second-feet. At the headwaters of the Upper Mississippi the ratio of flood discharge to drainage area is about 2 second-feet per square mile. A reduction of this discharge by one-half would require a forest reservation of 100,000 square miles to reduce the floods of the Upper Mississippi 100,000 second feet. On the Ohio River the ratio is six to one, and it would therefore require forests at the headwaters of the Ohio having an area of 66,000 square miles to reduce its flow 200,000 second-feet. In other words, to reduce the height of a flood at Memphis by reforestation at the headwaters of the river from that of 1912 to the next highest on record would require a forest reservation of about 566,000 square miles, an area exceeding that of the portions of Montana and Wyoming drained by the Missouri River and North and South Dakota, the portion of Minnesota drained by the Upper Mississippi River, and the States of Wisconsin, Iowa, Illinois, and Indiana. But even such a forest reservation would afford only partial protection, and large expenditures for levees would still be required. Under the above assumptions, to prevent any overflow by reforestation would necessitate a practical abandonment of the valley for agricultural purposes, and the development of an extensive irrigation system to produce tree growth in arid regions of the west.

It is therefore apparent that even under the most extravagant claims of forestry advocates, reforestation as a means of reducing flood heights on the Mississippi requires the conversion of too much farming land into a wilderness to be practicable. The waste land that can profitably be converted into forest reservations is too limited in area to produce an appreciable effect on the floods.

Reservoirs.—To have retained the Mississippi flood of 1912 within its banks would have required a reservoir in the vicinity of Cairo, Ill., having an area of 7,000 square miles, slightly less than that of New Jersey, and a depth of about 15 feet, assuming that it would be empty when the river attained a bank-full stage. If the site of such a reservoir was a plane surface, the quantity of material to be excavated in its construction would be over 100,000,000,000 cubic yards; and its estimated cost from 50 to 100,000 million dollars. Such a volume of earth would build a levee line 7,000 miles long and over 150 feet high.

Cairo is the logical location for a reservoir to regulate the discharge of the Lower Mississippi. It will not only control the floods from the Ohio, but also the discharge from the Missouri and Upper Mississippi. But if the reservoirs be transferred from the mouths of the tributaries to the headwaters, their capacity must be largely increased. No two floods have the same origin, unless they are referred back to the Gulf of Mexico. The wind bloweth where it listeth. If the prevailing winds in the early spring are from the southwest, the southern tributaries of the Ohio furnish the crest of the year's flood; if more nearly from the south, reservoirs will be required on the streams of Ohio, Indiana, and Illinois; a slight varying of the wind will produce a flood in the Upper Mississippi, while if it blows from the southeast the principal sources of trouble will be the Red, Arkansas, and Missouri rivers. To control the flow of every stream in the Mississippi Valley by reservoirs is a pretty large job, even for the United States Government, but that is what the control of the Mississippi during floods by reservoirs signifies.

The advocates of the control of the floods of the Mississippi by reservoirs do not, however, have in mind any such radical control as is above indicated. They limit the control to the headwaters of the various tributaries, and while every stream that flows in the valley may be considered a headwater of some tributary, I judge from the discussions of the reservoirs and their proposed employment for power purposes, which requires a considerable height of dam, that by headwaters is meant the sources of the rivers in mountainous countries as distinguished from the more level plains, and more specifically the sources of the Missouri above the mouth of the Yellowstone, those of the Upper Mississippi in the State of Minnesota, and those of the Ohio in the Appalachian range.

The flood which is now devestating the country affords data for determining the effect of such a system of reservoirs and its lessons are the more valuable because no effort is necessary to refreshen the memory. When, on April 2, the gauge at Cairo attained a height of 54 feet, there was flowing down the Mississippi River at least 2,000,000 cubic feet of water per second. It requires about eleven days for a flood wave to be transmitted the 966 miles between Pittsburgh, Pa., and Cairo; on March 22, the Pittsburgh gauge read 5.3 feet, which is produced by a flow in the Ohio River at that locality of about 15,000 second-feet. In ten days a flood travels the 858 miles between St. Paul, Minn., and Cairo; on March 2 the reading of the St. Paul gauge was 0.5 foot, corresponding to a discharge of the Mississippi of about 2,500 second-feet. In eight days the effect of a flood at St. Joseph, Mo., is felt at Cairo; on March 25 the gauge at St. Joseph read minus 0.1 foot, representing a discharge of the Missouri River of about 17,000 second-feet. If a system of reservoirs had been constructed which would have prevented all flow from the Allegheny, the Monongahela, the Mississippi above St. Paul and the Missouri above St. Joseph, it would have reduced the 2,000,000 second-feet discharged by the Mississippi River at Cairo on April 2 less than 35,000 second-feet.

The water which passed Cairo on the 2nd of April came principally from the White and Wabash, and the lower tributaries of the Ohio, and after the water of these rivers started to subside the flood from Cincinnati, though increasing from 57 to 69 feet on the gauge, could increase flood heights at Cairo less than 1 foot. The flood of 30 feet at Pittsburg on March 28 produced its effect on the Cairo gauge on April 8. It has merely prolonged the flood without increasing its height.

The proposed system of reservoirs would have cost hundreds of millions of dollars and its effect on this year's flood height of the Lower Mississippi could not possibly have exceeded 6 inches.

Neither the rain nor snow which falls upon the mountainous portions of the Mississippi watershed has much effect upon the floods of the lower river. The principal source of the floods is the great alluvial plain between the mountains. As pointed out, excepting the southern tributaries of the Ohio, the rainfall is relatively slight at the upper sources of the tributaries and their maximum flood discharge does not usually coincide with that of the mid-valley.

Great floods do not arise from average conditions, but from exceptional variations such as are caused by a series of heavy rains rapidly succeeding one another. Each rainstorm starts down a stream a flood, the volume of which can be absorbed by a reservoir with comparatively little trouble, but if a second storm sweeps over the valley the reservoir to be effective must be emptied or its capacity doubled. To hold all the excess rainfall till low water would require reservoirs of enormous capacity. Economic considerations usually require that the reservoirs should be emptied as soon as the crest passes, in order to utilize the same space for a second rainfall; so that while reducing the crest of a flood at a given locality they necessarily prolong the period during which the river remains at a high stage.

The water which is abstracted from the Gulf of Mexico is usually precipitated in the Mississippi Valley within a period of two days. The return flow extends over a period of two or three months. The sum of the maximum discharges of the various tributaries of the Mississippi River is nearly 4,000,000 second-feet, while the greatest measured discharge of the river itself is about 2,300,000. This apparent discrepancy arises from the fact that the floods of the tributaries do not reach the gulf at the same time. The crest of the Ohio River flood usually passes down the river in March or April, that of the Missouri in May or June. Moreover, the same law applies to the tributaries of a tributary. The waters of the southern branches of the Ohio tend to discharge into that river before those in Ohio, Indiana, and Illinois.

By the construction of reservoirs, this beneficient law of nature is deranged. Instead of the crest of the flood of one stream passing down the river before that of another reaches it, two prolonged high stages will obtain which will tend to synchronize and the resultant combination may be higher than either flood would have been by itself.

A system of flood control designed to be satisfactory for one city may be most disastrous to another locality further down stream. If a system of reservoirs had been in operation in the Allegheny and Monongahela rivers during last January, it would have protected Pittsburgh from overflow and diminished the flood at Cincinnati when it was 50 feet on the gauge, but only to increase it when it attained a height of 60 feet. And this effect would have been propagated to the gulf.

Pittsburgh, moreover, would never consent to such a manipulation of reservoirs on the upper tributaries of the Ohio as would insure the reduction of floods at Cincinnati or on the Lower Mississippi. Source stream control on the Mississippi River and its tributaries would therefore soon reduce itself to the question, Whose ox is to be gored?

Levees.—While the use of forests or reservoirs as a means of flood control is still in an experimental stage all over the world, the employment of levees for this purpose has been tested for centuries. The Po, Rhine, Danube, Rhône, and other rivers of Europe have been successfully leveed. The laws governing the flow of water in a confined stream have been carefully studied and the construction of levees is just as susceptible of mathematical analysis as other engineering problems. There is an element of uncertainty in all the forces of nature. No one can say positively, for instance, that St. Louis may not at some future time experience an earthquake or a cyclone of greater intensity than that which swept the city in 1896. There is also a possibility that there will be some combination of meteorological conditions which will create a flood of greater volume than has heretofore occurred in any drainage area. But the height to which levees should be constructed is as susceptible of determination as the strains to be permitted in an office building due to wind pressure or the moving load allowable on a bridge. The city engineer solves a similar problem whenever he constructs a sewer to carry off the storm water from the city streets.

Nor is there any evidence either that floods have been increasing in recent years, due to the cutting off of forests or that the beds of our main rivers are rising as they are leveed. The effect of forests on rainfall in Europe has been carefully investigated by Profs. Schlichting and Hagen. The records at London, Paris, St. Petersburg, and other localities where the rain has been recorded for long periods fail to show any tendency to an increased fall in recent years.

The meteorological records of the United States have not been maintained a sufficient length of time to be of much value in solving the problem. Such data as we possess indicate that the flood discharge has not increased in recent years. The greatest flood of the Mississippi at St. Louis occurred in 1844, the next largest in 1875. On the Great Lakes the high water of 1838 is the greatest on record. In the Ohio the flood of 1884 exceeded that of 1913 at Cincinnati, and that of 1832, while 5 feet lower at Cincinnati, was 5 feet higher at Pittsburgh than this year's flood. The gauge records at the bridges over the Upper Mississippi, which cover a period of thirty years, would indicate that the flow from Minnesota and Wisconsin, where the forests have been most extensively destroyed during the period, has been slightly improved, though the river shows signs of deterioration where it receives the flow from the prairie lands of Iowa and Illinois.

On the Merrimac River where the mill owners have accurate observations extending back to 1849 there appears to be some increase in flood discharge, though reports of the forestry commission of the State of New Hampshire and census returns from the State of Massachusetts indicate that the forest area of its basin is 25 per cent. greater than forty years ago, due to the abandonment of farms. Such records as we have in this country appear to confirm the conclusions of the German forestry authorities that the influence of forests on drainage is concealed by other causes more powerful in their effects.

The flood of 1912 was not due so much to excessive precipitation as to the fact that the surface of the ground was still frozen over the States of Illinois, Indiana, and Ohio, so that there was not the soil absorption of rain water that usually occurs.

There is not the remotest connection between deforestation and the disasters which have just occurred at numerous cities in Ohio and Indiana. The flood of 1832 was similar to that of 1913, but it was discharged by streams of the dimensions the Creator intended they should have. Since then cities have sprung up and land has become so valuable that riparian owners have encroached upon the waterways. Where the floods formerly flowed untrammeled, factories and dwellings have been constructed and numerous bridges have further restrained the stream's discharge.

The question of the rise of the river bed by levee construction has been exhaustively investigated. On the Rhine the maximum effects were observed at Dusseldorf, where the same discharge at low water appears to attain a height 8 inches greater to-day than it did one hundred years ago, while the same discharge at high water has lowered about 1 foot in a century. On the Po the maximum observed change in low-water conditions was 0.02 of a foot per year, but it is by no means proved that even these small changes have resulted from levee construction. They may have arisen from the improvements in the river bed which were made simultaneously with levee construction. The observations of the Mississippi River Commission agree with the Dusseldorf observations, in that the Mississippi River appears to be slightly enlarging its section, at least at mid-stages.

The present contents of the adopted levee line of the Mississippi River is about 243,000,000 cubic yards. It has been computed that with an addition of 200,000,000 cubic yards and at an estimated cost of $57,000,000 this line would be safe against any flood which has occurred in the Mississippi River. This sum, though large, is less than $4 per acre of land protected from overflow, and appears insignificant when compared with the amounts which are being expended per acre for irrigation purposes in the arid west. The increase in the value of land or the damage caused by one overflow like that of 1912 would pay for the completion of the levee system.

When a levee line contains but one-half the material that safety requires, crevasses afford no argument against levee construction. During the flood of 1912 hundreds of miles of levees were topped with earth in sacks to a height of from 2 to 4 feet, to prevent the water flowing over them, and water was seeping through their narrow bases in copious streams, which was unheeded until mud began to flow. The levee which failed at Beulah, Miss., this winter was held till the pile of sacks exceeded 20 feet in height.

The holding of 1,525 miles of such levees through the flood of 1912, even though 13 miles failed, is a powerful argument in favor of a properly constructed levee line. There was no failure where levees were built to a suitable grade and adequate dimensions, as in the Upper Yazoo District.

Conclusion.—While of the opinion that levees afford the only practicable method of controlling the floods in the case of the Mississippi River, I am strongly in favor, nevertheless, of both reforestation and reservoir construction, but limited to the purposes for which they are adapted, just as I am in favor of reinforced concrete for small bridges, though not considering it applicable to one spanning the lower Mississippi River. The price of lumber to-day is a sufficient argument for planting trees, without attempting to associate forestry with the climate or with the flood conditions of our rivers. If the Federal Government or the states do not conserve the forests, the time will soon come when the farmer will raise his crop of timber just as he now plants a field of wheat, and for the same reason, because it will pay him to use his waste land for the purpose.

Reservoirs are necessary for municipal water supplies, for purposes of irrigation, for the development of power and for feeders to canals. They can be successfully employed on small streams to diminish floods or increase the low-water flow. The trouble arises when an attempt is made to utilize them for too many purposes at the same time. There must be a paramount issue to which the others will be subsidiary.

If the main purpose is to supply a city with water only the excess can be used for power development. If the dams are constructed to produce power, the reduction of floods and the improvement of river navigation must be subordinate thereto. Water required for irrigation can only be used to develop power when the dam of the storage reservoir is given a greater height than is necessary for its flow over the land to be reclaimed.

During the next decade there will be an enormous development of reservoirs both for irrigation and for power purposes, which I hope will be utilized to correct man's folly and prevent many disasters similar to those which have recently occurred in Indiana and Ohio.

MINERAL PRODUCTION IN BRITISH COLUMBIA.

The year 1912 was exceedingly favorable to mining in the province and the mineral production made therein was the greatest in the history of its mining, according to statistics contained in the annual report of Wm. F. Robertson, provincial mineralogist for the Province of British Columbia. The gross value of the mineral production for 1912 was $32,440,800, an increase over that of the year 1911 of $8,941,728, or about 33.3 per cent. The greatest output formerly made was in 1910, amounting to $26,377,066, which is exceeded by the production of 1912 by $6,063,734, or 23 per cent., thus showing by comparison, even with what had been the record year, how much the mineral production has increased during the past year. The tonnage of ore mined in the lode mines of the province during the year 1912 was also greater than ever before, amounting to 2,688,532 tons, exceeding the greatest tonnage formerly mined in any year—1910—by 472,104 tons, equivalent to 21.3 per cent. increase.

As compared with the year 1911, the tonnage mined last year shows an increase of 917,777 tons, or about 52 per cent. The tonnage mined in 1912 was produced by the various districts in about the following proportions: Boundary, 74.00 per cent.; Rossland, 9.07 per cent.; The Coast District, 8.03 per cent.; Slocan District, 5.07 per cent.; Nelson, 1.94 per cent.; East Kootenay, 1.87 per cent. and all other parts of province combined, 0.02 per cent.

An electrical process for purifying clay, brought to the notice of the English Ceramic Society by Dr. W. R. Ormandy, depends upon the fact that clay is electro-negative, while its chief impurities are electro-positive. The emulsified clay is partially coagulated by adding electrolytes, and is further purified by passing through a vessel having electrodes differing by 60 to 100 volts. The clay-substance, with as little as 18 to 20 per cent. of water, is deposited as a continuous blanket 4½ feet wide and a quarter of an inch thick. Even fine particles are removed and the solid product may contain as much as 99.5 per cent. of china-clay.

POINTS IN THE PROGRESS & INSPECTION OF SURVEYS

HISTORICAL SKETCH OF THE GROWTH OF THE DEPARTMENT OF THE INTERIOR, SURVEYS BRANCH — REMUNERATION FOR SURVEYORS — POINTS WHERE CONTRACTOR AND INSPECTOR SOMETIMES DIFFER.

By E. W. HUBBELL, L.D.S.,

Chief Inspector of Surveys, Canada,

THE Department of the Interior was established July 1st, 1873, the first Minister being the Hon. Alexander Campbell, who had under his control the following branches of the service:—

1. The affairs of the N. W. Territories.

2. The lands and affairs of the Indians of Canada.

3. The ordnance and Admiralty lands and all other public lands, not under the control of the Department of Public Works, or of those of Militia and Defence, and Marine and Fisheries.

4. The Crown Lands in Manitoba and the N. W. Territories, styled "Dominion Lands."

5. The Geological Survey of Canada.

Prior to the first of July, 1873, the management of the N. W. Territories and the Lands and Affairs of the Indians, devolved upon the Department of the Secretary of State for the provinces, to which department the Geological Survey was attached. On the other hand, the Dominion Lands and the Ordnance and Admiralty were under the control of the Secretary of State for Canada.

In July, 1869, instructions were issued by the Minister of Public Works to Lieut.-Col. Dennis, P. L. Surveyor, requesting him to suggest a scheme or system upon which to base the surveys of the West. This was done and approved, and the survey of the Principal Meridian by Milner Hart and A. C. Webb was the first survey performed under authority of the Dominion Government, in the Territories. At this time the outbreak known as the Red River troubles occurred, and put an end to further surveys for the time being.

In 1870, no surveys were undertaken.

In March, 1871, Col. Dennis was appointed the first Surveyor General of Dominion Lands, and during the same month the administration of the Dominion Lands was transferred to the Department of the Secretary of State, and the Dominion Lands Branch was created. The first Manual of Surveys for the guidance of surveyors was issued in this year, and instructions were given to twenty-one surveyors, Mr. Lindsay Russell being appointed Inspector of Surveys.

In 1872, Captain Cameron, R.A., British Commissioner, was appointed in conjunction with the Hon. Archibald Campbell, named by the United States Government, to determine in accordance with the Second Article of the Convention of London of the 20th October, 1818, the International Boundary Line between Canada and the United States, from the northwest point of the Lake of the Woods, due south to the 49th parallel of latitude, thence westward to the Rocky Mountains. Along the south of the province of Manitoba, iron pillars were placed at two-mile intervals, west of the province the line was indicated by cairns, generally three miles apart.

*Paper read at 7th Annual Meeting of the Association of Dominion Land Surveyors, March 5th, 1913.

In this year instructions were issued to Mr. W. S. Gore, P.L.S., to survey certain reserves granted to the Hudson Bay Company. The first map to show the results of the surveys of Dominion lands was issued this year with the surveyor general's report, also the first official map of the province of Manitoba.

In 1871-72, all surveys were performed by contract, at so much per mile, but in 1873 all the surveyors except those employed in subdivision, were paid by the day.

During this year (1871), 3,800 miles were surveyed and surveyors were paid as follows, all under contract:—

	Prairie.	Poplar woods.	Heavy timber, windfalls, etc.
Block surveys	$9.00	$15.00	$25.00 per mile
Subdivision surveys	$7.00	$11.00	$18.00 per mile

In April, 1872, an Act was passed called the Dominion Lands Act, in which the manner of administrating the lands in Manitoba and the N. W. Territories was dealt with and the system of survey explained. The Act also provided for a Board of Examiners, who were to examine candidates for admission to practice as deputy surveyors, and provided for the admission to practice of surveyors from the different provinces.

In May, 1873, the bill creating the Department of the Interior was assented to, and on the 30th June the management and control of Dominion lands was transferred from the Department of Secretary of State to the Department of the Interior. The Geological Survey was also attached to the department, as was the administration of Indian affairs.

It might be of interest to note here two important Acts passed by Parliament. 1st, in 1873 an Act authorizing the establishment of a mounted police force in the Territories. We all know the incalculable value this magnificent field force (since its inception) has rendered our great country, and whose jurisdiction now extends to Hershel Island in the Arctic Circle. 2nd, in 1874 an Act prohibiting the importation into and manufacture in the N. W. Territories of all intoxicating liquors. This Act was rescinded in 1891.

In this year (1873), the first surveys of Indian reserves were undertaken, six surveyors being employed for that purpose, and on the 28th February, 1874, an order-in-council was passed authorizing a special survey of bases and meridians through the N. W. Territories, and extending to the Peace River. This important survey was placed under the control of Mr, Lindsay Russell, assistant surveyor general, and carried on for some years, one of the assistants being Mr. W. F. King, D.T.S.

It may be of interest to know that from 1871 to 1876, the cost of block outlines averaged $36.83 per mile. The cost of subdividing blocks of four townships into sections and quarter sections was 2.91 cents per acre, adding the cost of the block lines to the above acreage rates made the total cost of all the township lands surveyed to date (1876), to be 3.83 cents per acre.

In 1877, the Geological Survey became a branch of the Interior Department and the Museum was moved from Montreal to Ottawa.

In 1878, the charge of the N.W.M.P. was transferred from the Department of Secretary of State to the Interior Department. In this year, Col. Dennis was made Deputy Minister of the Interior and Mr. Lindsay Russell became surveyor general.

In 1879, a new branch was erected and added to the department, called the School Lands Branch.

In 1880, the Indian branch was created a separate department and assumed control of the Indian reserves in Manitoba and the North West Territories which had been carried on by the surveyor general.

The surveys of this year have consisted of two classes, outline, or governing ones, performed under the system of daily pay and allowance of actual expenditure incurred, and the subdivision surveys under contract, at rates of so much per mile for certain kinds of work; the rates of the latter having been fixed by competitive tender.

In 1881, 55 surveyors were engaged, 6,400 miles of meridian and outlines were run, and 16,800 miles of subdivisions.

Road allowances were reduced from 1.50 chains in width to one chain, and three of the east and west road allowances in a township done away with.

A new edition of the Manual of Survey was issued containing many improvements and much information to surveyors, as well as several useful tables prepared by Messrs. Deville and King, who were in this year appointed inspectors of surveys, succeeding Messrs. A. H. Whitcher and Milner Hart.

In 1882, Mr. Deville was appointed chief inspector of surveys and took charge of the surveys branch of the department, and Mr. Lindsay Russell became Deputy Minister of the Interior.

An important change this year was the substitution of iron posts for wooden ones at the section corners, the markings for each corner were stamped on a square tin about six inches square, placed over the bar and fastened to it by a nail.

In order to prepare the number of copies of township plans required, it was found necessary to establish a lithographic office in connection with this branch. Plans were printed by a cheap process, and although not presenting the appearance of good lithography from engraved stones, they met all requirements.

On the 8th of May an order-in-council was passed dividing the North West Territories into four provincial districts, called respectively Assiniboia, Saskatchewan, Alberta and Athabasca.

In 1883, 119 surveyors were employed. The extensive operations (the greatest on record) during this year and the previous season became necessary owing to the rapid construction of the Canadian Pacific Railway, which in the fall of this year, reached the Rocky Mountains. During the season surveying operations were conducted on a gigantic scale, over 70,000 miles were surveyed, providing 27,000,000 acres of land for the agriculturist.

Owing to the rapid growth of work in the department, the offices of Deputy Minister and Surveyor General, held by Mr. Lindsay Russell, were separated. Mr. Russell remained surveyor general, and Mr. A. M. Burgess became Deputy Minister of the Interior. The supervision of the surveys at headquarters was under the control of Mr. Deville, chief inspector of surveys, while Mr. King, inspector of surveys, had the direction of the operations in the field, and a third edition of the Manual of Surveys was issued.

In this year we have our first information regarding the examination of survey contracts.

In 1884 the Settlement Act was passed by the British Columbia Government, and the transfer under its provisions to the Dominion Government of a belt of land 20 miles in depth on both sides of the Canadian Pacific Railway was effected, and surveys within this belt were commenced, also the survey of old trails in the Territories.

In June, Mr. Lindsay Russell, surveyor general, retired from service on account of ill-health.

In 1885, owing to the Riel rebellion, surveys were limited. Mr. William Ogilvie was engaged in making a survey of the railway line in British Columbia, to be used as a base for the future subdivision of surveys at points along the line. In March, Mr. Deville, then chief inspector of surveys, was appointed surveyor general, which position he is faithfully, conscientiously and intelligently occupying to this day. Mr. W. F. King was promoted to chief inspector of surveys.

In 1889, iron posts of a larger diameter were substituted at section corners, and the markings cut on the bars with cold chisels, a vast improvement on the original method of marking.

In 1890, Mr. King became chief astronomer of the department, and in May, 1893, Mr. J. S. Dennis became chief inspector of surveys.

In 1891, the Immigration Department was transferred from the Department of Agriculture to the Department of the Interior.

In 1892, Mr. W. F. King, D.T.S., was appointed international boundary commissioner, and in February of the same year, the Board of Examiners for Dominion Land Surveyors at Ottawa, passed the following resolution:—

"That this board, after due consideration, have come to the opinion that examinations for provincial land surveyors in Ontario and Manitoba are not sufficiently similar to those prescribed by the Dominion Lands Act, for Dominion land surveyors to entitle provincial land surveyors of those provinces to the privileges of Clause 109, and the board is further of the opinion that it is desirable in the interests of a uniform standard, that no candidate should be granted a commission as Dominion land surveyor unless he has passed the full examination prescribed by the Dominion Lands Act."

"Surveyors of the province of Ontario and Quebec are accordingly required to fulfil now the same conditions as surveyors of Dominion lands, instead of as formerly, being admitted after examination in the system of survey only."

It may be of interest to note here, that all western provinces now have separate surveyors' associations, and in order to obtain a commission to practice as a surveyor in any of the provinces, it is necessary for a Dominion land surveyor to pass an examination in conformity with the laws of each province.

Space does not permit touching upon the following very important surveys which have been administered by the Department of the Interior:—

The triangulation survey in British Columbia, commenced in 1889, under the superintendence of Mr. W. H. Drewry, D.L.S.

The photo-surveying in British Columbia, commenced in 1886, under the superintendence of Mr. J. J. McArthur, D.L.S.

International boundary survey of the 141st meridian, under the superintendence of Mr. W. F. King, D.T.S., boundary commissioner, commenced in 1906.

The irrigation survey in Alberta, under the superintendence of Mr. S. J. Dennis, D.T.S., then chief inspector of surveys, commenced in 1894.

The perusal of the reports on the above mentioned surveys are most instructive and interesting, and can be readily found in the annual reports of the department.

In 1901, Mr. Wm. Pearce was appointed chief inspector of surveys, and upon request was superannuated in 1904. In this year also the office of the surveyor general was moved from its quarters on Wellington Street, to its present location on Metcalfe Street, but owing to the growing increase of the staff in recent years, it was necessary to move part of the staff to the Imperial Building on Queen Street.

The present numerical strength of the surveyor general's staff is about 140, which is an indication of the clerical work performed by this important branch of the department.

In the surveyor general's report of 1903 it was provided by the Dominion Lands Act that the township subdivision surveys of Dominion lands should be performed under contract at a certain rate per township, per mile or per acre fixed, from time to time, by the governor-in-council or by competitive tender, as the governor-in-council would from time to time direct. The rates fixed under the provisions of this clause, at the inception of the surveys of Dominion lands more than 30 years ago, were, per mile of line surveyed, $7 for bare prairie, $18 for solid woods, and $11 for woods alternating with prairie. These rates remained in force until 1901, although the cost of labor and supplies had advanced considerably. In May, 1901, the rates were increased to $7, $13 and $21 respectively, but the cost of labor and supplies having continued to advance, the increase proved inadequate. The situation was aggravated by a succession of wet seasons, which made survey operations slow and costly. Survey contractors made little or no profit, and showed great reluctance in accepting new contracts. It was deemed reasonable that the rates should be increased sufficiently to leave a fair margin of profit to the contractors, and at the same time that the classification be revised so that the remuneration should be more nearly proportional to the cost of the survey. After consultation with all the surveyors who were engaged recently on township surveys, and who are conversant with present conditions, a new classification and schedule of rates was prepared and approved by order-in-council of February 3rd, 1903. The remuneration for prairie work was not increased, but surveys in the woods were, in some cases, paid as high as $38 per mile. The classification was entirely new and somewhat complicated; it was to be expected that experience would show the necessity of amendments.

Manual of Survey.—The last edition of the manual of instructions to surveyors for the survey of Dominion lands was issued in 1892; it was a revision of the previous edition (1883) prepared, under instructions of the Deputy Minister, by the chief astronomer, Mr. W. F. King, and the chief inspector of surveys, Mr. J. S. Dennis. A new revision had become necessary to bring our methods in accordance with the best modern practice, and to provide for the changes made in the system of survey during the last eleven years. The revision was prepared by the surveyor general, and issued to surveyors before the beginning of the present season's operations. An important departure from the previous practice is that township plans, instead of being made by the surveyors as formerly, will now be plotted from their field notes by the office staff. The plans will thus be made uniform and accurate—they will be made in better style and will contain all the information necessary for the record of a land survey; there will also be less delay between the completion of the surveys and the issue of the plans. Throughout the manual, the governing idea is that the plan of a land survey must be a true representation of the survey as it exists on the ground, and not a conventional illustration of the survey which it had been the intention to make. For this and other purposes, new clauses and numerous amendments to old ones were inserted. The old tables have been re-arranged and a new one compiled for the determination of the azimuth by the observation of Polaris. This last table will, it is believed, prove a most useful one to township surveyors; by its means, they may, at any time, in a few minutes, and almost without calculation, ascertain the astronomical bearings of the lines of survey. A very complete index is provided to facilitate references, and a large number of speciman plans and illustrations add to the value of the book. It is confidently expected that this manual will be found a very great improvement upon previous editions.

Remuneration of Surveyors, 1908.—At the inception of the survey of Dominion lands, nearly forty years ago, Dominion land surveyors were paid five dollars per day. Shortly after, six dollars per day was allowed to surveyors of base lines. These rates remained in force until 1901, when they were increased to $6.50 and $7.50 respectively. The advance proved inadequate; in order to induce properly educated men to qualify as Dominion land surveyors, so that there should be no difficulty in securing the services of competent surveyors when they are wanted, a further increase of $8 and $10, respectively, was granted by order-in-council of March 30th, 1908. The increase, it will be observed, is for ordinary surveyors, 60 per cent. over the rate of forty years ago; for surveyors of base lines it is a little over 60 per cent. Considering the enhanced cost of everything, the increase does not appear too large. By the same order-in-council the salary of the inspectors of surveys was fixed at $9 per day in the field and $5 per day at office work.

In August, 1911, an order-in-council was passed authorizing the payment of $12.50 per day to surveyors engaged upon the survey of base lines and initial meridians.

Inspection of Surveys.—In the earlier prosecution of the surveys, inspection was confined to a visiting of the various parties in the field by the inspector to satisfy himself that they were really at work, and to judge by what he saw of their manner of doing it, whether the requirements of the contract were being duly complied with; but, unless he became aware of something to give him suspicion of error or neglect, no check measurements were made beyond that of an occasional rough testing of an angle, with a pocket sextant that could be carried about by a person travelling on horseback or on foot, and generally alone. This kind of inspection, though certainly inexpensive, proved to be correspondingly ineffective. It became evident that the cost must be incurred of applying check measurements to portions, chosen unsystematically, of each contract in order thus to insure the obtaining average samples of the work. Inspection surveys were therefore established. At first this consisted of lines run at random diagonally through a contractor's township and closing on the surrounding block outline surveys, with the object of having a rigid check both on the contractor and on the work of the inspection survey itself. This method was, however, abandoned on account of the labor it entailed in the office in obtaining, from the data, comparison of the actual position of boundaries checked, with that which theoretically they would occupy, and also because that the inspecting surveyor could judge but from what he saw at points where his lines intersected those of the contract, what care had been taken in placing its monuments.

To make a thorough inspection of a survey, it would be necessary to remeasure all its lines; in fact, an exhaustive inspection means a duplicate survey. This forms a fundamental objection to survey by contract. It is impossible that any government officer can certify that the full value has been received by the public for the contract money paid, unless he has so executed or caused to be executed, a duplicate survey. The most, therefore, that is practicable, within reasonable limits of cost for inspection, is that tests should be applied here and there at hazard, throughout a contractor's work, and the inspecting officer report the resulting facts, together with a presumptive opinion based thereon, respecting the necessarily very much larger untested portion of the contract.

To obtain a contract, a surveyor makes written application to the department for the sub-division of a number of townships (these contracts are limited in size from 4 to 8 townships). Before his application is accepted, he is requested to make himself conversant with the nature of the country in which his contract is situated. If he asks, he is given all the information possible that the department has relative to the description of the country, i.e., means of access, transportation, nearest post-office, railway and express offices. It is therefore through no fault of the department if he accepts blindly a contract and does not take sufficient time to complete his work. Contractors in general would find it to their advantage if they paid more attention to entering on the contract forms the dates of commencement and completion of their work, as it would save both themselves and the department a lot of unnecessary correspondence, besides worrying their sureties for an extension of time, etc. I would like to suggest that when contractors have a knowledge that the country they are going to work in is interspersed with numerous muskegs and unusually wet, it would be more advantageous to them to leave their work until the ground freezes. Nearly all our survey work now is in timber, in which there are great areas of swamps and muskegs, and the survey work (except mounding), can be done cheaper and just as accurately in the winter as in summer.

Every surveyor has his own particular method of conducting a survey, it therefore would appear presumptious to offer suggestions. However, I take the liberty of telling younger members of the profession, who are commencing contract work, that it is unnecessary to purchase a lot of horses, they are expensive and not absolutely necessary. Before going into your contract, establish a cache as near your work as possible and engage teamsters, half-breeds preferably, to haul your supplies there, and no matter what happens thereafter, you will at least have sufficient supplies to keep things moving; men will not work on empty stomachs. Make provision for your mail service at least once a month, it is absolutely necessary that you keep the department informed of your movements and progress, many vexatious delays are apt to occur if you do not, and the department is the one to suffer least.

One thing to be impressed strongly upon contractors is the incorrect placing of ¼ section monuments on chords. The inspectors find this a very common error, after the chords have been cut out and chained, the contractor is apt to leave the offsetting of these monuments to the mounders, who in many cases (as experience has shown) are apt to be careless and offset, if at all, the wrong way, this makes a very bad showing in the bearings of the chords and the error appears worse than it really is.

At this juncture it should be in order and to the best interests of all concerned if we discuss a few of the most salient points in connection with contract work. The points that most frequently arise between the inspector and contractor, are the following: Opening of lines; blazing of lines; marking on posts; classification; mounds and pits, and traversing.

There are frequent complaints that some contractors do not open their lines widely enough. Personally I do not think it is the intention of the department to require the surveyor to open lines wide enough to drive a wagon through, or cut off all trees and brush to within six inches of the ground. On the other hand, it is certainly not the intention to have lines so narrow that the line of sight can barely pass the trees. There should be a mean, and my own opinion is that no tree should be left standing that is within, say a foot of the line on either side of the line of sight. Of course there are exceptional cases, when the contractor runs against a tree close to the line, that is about three feet in diameter. In such isolated cases, I do not think the inspector would worry the contractor very much if this tree was not cut down, but rabbit runs and lines of the "key-hole" variety should be condemned, and the bush and wind fall cut low enough so as to insure accurate chaining.

Blazing.—Clause 76 of the Manual, reads in part as follows: "All lines are to be further marked by blazed trees not more than 75 links apart, and are not to be omitted when there are trees more than two inches in diameter within 50 links from the line. If this is not done, a maximum penalty of $2 per mile may be applied, see Clause 314."

In my opinion, the blazing of trees two inches in diameter is rather absurd, after a tree of this size is blazed on three sides little of the tree remains, at all events so much blazing is apt to kill it, thus rendering it useless as a permanent mark. I think this clause should be amended to read 3 inches in diameter. I also think that trees blazed 50 links from the line is too far away, 25 links is quite sufficient for all practical purposes.

Markings on Posts.—These should always be distinct and cut well into the iron, and care taken not to mark on the crown or penalty side of the bar. The markings on the iron posts, in many cases, are but indifferently done and sufficient care not given to the driving of them into the ground. At witness corners, in addition to the distance of bearing from the true corner, the reverse side is to be marked with the section number only, and but one side of a quarter section post is marked. A quarter section corner falling in a lake or marsh not more than three feet deep is marked by a wooden post, flattened on two sides and marked. The post must not be less than five inches in diameter and long enough to be driven three feet into the ground and to show six inches above the water (Clause 152). Where there is a witness mound and a wooden post for the same corner, in my opinion the witness corner in case of dispute should govern.

Penalties are sometimes exacted for not driving the bars deep enough in the ground. There are cases where it is impossible to drive the bars the required limit, in rocky country, hard frozen ground, gravel and sand or in gumbo, and if you attempt to drive them in the top breaks off. The inspector in such cases should use his judgment. Care should be taken that all posts are lined in correctly by the instrument, as upon their "exact location" depends the bearings of the lines, and precision of future surveys. In my opinion the square ends of the bars are not long enough, there is not sufficient room for marking large numbers. I have spoken to the surveyor general about this, and he has promised that the next issue will have longer flattened ends. Bars should be driven in plumb.

Classification.—Clauses 311 to 314 of the Manual describe in detail what is expected from the contractor.

As our subdivision surveys are now nearly all in bush country, interspersed with muskegs and marshes, it is therefore only in the openings, across water or marshes where there should be any doubt in the ratings. As all openings of half a chain are required to be recorded, it appears to me that there should be but little difference of opinion as to the nature of classification (Clause 316). The contractor is given the benefit of the doubt, as whenever he shows proof of actual cutting, no matter how small the scrub, he is paid 100% for his work. This also applies to park country, where he may only have to cut down a tree in every five or six chains. Where surveys are made in the winter and examined in the summer, or vice versa, there is apt to be a difference of opinion between the contractor and inspector, as the topographical features are somewhat different, especially is this noticeable across muskegs, lakes, etc., etc. There appears to me good reason for argument in this proposition, as the inspector's returns are apt to vary from the contractor's. If the work of the inspector and contractor is done at different seasons of the year, consequently the returns in ratings will not agree.

Mounds and Pits.—There is a standard for the dimensions of all mounds and pits in the Manual of Survey (Clauses 154 and 155). It is no trouble to build mounds or dig pits in accordance with the standard, when the ground permits, and under such circumstances there is no excuse if not properly made, and a rigid enforcement of the regulations should be enacted. On the other hand, it is almost impossible to comply with these regulations, such as building mounds and digging pits in swamps and muskegs, the composition of the soil is such that when the mounds have been made the standard size, they will not retain their formation for any length of time, but shrink to almost half their original size; the same applies to the pits. The contractor builds them in water and muck and the inspector frequently examines them in drier weather, when the water has evaporated and the mounds and pits have in consequence shrunken considerably since being constructed. In such cases it seems to me hardly fair to impose a serious deduction on the contractor, unless the inspector is thoroughly satisfied that the mounds and pits were carelessly constructed in the first place. In such cases the inspector should use his own discretion, and when submitting his report to the department, explain in full his reason for condemning or approving these mounds and pits; a little give and take on the part of the inspector is in my opinion most desirable. Personally I have never been in favor of mounds in scrubby country, as experience has shown that they serve as an incentive to cattle and wild animals to stamp down, and supply additional material for filling in the pits, and now-a-days most farmers keep a few cattle. In the wilder regions the cut lines are regular pack trails for the wild animals. I consider that mounds built of earth, sod, stones and other material, will last longer and retain their formation better than if built of earth alone. Stone mounds, when properly built, form a good permanent mark, and if the iron bar is bent at right angles about the centre and one-half of it placed under the mound, it will, unless wilfully removed, remain in position for many years. It occasionally occurs that contractors place the iron posts at the east and west corners of the mounds, and sometimes build mounds and pits square with the line, when they should be placed diagonally. These are small errors, but should not be overlooked.

Traversing.—Clause 105, states that a hub shall be planted firmly where the line intersects the bank of a lake or river which has to be traversed. Do all surveyors comply with this regulation?

Clause 137 states that along tidal waters, the line to be traversed is the high water mark at ordinary tides. For a lake or navigable river, and also where the Irrigation Act applies, for a river not navigable, the line to be traversed is the bank. The bank, be it understood as applicable to a lake or navigable stream, is the edge of the bed of the lake or stream, and the limit of the bank is the line where vegitation ceases, and the shore is the space between high and low water mark at ordinary tides. As the edge of a marsh is inadmissible as a boundary, and subject to change, it follows that an inspector when making a traverse, should select a well defined boundary of a lake or river so that upon comparison there will be less likelihood of a disagreement between the contractor and the inspector's returns. Lakes that are traversed in the summer and inspected in the winter cause some trouble, as shore lines in many cases are bound to vary under the changed climatic conditions. It is permissible to make traverses with the chain, stadia or micrometer, if by the latter, the closing error must not exceed one chain in one hundred and the distances measured must not exceed half a mile. Traverses of lakes, rivers and connecting traverses are paid for at the rate of $11 per mile, and the distance paid for is between fixed points in a straight line.

Observations.—Clause 111, states that in subdividing townships at least one astronomical observation for ascertaining the direction of the meridian is made in each township, but two or more are desirable, etc., etc. When the weather is not favorable for observing, work may be commenced with an assumed meridian, and if possible connected by angular measurement with a base line. The telescope now used is powerful enough to show stars of the second magnitude within a few hours from noon, and stars of the third magnitude in twilight when it is still clear enough to read the graduation. The observation should be taken in daylight whenever practicable. A complete observation under favorable conditions, gives a result correct within a few seconds. An observation for time should be taken either shortly before or after every azimuth observation.

COAL PRODUCTION IN BRITISH COLUMBIA.

The collieries of the province made in 1912 a gross production of 3,025,709 tons (2,240 pounds) of coal, an increase over the preceding year of 727,991 tons equivalent to an increase of 31.5 per cent., according to statistics contained in the annual report of the Minister of Mines by Wm. F. Robertson, provincial mineralogist for British Columbia.

While this comparison is true, it must in fairness be stated that the producton for 1911 was much below normal, due to the labor troubles in the East Kootenay coalfield, whereby the collieries of that district were closed for the last eight months of the year.

It might be better, therefore, to make comparison with the year 1910, in which the coal production was by far the greatest in the history of coal-mining in the province and during which the gross coal production was 3,139,235 tons, or only 113,526 tons greater than last year.

Had it not been for labor troubles in the mines of the Canadian Collieries, on Vancouver Island, during the latter part of 1912, whereby the company's output was reduced to a point 150,000 tons lower than the preceding year, there is little doubt but that 1912 would have been the record year to date, instead of occupying second place; but, with the exception noted, it is greatly in advance of any other year.

The greater part of this production is still mined by three companies—the Crow's Nest Pass Coal Company of East Kootenay, the Canadian Collieries and the Western Fuel Company, of Vancouver Island, which mined, collectively, 75 per cent. of the gross output, their respective production representing 31.5 per cent., 34.5 per cent. and 19 per cent. of such total.

Of the other collieries: In the Coast District, on Vancouver Island, the Pacific Coast Coal Mines, Limited, produced 151,589 tons and the Vancouver-Nanaimo Coal Company, 88,253 tons and in the Nicola Valley section of the district, the Nicola Valley Coal and Coke Company mined 142,973 tons, the Inland Coal and Coke Company 31,300 tons, the Princeton Coal and Land Company, 28,174 tons, the Diamond Vale Coal Company, 3,310 tons, while the United Empire Coal Company made a start, producing some 500 tons of coal.

In the East Kootenay District, in addition to the Crow's Nest Pass Coal Company, which produced 950,706 tons, the Hosmer Mines, Limited, produced 188,243 tons and the Corbin Coal and Coke Company, 122,263 tons. In addition to those companies actually shipping, several other companies have been installing plant and have approached the shipping stage.

The collieries of the Coast District, including the Nicola Valley field, are to be credited for 1912 with about 58.3 per cent. of the total coal output.

The gross output of the collieries for the past year was, as already stated, 3,025,709 tons, in addition to which some 17,809 tons of coal was taken from stock, making the gross amount of coal distributed 3,043,518 tons. Of this gross amount, there was sold for consumption in Canada, 1,263,427 tons; sold for consumption in the United States, 858,981 tons; while 108,157 tons was exported to other countries, making the total coal sales for the year 2,230,565 tons of 2,240 pounds.

In addition to the coal sold, there was used in the manufacture of coke 396,905 tons, all in the East Kootenay field; and used under companies' boilers, etc., 240,304 tons; while 175,744 tons was lost in washing and screening.

There was no coke made last year in the Coast District, although some 4,266 tons was sold from stock, the total coke production having been made by the Crow's Nest Pass Coal Company, and Hosmer Mines, Limited, in the East Kootenay field, where from 306,005 tons of coal, 264,333 tons of coke was manufactured, of which 91 tons was used under the companies' boilers.

WATER POWERS IN NEW QUEBEC.

In extracts from reports published in bulletin form by the Department of Colonization, Mines and Fisheries on the district of Ungava, recently added to the Province of Quebec under the name of the territory of New Quebec, a vast amount of information is obtainable concerning this addition and that respecting its water powers is most interesting.

The interior of Ungava or New Quebec is a huge plateau which rises somewhat abruptly within a few miles of the coast line to a height of 1,500 to 2,500 feet. The various streams, therefore, afford numerous water-powers, more especially where they leave the interior plateau to flow through the strip of lowlands, a few miles wide immediately adjoining the coast. For instance, on Great Whale River, within 20 miles of the mouth, there are three falls 150 feet, 230 feet and 65 feet respectively. On the South branch of this same river, a few miles from its mouth, a fall of the river gives 136 feet. Nastapoka Falls near the coast has falls 170 feet. Near Richmond Gulf, the Wyachuan River falls give a head of 315 feet. A remarkable case of very high waterfalls in the interior is that of the Hamilton River. The Grand Falls of this river are situated some 300 miles from Rigolet. These falls were first viewed by a white man, John McLean, in 1839. McLean was in charge of the Hudson's Bay Company's post at Fort Chimo and crossed overland from that post to Hamilton Inlet.

The falls themselves have a sheer drop of 302 feet and Low estimated their discharge at 50,000 cubic feet per second. For twelve miles above the falls, the river rises rapidly, so that in the distance the difference of level, including the falls proper, is 760 feet. Adopting the discharge estimated by Low, these figures would give approximately 1,500,000 H.P., for the falls proper and 3,660,000 H.P. for the twelve miles of falls of the river. However, Dr. Low only saw the river during a period of high water and the above figures are probably much too high. In the data compiled by the Commission of Conservation and published in the "Report on Water-Powers in Canada," the possibilities of Grand Falls are based on a low-water drainage of 0.4 c.f. per second per square mile of drainage area, which is the quantity generally adopted under the climatic conditions of the country. Under these conditions, the estimated H.P. of the falls would be 120,000 and of the total fall for a distance of twelve miles 300,000.

A factory in Grenoble, France, utilizes the water of a reservoir situated in the mountains at a height of 200 yards. The water reaches the factory through a vertical tube of the same length, with a diameter of considerably less than an inch, the jet being used to move a turbine. Experiments have shown that the strongest men cannot cut the jet with the best-tempered sword; and in some instances the blade has been broken into fragments without deflecting a drop of water, and with as much violence as a pane of glass may be shattered by a blow from an iron bar. It has been calculated that a jet of water a small fraction of an inch in thickness, moving with sufficient velocity, could not be cut by a rifle bullet.

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REPORTS FROM MUNICIPAL ENGINEERS.

There is a great tendency among Canadian municipal engineers to evade written reports where possible. They surpass engineers of other countries in this respect, despite the fact that municipal engineering is comparatively young in Canada and requires as much benefit from reports of accomplished work as can be derived, if it is to hold its own with respect to the country's demands.

The value to one municipality of how work is progressing in others, what methods are being employed to advantage, and where warning notes should be sounded against unscientific or untried tactics, is obvious, and to the municipal engineer falls the duty of supplying his corporation with exact, concise and complete data, in order that the information may be of use, not only to itself but to sister municipalities.

But it is the value of these reports to the engineer himself that we wish to emphasize. So long recognized by engineering and business institutions, many of whose clerical compilations are nothing short of stupenduous, the value of records to him is as his confidence in future success. There are numerous occasions when reference to past work is needed at a moment's notice, and to come into contact with the advantages of written reports, one needs but to experience one or more embarrassments ensuing from the fallacy of attempting to recall the wording of previous oral reports, owing to the wanton traits of memory. If alone for the purpose of having an exact record of all his reports of progress, proposals, opinions, etc., to committees and to council, so that when desired, immediate and exact repetitions of statements made perhaps months before, may be presented, the engineer will find in it a safeguard to his professional standing in the community.

The exhortation applies more to the municipal engineer than to those of other branches of the profession owing to the wider and more diversified knowledge of engineering which he must necessarily possess. As his success generally depends upon his up-to-date knowledge of hydraulics, sanitation, surveying, railways, roads and pavements, electricity, structural work, etc., etc., his calling does not admit of traditional, rule-of-thumb, or unbusinesslike methods in any phase, and his brain will work up closer to the knee of its efficiency curve if it is not hampered by a continual trusting, or mistrusting, of memory. Finally, a municipal engineer's report should contain all that it is desired to express; it should be complete in itself, not requiring to be supplemented by oral explanations. It should be clear to avoid misconception or liability to distortion, and should be clothed in language understandable by men not fully conversant with engineering terms.

STRENGTH OF CONCRETE, WET vs. DRY.

Concrete has developed into a prominent essential of construction. Knowledge of the percentage range of water used in the making of it does not appear to have ever been apace with its widening scope of usefulness. Experiments on the relative strength of concrete having different degrees of plasticity have been comparatively few. There seems, nevertheless, to be a sufficient variation in strength between what is ordinarily known as wet concrete and dry concrete to endorse a more thorough investigation of it than has yet been carried on. The correct proportion of the other ingredients, and quality of material, appear to have been receiving the bulk of the attention which has been given to the mixing of concrete in late years.

Some experiments, carried on nearly fifteen years ago, and claiming to be the first on the problem, brought out the advantages of working a wet mixture over a dry or moderately dry one, simultaneously stating that a moderate excess of water was in no way injurious to strength. Another report, the outcome of experiments by Mr. Irving Hiltz, of the Chicago, Milwaukee and St. Paul Railway, stated that it was impossible to get a compact concrete without using what might be theoretically termed an excess of water, while others claimed that a moderate use of water, tending, if anything, toward excess, was necessary for the strongest concrete.

Then, in 1903, Mr. J. W. Sussex, of the University of Illinois, arrived at a few conclusions that were a little less indefinite. His experiments were quite elaborate, as experiments with concrete went at that time, and from them he deduced the conclusion that dry concrete should never be used at all; that medium concrete might be used where immediate strength is desired, but that a wet mixture would produce concrete stronger and cheaper than either dry or medium, at any age beyond three months.

It will be interesting for engineers conversant with the more recent reports of special committees of our technical societies and of engineering testing laboratories to compare them with the conclusions of earlier experimenters as mentioned above.

EDITORIAL COMMENT.

The third annual congress of the Canadian Public Health Association will be held in Regina on Thursday, Friday and Saturday, September 18, 19 and 20, instead of 16, 17 and 18, as previously announced. The programme of papers promises to be an exceptionally attractive one, and the Provincial Government and the city of Regina are co-operating in plans for the entertainment of the delegates.

* * * *

Canada's side of the boundary dispute arising from the proposal of the Michigan-Lake Superior Power Company, referred to editorially in July 10th issue of *The Canadian Engineer*, is being prepared by Mr. Chas. S. MacInnes, K.C., of Toronto. The lease, as proposed, occasions a diversion by dam of the St. Mary's River flow at Sault Ste. Marie, Ont., and has aroused a good deal of discussion.

* * * *

Owing to the number of requests for copies of Mr. J. M. M. Greig's "Sewer Discharge Diagram," reprints of which were made from the article appearing in June 5th issue of *The Canadian Engineer* for distribution to interested engineers, our supply was soon exhausted, and the continued accumulation of requests has occasioned the printing of another edition. These are being mailed to readers upon request.

The mineral production of Alaska for 1912 amounted to $21,850,000, of which $16,650,000 was in gold, $4,630,000 in copper, $300,000 in silver and $260,000 in tin, marble, gypsum, coal and petroleum.

DRAINAGE AS AFFECTING HIGHWAY TRAFFIC.

The increasing use of highways by heavy traffic has brought forcibly before those who have charge of them the weakening effect of water which is allowed to remain on the surface, in the subsoil, or in close proximity to it. Mr. W. Gregory, who has had over twenty years' experience in English road construction and maintenance, writing in Contractors' Record and Municipal Engineering, London, covers many important points that will be of interest to highway engineers who have to contend with the difficult drainage of stretches of road where surface water is not disposed to depart without a struggle.

To a casual observer, it might seem to be efficient drainage to conduct ordinary surface water by cross channels to back ditches, and away by the natural outfalls.

There are, however, miles of roads which, by reason of their cross section and situation, are practically waterlogged, as, for instance, where passing between high banks, with surrounding land several feet higher than the road surface, while the roads are so narrow that two vehicles can barely pass at walking pace; it will be obvious that in such cases ditches at sides are sources of more or less danger, while their absence produces mudholes in wet, and ice in frosty weather.

Even where there is sufficient width of surface and greensward to construct back ditches, there are not always sufficient to drain a road effectively. Roads passing over clay lands, in a wet season, are, regarding their subsoils, in a tremulous condition.

The experience of the writer, for some years, has been with roads resting on clay, chalk, or a combination of both, where this state of things has given rise to much difficulty.

The increased use of mechanical means for agricultural work has produced serious effects on roads only made to carry ordinary light vehicular and farm traffic; the passage along roads of heavy steam ploughs, usually in couples, and with vans and tackle totalling in weight anything from 40 to 60 tons, traction engines drawing laden trucks, threshing equipment, heavy motor lorries, etc., has produced such an alteration in the shape of the road crust that it was puzzling at first to know how best effectively to deal with it.

Some years since the writer decided to lay deep side drains in these weak roads, which should act in a threefold capacity, as surface water drains, subsoil drains, and abutments for the thrust of heavy vehicles. In many instances the passage of heavy engines had squeezed the ordinary side ditches up higher than the road surface, rendering them useless, and the constant attention, digging out and levelling was of little avail in draining the road.

These side drains were dug to at least 3 feet in depth, the outfall being in some ditch or natural watercourse, and where, owing to the variations in levels, the drain came near to the surface, iron pipes were used until a minimum cover of 2 ft. 6 in. was obtained, when glazed earthenware socket pipes of 6 in. diameter were used, these being laid with open joints and the trench carefully filled with large lump hardcore, or boulders, and finished near the surface with smaller stones, down to 1¼ in. size.

At intervals, depending on local circumstances, 9-in. brick catchpits, 24 in. by 18 in. by 3 ft. 6 in. depth, were constructed, with ordinary cast iron, hinged gulley gratings as covers.

Where these have been laid the effect on the roads has been most marked, the sides being firm, and the aerating effect on the subsoil has diminished the rolling movement of the clay to a minimum, although the engine traffic has enormously increased.

There has been considerable opposition by local people, and the work has been referred to as useless and a waste of ratepayers' money, the prevalent idea being that what was good enough for the former generations is good enough for the present day; and the instilling of scientific knowledge into the minds of such ratepayers is not a pleasant occupation, but the sooner they realize the benefits to the roads from these works the more likely are the highway surveyors and engineers to be able to improve roads to meet the requirements of modern traffic.

One instance of the effectiveness of these drains will illustrate the whole. During a dry portion of the year, the outfall of the longest drain (half a mile) was gauged, and found on different occasions to discharge 10,000 gallons per 24 hours; previously the road absorbed or carried this water, forming a slough in damp weather and being almost impassable in frost.

The cost in the district under reference would be much higher, no doubt, than in many other parts, as there is no suitable local material (in fact, no local road metal at all), and the distance from railway stations varies from 3 to 7 miles.

The work, with the exception of the catchpits, is done by the ordinary roadmen, and the cost (including pipes, metal, labor, carting, brickwork, etc.) does not exceed $1.85 per lineal yard, and in some cases less.

The extended use of by-roads by heavy traffic calls for a much higher standard of surface than formerly, and the above method, in the writer's opinion, will do much towards bringing this desirable state to pass, and enabling a road with a thin crust of metal to carry a greater amount of heavy traffic than it otherwise could, with less damage to the surface.

In many cases, the effect of the enormous weights on these roads appears to be the alteration of minor springs in the subsoil, and forcible closing of some of the capillary passages of water, resulting in springs bursting through the crust in places not previously known.

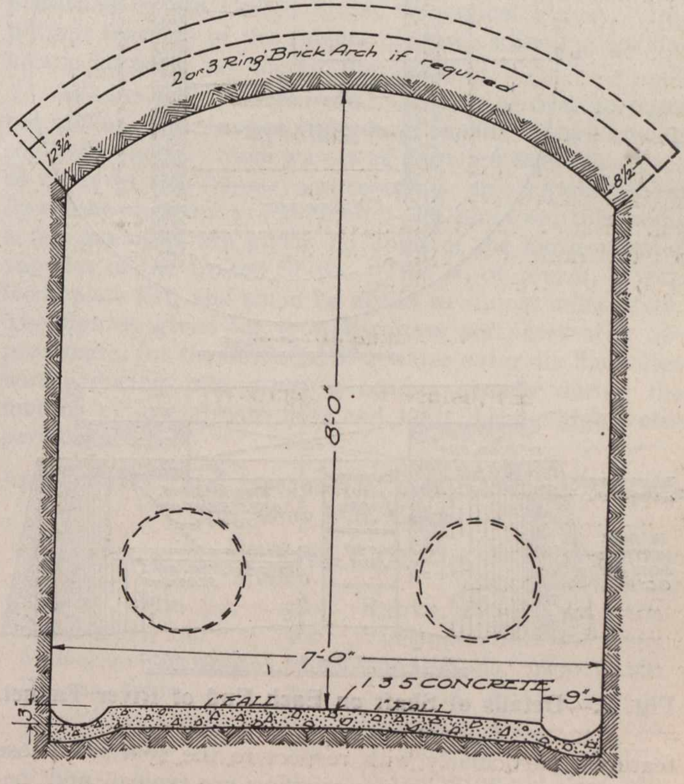
An instance of this occurred some years since, where, owing to months of wet weather, the high, clayey fields adjoining a road (in a cutting) presumably became surcharged with water, which burst out on the face of a hill in the centre of the road, the whole surface suddenly giving way as a vertical quagmire, to a depth of 3 or 4 feet.

The immediate remedy was to start lower down the hill with two trenches at sides of road, and work upwards, gradually increasing the depth until level with the bottom of the burst and joining the two trenches in the centre of same. Pipes were then laid from centre along each trench, and the water conducted so as to emerge at sides further down the hill, the trenches and centre being filled in with brick rubble, etc., that could be obtained, and, when settled, the surface coated with metal.

Similar cases, but in a minor degree, occur on trunk roads which have been tarred, one helping cause, no doubt, being the prevention of ventilation by the tarred surface, and the retention of the water until the pressure of same, or the heavy traffic, causes the surface to give way.

RIVER CROSSINGS FOR WATER MAINS AT FORT WILLIAM.

THE city of Fort William obtains its water supply from Loch Lomond, a lake located about six miles from the city, about 10 square miles in area, draining a watershed of about 30 square miles; at an elevation of 332 feet above Lake Superior. The system at present laid out consists of tapping this source with a 36-inch diameter steel intake pipe, which, at normal lake level, has a capable discharge of 32,000,000 Imperial gallons per day into a gate chamber. From the gate chamber to a fore bay a tunnel is constructed about 5,000 feet in length, 5 ft. by 4 ft. in size. This tunnel is so laid that it serves simply as an arm of the lake, the water level in the fore bay being the same as the lake level. The capable discharge of the tunnel approximates 54,000,000 gallons per day. From the fore bay a gravity



CROSS SECTION THROUGH TUNNEL

Fig. 1.—For Water Mains Under Kaministiquia River.

18-inch diameter cast-iron pipe is laid for a distance of 3,356 yards, discharging into a reservoir which provides the static head to the city supply. With normal lake level and the reservoir standing three-quarters full (with 15 feet depth of water) the discharge of this pipe is about 3,657,000 Imperial gallons per day, which can be increased up to 4,198,800 gallons per day at the expense of lowering the water in the reservoir to zero, with consequent loss of static head to the city supply.

The 18-inch pressure main crosses the Kaministiquia River at a point south of and in line with Syndicate Avenue. The pipe is laid in duplicate on concrete slabs practically in the river bed, and is provided with controlling valves at each side of the river.

Desiring to increase its water supply, the city contemplates a duplication of pipe lines between the fore bay and the city and the addition of a 24-inch pipe line, providing then an available supply of over 11,000,000 gallons per day.

The proposed extensions necessitate the abandonment of the present Kaministiquia River crossing and the provision of tunnel crossings about 650 feet in length under the Mission and McKellar Rivers, while the Kaministiquia River will be crossed in another spot by a tunnel some 1,285 feet in length, and with cross-section and dimensions as shown in Fig. 1. The design of this shaft and tunnel system presents some very interesting

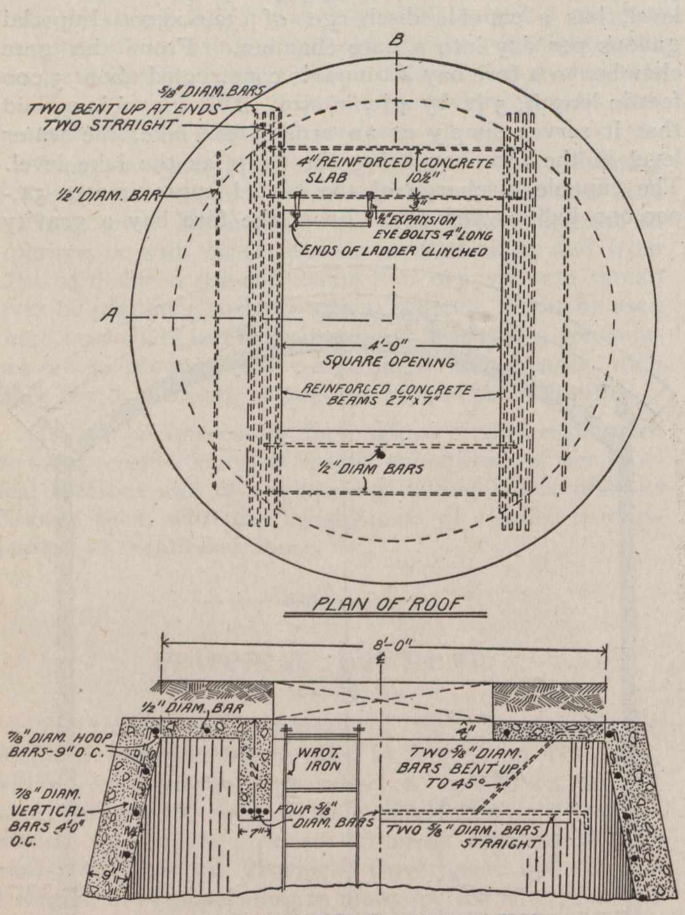


Fig. 2.—Details of Shaft on Each End of River Tunnel.

features, particularly with respect to the shafts. Those at the Kaministiquia River crossing are typical, and, being the largest, they are chosen for this description. Figs. 1 and 2 show details of roof and platform respectively.

The typical shaft is lined with reinforced concrete and is provided with reinforced concrete platforms, at normal intervals of 20 ft. to serve as landings for the ladders and to provide support for the pipe lines. At the Kaministiquia crossing there will be two reinforced concrete lined rock cut shafts each 10 ft. in diameter. They are 121 ft. 9 ins. and 116 ft. deep, traversing sand, blue clay, dyke, broken rock and Hudson shale. The concrete shaft lining is carried into the shale for at least 6 ft. Below this point the shaft is rock cut and a lining is not necessary. The tunnel lies wholly in the Hudson shale.

The reinforced lining is a 1:2:4 concrete, 9 ins. thick. The vertical reinforcement consists of ⅞-in. round rods spaced 4 ft. apart The horizontal rods are also ⅞ in. round, and are spaced 9 ins. on centre.

The sinking of these concrete linings provides an interesting problem. If the choice of the contractor is to build them at or near the ground level, and then sink them by gravity, steel shoes will be required to form the footing, and the concrete will require at least 48 hours in which to properly set before lowering.

The use of the lubricant between the lining and excavation walls will likely be taken advantage of to facilitate sinking.

For this form of construction care must always be exercised to excavate to a true circle of not more that ½ in. larger diameter than the outside of the concrete linings. If deemed necessary the linings should be slowly and evenly lowered by means of screw jacks. For this form of construction it is also specified that three times the number of vertical reinforcing rods shown in the accompanying illustrations be used. When the shoe reaches

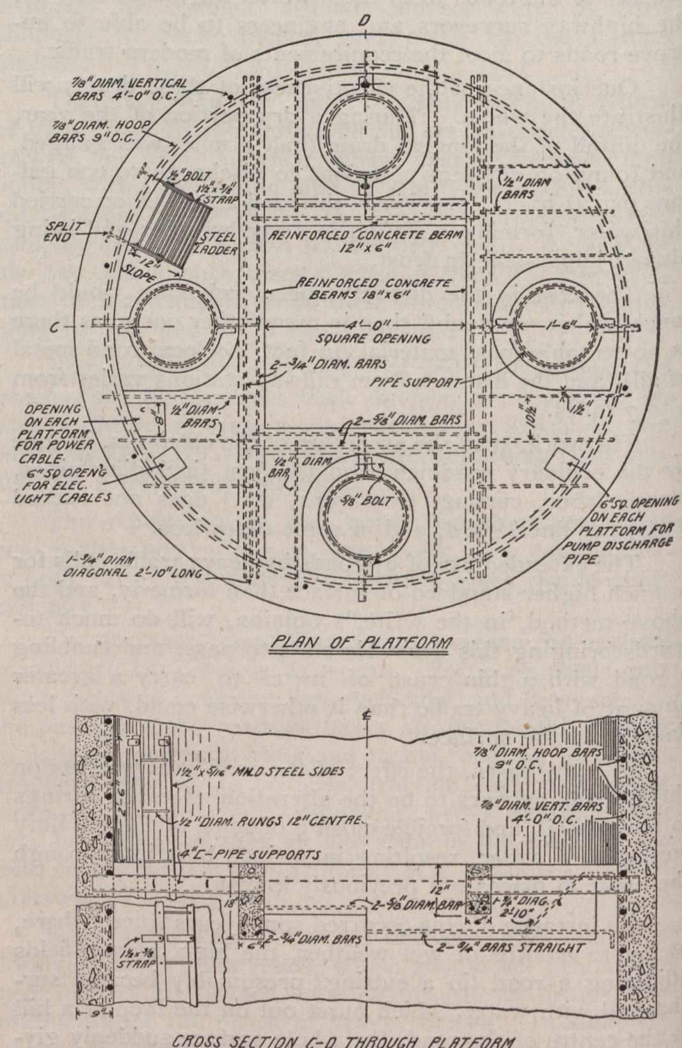


Fig. 3.—Details of Shaft Platform.

the rock an excavation will be made into the rock to a depth of 1 ft., so that the shoe will have an even bearing. The cavity left will be built up with brickwork and grouted in. Air and grout pipes at 2-ft. intervals will be provided for this purpose.

Only steel forms will be used on the concrete shaft linings. These forms will be well braced and stiffened to prevent deflection or twisting. Variations in the line and level exceeding ¼ in. will not be permitted in placing the forms

In case the reinforced concrete platforms are built after the shaft lining is completed, holes will be drilled for reinforcing bars, and cuts at least 1½ ins. deep will be made in the lining to receive the ends of the beams and slabs.

Where shale or loose rock is encountered in the roof of the tunnels this material will be removed and replaced with a brick arch. Permanent sumps and segmented drains will be cut in the rock at the bottoms of the shafts and along the floor of the tunnel. At intervals of 12 ft. along the tunnel floor, hardwood blocks 3 ft. long by 8 ins. wide by 3 ins. deep will be placed for pipe supports.

The work was designed by Mr. T. Aird Murray, consulting engineer, and will be carried out under the direction of Mr. R. R. Knight, city engineer, of Fort William.

A HANDY PLUMB BOB HOLDER.

The carrying of the plumb bob from station to station, or to and from the line, has always been a source of annoyance to the transit-man. It will persist in punching holes in pockets and getting lost.

A device is described by F. H. Kitto, D.L.S., in the latest annual report of the Association of Dominion Land Surveyors, that will serve to overcome a great deal of annoyance from this source. It consists of a simple attachment on one leg of the tripod, for holding the plumb bob when not in use, and forms, in fact, a neat permanent receptacle for it, so that it is always with the tripod when required.

The attachment is briefly described as follows: The point of the plumb bob is safely disposed of by dropping it into a hole ¼ inch in diameter bored to a depth of ½ inch in the centre of the wood cross-piece of the tripod leg. The neck of the plumb bob rests in a strip of brass extending across the split of the tripod leg, and fastened at each end by two half-inch screws. This brass strip is bent to a curve at the centre so as to fit the neck of the tripod. The outer strip is also of brass and hinged at one end on a round-headed inch screw, which passes through the inner plate and screws firmly into the wood. The other end hooks over a pin which is fitted as a clamp screw, so that by a slight turn of the mill-headed thumb nut the plate cannot come unfastened and allow the plumb bob to drop out. This screw extends through the wood of the leg and tightens in a nut, which is fitted by two ⅜ inch screws to the inner side of the leg. The inner plate is bent in such a way that the neck of the plumb bob does not exactly fill it, but is gripped on either side. This is to allow for string which is generally wrapped around the neck. As the plate will spring according to the thickness of string, the plumb bob is always held firmly.

This is a very simple contrivance, easily made and easily fitted to the tripod; and a great deal of satisfaction may be received from this little arrangement. There is no place more convenient for the plumb bob when carrying the transit, or when the transit is in camp, on transport, or in the office. It cannot be lost and it cannot be forgotten.

A calculation has been made of the time that elapses before a drop of water evaporated on the surface returns to the ocean. The total volume of water brought annually to the sea is 1/3460 of the total contents of the ocean. A particle of water before evaporation has stayed in the ocean on an average 3,460 years. Once evaporated, the drop becomes condensed in about ten days and is then speedily drawn back to its ancient home.

MUNICIPAL WATER SOFTENING

By Geo. A. Johnson.

HARD waters—those containing high quantities of lime and magnesia in a dissolved state—are less desirable for domestic and industrial use than soft waters. Hard water produces scale in boilers, wastes coal, and shortens the life of the boiler. It is ill-suited to the needs of many industries, particularly those in which chemicals are used, such as paper mills. Hard water wastes soap in the laundry and frequently makes necessary the use of washing soda or other compounds which have an injurious effect on some fabrics. It almost always affects the skin unpleasantly, and is more or less undesirable and uneconomical in various ways for general household use. A careful treatment of the subject forms a part of a paper by Mr. Johnson entitled "The Purification of Public Water Supplies," and published by the United States Geological Survey. Important features of the subject of water softening for domestic purposes are therein discussed.

Waters which have a total hardness of over 50 parts per million (3 grains per gallon) are usually classed among the hard waters. Such waters as these are found in scores of cities in this country, particularly in regions where limestone deposits predominate. To illustrate this point a few examples are given of some of the hardest water supplies of the United States. This is, of course, a very incomplete list, and could be added to almost indefinitely. The figures given for total hardness are necessarily approximate, for the hardness of a water naturally fluctuates widely during the year, becoming greater during the months of low stream flow and least during high-water periods.

Approximate Total Hardness of the Raw-water Supplies of Some U.S. Cities.

	Parts per Million.		Parts per Million.
Warren, Ohio	580	Starke, Fla.	165
Shreveport, La. ..	360	Vincennes, Ind. ...	165
McKeesport, Pa. ..	300	Minneapolis, Minn.	160
Dayton, Ohio	290	St. Paul, Minn....	150
Columbus, Ohio ..	275	Lancaster, Pa.	120
Toledo, Ohio	200	Quincy, Ill.	105
Oswego, N.Y.	190	Washington, D.C..	100
Philadelphia, Pa. ..	180	New Orleans, La..	95

Water softening is not widely practiced in America except by private industries. Among the cities where the public supply is softened may be mentioned Freeport, Ill., Oberlin, Ohio, St. Louis, Mo., McKeesport, Pa., New Orleans, La., and Columbus, Ohio, the municipal water-softening plant at Columbus, first placed in operation in the fall of 1908, being the largest and the most complete. For complete details of the chemistry of the water-softening problem at Columbus, the reader is referred to an article by A. E. Kimberly, published in the supplement to the Journal of Infectious Diseases, May, 1909.

Dissolved Mineral Constituents.—In problems of water softening, the most important features requiring thorough and reliable data are particularly the nature and the relative amount of the dissolved mineral constituents to the presence of which the water owes its hardness. Such data indicate, in large measure, the treatment of the water best adapted to its softening. With rare exceptions the hardness of water is due to the presence of calcium and magnesium radicles.

There are two kinds of hardness, temporary and permanent. Waters in which carbonate or bicarbonate radicles are equal or greater in reacting value than the calcium and magnesium may be almost completely softened by boiling and their hardness is known as temporary. Waters in which carbonate and bicarbonate radicles are less in reacting value than the calcium and magnesium can not be effectively softened by boiling. The removal of all the calcium and magnesium from such water can be effected only by the addition of chemicals that will cause the formation of insoluble calcium and magnesium compounds. Hardness corresponding to the excess in reacting value of calcium and magnesium over carbonate and bicarbonate radicles is termed permanent.

Lime and Soda Ash as Softening Agents.—The process of softening water consists primarily in removing from it the calcium and magnesium radicles. This is accomplished with lime and soda ash by the formation of insoluble compounds of these radicles, but these chemicals also react with other substances in the water. The lime is introduced as calcium hydroxide and the soda ash as sodium carbonate. The effects are:

(1) Hydrogen (acidity) is neutralized, forming water; (2) carbon dioxide is changed to carbonate radicle and water; (3) bicarbonate is changed to carbonate radicle and water; (4) iron, aluminum, and magnesium form their insoluble hydroxides and fall as precipitates; (5) calcium present in the water and added as lime is precipitated as calcium carbonate; (6) the sodium of the added soda ash remains in solution in the water.

From the foregoing it appears that lime must be added in quantity sufficient to provide hydroxyl (OH) to combine with the iron, aluminum, magnesium, bicarbonate, and hydrogen radicles, and carbon dioxide. Moreover, if the carbonate radicle in the water plus that formed by the change of the bicarbonate radicle and carbon dioxide is not sufficient to precipitate the calcium present in the water and added as lime, a larger quantity must be provided by the addition of soda ash in order that all the calcium may be precipitated. This latter consideration determines the amount of soda ash to be added. In terms of pounds of 90 per cent. (CoO) and 95 per cent. soda ash (Na_2CO_3) per 1,000 gallons of water, these statements may be expressed in the following formulas, in which the symbols represent the number of parts per million of the various radicles, respectively, found by analysis. The symbol "r" represents the "reaction coefficient." The indicated product represents reacting value in parts per million.

1. Lime required:

$$= 0.26\ (rFe + rAl + rMg + rH + rHCO_3 + 0.0454CO_2)$$
$$= 0.00931\ Fe + 0.0288Al + 0.0214Mg + 0.258H + 0.00426HCO_3 + 0.0118CO_2.$$

2. Soda ash required:

$$= 0.465\ (rFe + rAl + rCa + rMg + rH - rCO_3 - rHCO_3)$$
$$= 0.0167\ Fe + 0.0515Al + 0.0232Ca + 0.0382Mg + 0.462H - 0.0155CO_3 - 0.00763HCO_3.$$

In the latter formula a negative value indicates that the water has no permanent hardness and that the use of soda ash is unnecessary.

The formulas may usually be simplified for practical use by the omission of iron, aluminum, and hydrogen, for they are not often present in sufficient quantity to affect the results. Total incrustants in parts per million (as determined by the standard method of the American Public Health Association) multiplied by 0.0093 will be practically equal to the value of Formula 2.

Manufacture of Lime.—The raw material for the manufacture of lime is carbonate of lime, either as a natural limestone or in the form of the shells of mollusks. By subjecting the raw material to a temperature of 900° to 1,000° C., the carbonic acid is driven off and calcium oxide or quicklime is left.

There are two distinct types of furnace in use for the manufacture of lime, namely, periodic and continuous kilns. In the continuous system the kilns, once charged with alternate layers of limestone and fuel, are never allowed to cool down, resulting in great economy of heat. In this country more lime is perhaps burnt in kilns operated periodically. In this system the charged kiln, after the burning, is allowed to cool down, the lime is removed, and the kiln is recharged and reheated for the following run. In comparison with the continuous system, the periodic method of operation is uneconomical, owing to the losses involved in fuel and in time.

As the result of the burning a good limestone is broken into lumps; it suffers no change in volume, its weight and properties only being affected. The loss of weight during the decarbonization is about 50 per cent. Well-burnt and entirely satisfactory lime should be porous, nearly as hard as the original limestone, and should contain little, if any, magnesium and but inappreciable quantities of silica and iron. For softening water, economy and expediency demand that the highest grade of lime obtainable should be used. It is evident that for softening water the value of a given lime is dependent on the amount of available calcium oxide it contains. As lime is bought and sold on this basis for softening water, the chemical analysis should be the standard under all circumstances.

Manufacture of Soda Ash.—The manufacturing process of soda ash depends on the fact that bicarbonate of soda is insoluble in ammoniacal solutions of common salt. Common salt, ammonia gas, and carbonic acid gas constitute the raw materials. Strong brine saturated with ammonia is pumped to the top of carbonating towers and allowed to descend through iron baffle plates up through which a stream of carbonic acid is constantly flowing. Under these conditions bicarbonate of soda is formed and separates out, falling to the bottom of the tower, whence it is removed. The crude product is subsequently calcined, carbonic acid and water are driven off, and the pure normal carbonate of soda or soda ash is left.

Soda ash of a high degree of purity may be obtained in the market, and such soda ash alone should be used in all water-softening plants. The percentage of soda ash will vary from 95 to 98 per cent.

Cost.—The cost of high-grade lime and soda ash is subject to considerable fluctuation. Speaking generally, a high-grade lime, containing 90 per cent. available calcium oxide or more, may be obtained for about $4.50 a ton in bulk in carload lots. Soda ash, containing upward of 95 per cent. sodium carbonate, may be obtained in bags of 300 pounds each for about $20, or somewhat less, a ton in carload lots.

Preparation of Lime Solution.—It may be stated, practically without reservation, that it is advisable to use limewater for softening water. The reason for this is that limewater, being a true solution, is much more readily applied in uniform quantities than milk of lime. In water-softening plants which are operated on an intermittent basis it is possible to make use of milk of lime, owing to the fact that the application of the desired amounts of chemical may be kept under strict control. In plants which are operated on a continuous basis it is obvious that the effect of errors relating to the faulty application of lime must in a great measure vary inversely with the amount of water to be treated, or, in other words, with the amount of chemical to be used.

Although it is true that milk of lime is used in a small number of continuously operated water-softening machines of considerable size, the agitation factor is more particularly emphasized in such apparatus than would perhaps be feasible in larger plants. Without adequate mixing of the raw water and the milk of lime there is a marked loss in softening efficiency on the part of concentrated suspensions of lime, owing to the fact that the suspended particles of calcium oxide become coated over with the precipitating carbonate of lime and hydrate of magnesium, and thereby become inactive. With vigorous agitation this vitiating factor—the inactivity of a part of the lime suspensions—is greatly diminished, but doubtless it is still to be considered as important in proportion to the amount of suspended calcium oxide which the milk of lime contains.

From the evidence available it appears to be clear that limewater possesses distinct advantages over milk of lime in continuously operated water-softening plants for two reasons—first, because of the relative ease with which accurate and uniform application of this chemical may be maintained when it is applied in solution, and, second, because the softening efficiency of limewater is relatively higher. This second consideration involves questions of cost, which must be considered.

In a system of water softening operated on the continuous plan the device in which limewater is prepared is an important feature. In practice limewater is generally produced by diverting a portion of the raw water to the bottom of a tank or reservoir, sometimes known as the lime saturator, where it meets a continuous flow of cream of lime in slight excess of the quantity necessary to soften the raw water and to produce a saturated limewater. Thorough mixing of the cream of lime and the raw water is obtained by means of a stirring device situated at the bottom of the lime saturator. The raw water, softened to the fullest extent possible by treatment with cream of lime alone, becomes a saturated solution of lime. In order to obtain limewater which shall be practically free from undissolved lime and the precipitated salts of lime and magnesium the saturator is made sufficiently deep so that, as the water passes upward to the outlet at the top of the tank, the suspended matter will largely subside.

Preparation of Soda-Ash Solution.—Available evidence indicates that a 20 per cent. solution of soda ash in hot water should be used. Such a solution has a specific gravity of 1.23. A solution of approximately this composition is made by dissolving 20 pounds of soda ash in 100 pounds of water.

Limitations in Water Softening.—When once raw water, charged with carbon dioxide, has in its course over or through the earth become impregnated with calcium and magnesium there is no practical process applicable to municipal use which can restore the water to its pristine condition. The reactions and the resulting precipitation will vary in completeness with conditions of temperature, mixing, and sedimentation. Furthermore, the precipitates formed are not wholly insoluble. In a water softened under ideal conditions there may remain in solution 5.2 parts per million of calcium and 3.4 parts per million of magnesium, together with equivalent amounts of negative radicles, representing an alkalinity of nearly 30 parts per million. These figures may be increased by the presence of other substances, so that it is apparently certain that a water once hard can not be softened in a practical plant to less than 34 to 37 parts of alkalinity per million.

With regard to the permanent hardness, it is not generally thought economical or advisable to remove all of the incrustants. As soda ash, which is used for the removal of these constituents, constitutes one of the chief items of expense in softening a selenitic water, its use should be restricted to the lowest limit commensurate with the benefits to be derived therefrom.

Factors Influencing the Speed of Softening Reactions.—The process of softening water requires considerable time for its completion. Chief among the factors that influence the rapidity with which the chemical reactions involved in the softening process may take place are the temperature of the water, the thoroughness of the agitation to which the water is subjected following the addition of the softening chemicals, and the maintenance in suspension of the precipitating salts during the period allowed for the reactions to take place.

It is a well-known and accepted fact that the majority of chemical reactions take place with relatively more rapidity as the temperature is increased. Those chemical reactions which are involved in water softening belong distinctly to this class. Cold weather during softening retards the process to such an extent that considerably more time is required for the completion than when the water is at a higher temperature; in extremely cold weather the maximum softening effect is often not obtained.

Even when the amounts of chemicals theoretically necessary for complete softening are applied to a given water, a satisfactory removal of the dissolved calcium and magnesium salts will not be obtained without thorough agitation. The importance of agitation in softening water has long been recognized, the means for effecting this end constituting an important feature in the design of the majority of proprietary water-softening machines.

It is a well-known fact that the presence in suspension of the precipitate previously formed or of that formed in the initial stages of the reaction generally assists materially the completion of the process, its success depending on the removal of dissolved substances by the formation of a precipitate as the result of chemical reactions. In water softening this matter is of particular moment, owing in large measure to the fact that the chemical changes involved are taking place in solutions of a high degree of dilution. The importance of the presence of the suspended precipitates throughout the course of the softening reaction has been recognized for many years, and many water-softening machines have been designed with the view of retaining these precipitates.

Available information indicates clearly that at the beginning of the softening process it is highly advantageous to apply the entire amount of lime required to the major portion but not to the total amount of the raw water to be softened. Mention has already been made of the fact that the maintenance in suspension of the forming precipitates materially accelerates the softening reactions. By overdosing a major portion of the water to be softened, the initial softening reactions are greatly accelerated. The action is particularly marked in the precipitation of the magnesium, which is much more rapidly and completely removed under the conditions outlined above than would otherwise be the case. Further, the indications are strong that by splitting the flow of water to the reaction chamber, overtreating with lime the major portion at the inlet end of the reaction chamber, and, some time after the application of the soda ash, introducing the minor portion of the raw water, the undesirable factor of residual causticity, true of all water-softening processes, would in a large measure be overcome.

In general, therefore, it may be said that the concentrated action of the total amount of lime on the major portion but not on the total amount of water serves to speed up and to render possible a more complete lime reaction, not only as relates to the removal of magnesium but also to the removal of the calcium.

Elimination of Residual Causticity.—In all processes of softening hard water in which lime or caustic soda are used as softening agents, there is a possibility that the softened product will at times contain an excess of free caustic alkali, owing to the frequent changes in the character of the raw water, or to carelessness or accident in the operation of the plant, or to the method of application of the softening chemicals to the raw water. Another condition instrumental in the production of a caustic effluent is the retarding effect caused by low temperature on the rapidity and completeness of the softening reaction. In systems of water softening where the period allowed for the softening reactions to take place is comparatively short, particularly where such plants are designed to furnish water for drinking, rigid precautions are demanded to overcome the occasional inevitable residual causticity. In some plants the matter is controlled by installing carbonating devices for the purpose of subjecting the softened water to the action of carbon dioxide. If properly distributed in adequate amounts through a water possessing causticity, this gas is effective in overcoming this inadmissible condition.

This process is known as "carbonating," the principle involved being the same in all devices designed to accomplish this end. The features essential to successful carbonating are the uniform rate of application of the gas, and the thoroughness with which it is disseminated through the water. Although the process is without doubt practicable for small water-softening plants, its use in large plants would probably entail too great an expense to justify its installation. Further, aside from the cost, which perhaps might be reduced, it appears that the application of the gas to large volumes of water would cause great uncertainties in this feature of the plant, which must be under perfect control at all times.

Causticity that the raw water can neutralize is obviously equal to the amount of caustic lime (or caustic soda) required to soften the water. As a substitute for the carbonating devices in use in small water-softening plants, the application to the softened water of a small percentage of raw water may be practiced. It is apparent that the percentage of raw water required for each part of free causticity which may remain in the softened water will be one hundred times the reciprocal of the number of parts of lime (CaO), required to soften the water. In other words, all unchanged caustic alkalinity which the softened water may contain will be neutralized by the addition of a small percentage of raw water, the caustic neutralizing power of which is at a maximum.

Sedimentation of Softened Water Prior to Filtration.—Where river waters are to be softened, filtration usually follows the softening process. The necessity for the sedimentation of the softened water after the reaction period and prior to its filtration refers to the removal of an economical percentage of the precipitated salts of lime and magnesium, together with the suspended mud, silt, and clay carried by the water at flood seasons. It is clear that it would not be practicable or economical to apply to filters the softened water as it leaves the reaction chamber. As the precipitating salts are purposely held in suspension during the reaction period, the major portion of them passes out with the water as it leaves this chamber. The volume of this precipitate will be so great as probably to preclude the direct application to the filter of the water as it leaves the reaction chamber. Furthermore, at times when the river water carries high amounts of sediment, economy in filter operation demands that a period of sedimentation be allowed to intervene before such water is applied to the filter in order that a substantial removal of the mud, silt, and clay may take place in the settling basins.

For still other reasons it appears advisable to provide for several hours' subsidence as a means for compensating irregularities in the operation of a softening plant, namely, to guard against incomplete softening in the reaction period; to overcome uncertain factors introduced by winter weather, producing retardation of the softening action; to avoid the undesirable effect produced by possible after-reactions, which cause deposition of slow-forming precipitates on valves, boiler-water condensers, and the like, and to remove the esthetic objection introduced by the presence in the water, as delivered to the consumer, of small particles of precipitated lime and magnesium compounds.

RATING REFRIGERATING MACHINES.

In this country there are two generally accepted units for rating a refrigerating machine. These are commonly called the ice-melting or refrigerating capacity and the ice-making capacity. Both are expressed in tons of 2,000 lb. per day of 24 hour. When a machine is rated at one ton ice-melting or refrigerating capacity, it would mean that under an assumed range of operating temperature it would remove from the refrigerator the number of heat units equivalent to that required to melt one ton of ice at 32 deg. F. into water at 32 deg. F. The latent heat of ice has been variously taken as 142, 143, 143.7 and 144 B.t.u., but 144 B.t.u. is now the figure generally accepted. Then

$$2{,}000 \times 144 = 288{,}000 \ B.t.u.$$

is the equivalent of a ton of refrigeration per day of 24 hr. This would give 12,000 B.t.u. per ton per hour and 200 B.t.u. per ton per minute, all convenient figures to work with. The machine is supposed to work between a condenser temperature of 90 deg F., and a temperature of zero in the expansion coils.

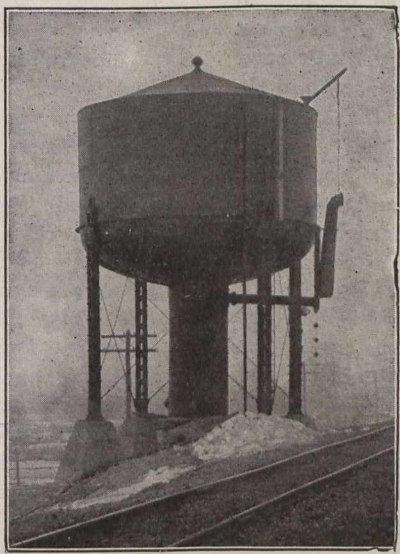
The ice-making capacity is a measure of the actual weight of ice made by a machine, designed for the purpose, in tons per 24 hr. For a machine not designed for ice making this unit would appear of little value, but for the sake of comparison it is approximately six-tenths the ice-melting or refrigerating capacity.

The Board of Railway Commissioners for Canada has issued to the railways a circular calling attention to the advisability of warning employees about the absolute necessity of keeping away from all electric light or power lines, and also to the advisability of becoming familiar with the recently revised rules for "Resuscitation from Apparent Death from Electric Shock."

NEW INDUSTRY FOR CANADA.

The Chicago Bridge and Iron Works, which has developed a prominent type of steel water tank for municipal, factory and railroad service, has built and is now operating a new plant at **Bridgeburg, Ontario.** This company began twenty years ago to construct for small towns and cities the hemispherical bottom type of tank, and since then has built a great number of tanks in every province in Canada and in every state in the United States.

About ten years ago Mr. George T. Horton, now president of the Chicago Bridge and Iron Works, designed and patented the elliptical bottom tank intended at first only for locomotive service. This tank, as shown by the cut above, has a large diameter and shallow depth, thus giving, as nearly as possible, the absolutely uniform pressure that is so desirable for all kinds of water service. Its special feature is the large steel riser pipe riveted directly to the tank bottom. This construction eliminates the leaky expansion joint and wooden frost casing, common to all other types of tank, and makes an all-steel structure which will last indefinitely. The large riser pipe is built from three to six feet in diameter, depending upon the climate. The success of the design is well illustrated by the municipal tank at Moose Jaw, shown herewith, which has never been put out of service by the coldest weather.



Grand Trunk Pacific Railway; Capacity, 50,000 Gallons; Height, 20 Feet to Bottom.

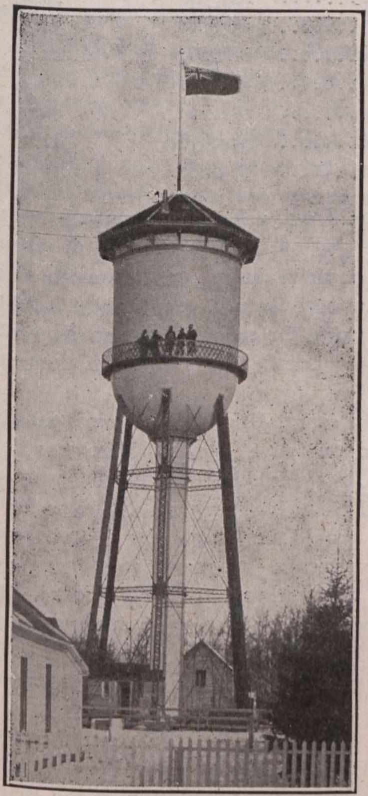
The tank bottom is practically flat where the riser is attached. It is, therefore, flexible and is in itself an ideal expansion joint, as is testified by the large number of high tanks of this design now in successful service. One in particular, a 200,000 gallon tank, 175 feet to the bottom, shows how well the expansion is taken care of. This elliptical bottom is now widely used for municipal and sprinkler as well as for locomotive service.

The large riser, besides doing away with wooden frost casing and expansion joints, serves as a settling basin. The inlet and outlet pipes extend up into the large riser several feet so as to be above any possible accumulation of sediment. A washout valve, operated from the outside, is installed at the bottom, so the tank can be cleaned without emptying or interrupting its service.

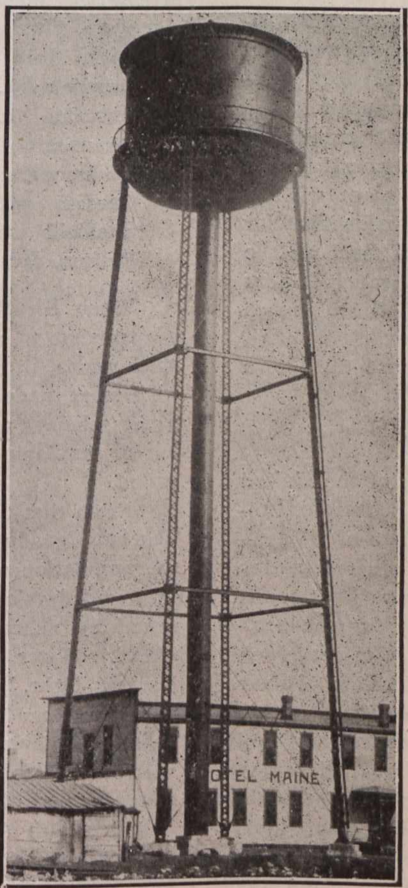
The self-cleaning feature of these tanks proved so important that Mr. Horton went a step farther. He designed and patented for railroads using extremely muddy water a conical bottomed tank with a large riser. This tank differs from the elliptical type only in that the bottom makes an angle of not less than forty-five degrees with the vertical so that the sediment has no chance to stop on its way to the settling basin.

How well these tanks are liked by the railroads is shown by the fact that they are in use on 85 railroads in numbers from 1 to 150 tanks per railroad.

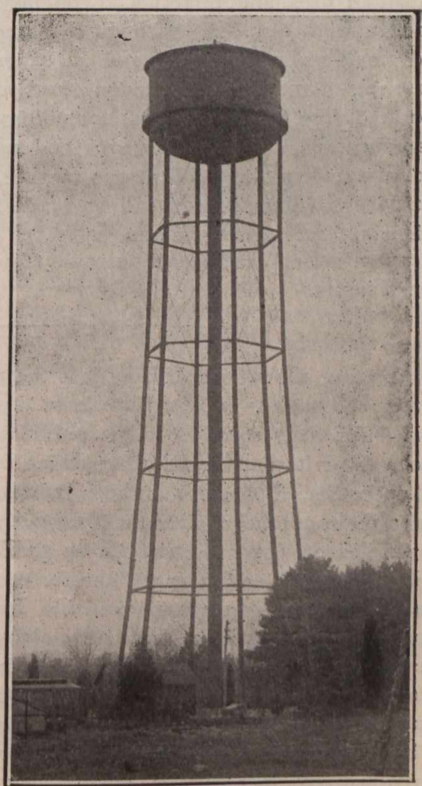
Three years ago the Chicago Bridge and Iron Works' all-steel locomotive ser-



Edmonton, Alberta; Capacity, 75,000 Gallons; Height, 81 Feet to Top.



Capacity, 100,000 Gallons; Height, 111 Feet to Top; Moose Jaw, Saskatchewan.



Standard Elliptical Bottom Design; Capacity, 200,000 Gallons; Height, 175 Feet to Bottom.

vice tank was introduced on the Canadian railways when the Grand Trunk Pacific built a tank for experimental purposes at Scott, Sask. This tank proved so satisfactory that steel tanks were adopted as the standard for the entire system. Twenty-six tanks of the design shown herewith are now being installed at different points west of Winnipeg by the Chicago Bridge and Iron Works.

The elliptical or conical bottom tanks when installed at terminal points, or points where much water is used, do not require any heating even in Canada. Where but little water is used and steam is available a steam jet introduced into the tank near the bottom is a very satisfactory method for preventing an undue amount of ice.

Two years ago, when the Chicago Bridge and Iron Works tank was adopted as a standard on the Transcontinental Railway between Superior Junction and Cochrane, Ontario, the question of heating isolated tanks where no steam supply was available came up for consideration. Mr. Horton then suggested the method described below, which the Government engineers later adopted, and which has since been adopted by other railroads and other tank manufacturers.

The method used is very simple and consists of raising the bottom of the large riser a few feet, and installing a stove in the small room provided. The stove pipe extends up through the centre of the tank and out through the roof. The inside of the large riser at the bottom is lined with brick so as to prevent the heat from radiating.

The company has in operation, besides its original plant at Chicago, and its new shop at **Bridgeburg,** a plant at Greenville, Pa., in the Pittsburg district.

The mines branch of the Canadian Department of Mines has installed at Ottawa a modern laboratory for the purpose of experimental concentration and metallurgical tests with Canadian ores and minerals. The laboratory appears to be already well-equipped with both standard size machinery and small-scale apparatus, and an experimental roasting and sintering plant is to be added shortly. The plant will be operated free of all charges, including assays necessary for test purposes, on Canadian ores and reports of tests will be incorporated in the publications of the Mines Branch. Under ordinary conditions tests will be made by the Mines Branch officials, but arrangements may be made whereby engineers or other competent persons may supervise their own experiments.

During the month of May last the railways of the United States, according to the Bureau of Railway Economics, received for their services to the public an average of $8,230,000 a day; it cost to run their trains and for other expenses of operation, $5,920,000 a day; their taxes were $341,500 a day; their operating income, $1,972,322 a day for the 220,897 miles of line reporting, or at the rate of $8.93 for each mile of line for each day. Thus for every six dollars of their earnings which remained available for rentals, interest on bonds, appropriations for betterments, improvements and new construction, and for dividends, the railways had to pay more than one dollar in taxes. All of these amounts are substantially greater than the similar returns for May, 1912. They are from the summary of the earnings and expenses compiled by the Bureau of Railway Economics from the monthly reports of the steam railways of the United States to the Interstate Commerce Commission. They include over 95 per cent. of the mileage and earnings of all the railways of the country.

THE FINANCING OF MUNICIPAL WORKS.

Comparison of Canadian, British and South African Methods.

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The subject of loans required for the execution of municipal works, is one with which Canadian municipalities have been openly confronted with in the course of the present season. A few observations bearing with special significance upon Western Canadian municipalities, may be considered opportune, they being chosen. Firstly, because much attention has been directed to the amount of money required by them; secondly, because the conditions are unique in the history of British municipalities, and thirdly, because the precedure observed in relation to obtaining money for new works is somewhat different to that obtaining in other parts of the empire.

In England the growth of towns has been steady and practically uniform, during the last fifty years. Some towns have grown much quicker than others, but the average increase of urban population was about 15 per cent. between the years 1891 and 1901, and about 11 per cent. in the next decennium.

Some boroughs round London had grown about 26 per cent. in the years 1901-1911; this was due to immigration from the central parts to the suburbs owing to improved transportation facilities.

The following probably represents the largest increases in England and Wales during the last census period.

	Population.	Increase per cent.
Croydon	169,500	26.6
Rhondda	152,780	34.3
Swansea	114,663	21.3
Huddersfield	107,821	13.4
Cardiff	182,259	10.9
Sheffield	454,632	11.1
Belfast, Ireland	385,000	10.4

When Sir Robert Rawlinson was commissioned by the government to investigate the sanitary condition of Lancashire towns, in the forties or thereabouts, public health works were most inadequate and unsatisfactory. Sir Robert initiated great schemes to provide work for masses of men who were out of employment owing to the depression which then prevailed.

From that time to the present, English municipal authorities have gradually carried out such works. The growth of the population was steady, very few towns have had any exceptional development, and there has been no difficulty in undertaking schemes which would be ample for a generation ahead. Water supplies, sewerage schemes, street railways, electric light, gasworks, and other municipal works have therefore been provided without imposing an undue burden on the ratepayers. The only public work of importance which was difficult to carry out with a degree of assurance of success was that of the purification of sewage.

In South Africa, the conditions are different, for apart from Capetown district, Port Elizabeth, East London, Durban, Pretoria and Johannesburg, the population of the British and Dutch element has not grown to any extraordinary extent. The above towns during the ten years ending 1911 have grown considerably, but not in anything like the same manner as Western Canadian cities. Johannesburg is about 30 years old, but the other South African cities are much older and all have had time to carry out many municipal works, but there is much left to be done.

With regard to Canadian expansion, it may be instructive to analyse and compare the census returns for the 1911 decenium. The increase in population in Canada was 32 per cent. as compared with 11 per cent. in England and Wales. The province of Saskatchewan had increased 439.48 per cent.; Alberta, 413.08 per cent.; British Columbia, 119.68 per cent.; Manitoba, 78.52 per cent.; Ontario, 15.58 per cent.; and Quebec, 21.46 per cent.

The urban population in Canada had grown 62.25 per cent. as compared with 11 per cent. in England and Wales.

If we analyse the returns still further we find that the increase in a few of the cities were as follows:—Regina, 1243.40 per cent.; Moose Jaw, 787.23 per cent.; Edmonton, 848.21 per cent.; Vancouver, 51.35 per cent.; Fort William, 354.11 per cent.; Toronto, 80.99 per cent.; Saskatoon, 105.23 per cent.; Calgary, 893.72 per cent.; Medicine Hat, 257.20 per cent.; Winnipeg, 221.29 per cent.; Ottawa, 45.27 per cent.; Montreal, 75.73 per cent.

It may be interesting to know that Toronto and Belfast have about the same population but the rate of increase was as 8 is to 1. Montreal and Sheffield are somewhat similar in the number of inhabitants, yet the growth of Montreal was nearly seven times as great as in Sheffield. Winnipeg in 1911 was about three-fourths the size of Cardiff, but the expansion of the former was about 21 times as much as the latter.

Unfortunately, comparative figures are not at present available to contrast the other Canadian cities mentioned, but there is no doubt that their growth has been enormous as compared with English standards. It is palpable that in the West, the development of villages into towns will show an abnormal percentage of increase, but even if such cases are excluded, the expansion was far in excess of what ordinarily occurs in other countries.

The influx of people into Western Canada during the last five years was even greater than in the decenium 1901-1911. For instance, the writer when investigating the question of water supply of Regina, found that the annual increment for five years ending 1912 was about 36 per cent. compound. It is, of course, possible that this rate of increase has been equalled or even exceeded in other cities.

The extension of railways, the great development of the agricultural industry and the immigration of people, demand the creation of new towns and villages to provide for the commercial and social requirements of the inhabitants generally.

The enormous growth of the existing towns and the ever-increasing number of new villages, some of which develop very quickly, give rise to sanitary works, better means of locomotion, more efficient lighting, cheap power, and the many other civic requirements of modern times.

It will be acknowledged that the best policy and the only efficient administration for municipal authorities to undertake, is to carry out the necessary public works as the towns grow, and not to allow the works to accumulate in such a way as to be difficult to be overtaken. It is far cheaper and more satisfactory to carry out sanitary works in advance of the actual requirements, rather than to neglect keeping abreast of the times, and wait until a disastrous epidemic of some disease has broken out, which will not only need eradicating, but also the execution of the essential precautionary works, after causing sufferings and losses which cannot be reckoned in dollars and cents.

The influx of people into Canada, therefore, imposes an important and difficult duty on the municipal authorities, which cannot be safely ignored. That the majority of the authorities are endeavoring, within the statutory limits of their borrowing powers, to meet the requirements is proved by the calls for capital.

While English municipalities have had fully fifty years to carry out such works, the Canadian cities and especially, the Western ones, are called upon to undertake the same in about ten years. The difficulty is enhanced by the exceptional growth, for engineers find it almost impossible to estimate the future with the same confidence as they can in other parts of the world.

This difficulty is not inherent to city works, for banking corporations have frequently erected buildings which were soon found to be inadequate; railway companies have built railways and structures only to find that it was necessary to enlarge the same almost before completion; governments are guilty of similar delinquency, and business men who erected what others called "white elephants," have had to face similar conditions and exigencies.

Such, then, is the almost universal development of municipal enterprises in Canada. It is small wonder that criticisms have been levelled at civic authorities, both by investors who are not thoroughly familiar with Canadian expansion, and by people who are disappointed to find that public utilities are not developed as in England. The problem is to find the money needed. The financial aspect of this question is probably more interesting than the incomplete description of the conditions which now prevail.

The monetary requirements of a Canadian city is controlled by the total assessable value of the properties, for the power to borrow is usually limited to twenty per cent. of such value.

The next question to be dealt with will be the procedure observed when seeking loans for new works.

In England and Wales, there are the borough councils, which consist of the mayor, aldermen and councillors. The mayor is elected from among the aldermen and councillors for one year, sometimes he is elected from outside the council. The aldermen are elected from among the councillors for a term of six years, and the councillors are elected by the ratepayers for a term of three years. The urban district councils consist of the chairman and councillors.

There is usually a plethora of candidates for these honorary offices, and in the majority of towns the members have held office for many years. In the boroughs the aldermen add more permanency to the membership and policy. There is much to be said in favor of aldermen and also against the institution. Aldermen act like a ballast to a ship, so long as they are sensible and progressive, but there is a tendency sometimes, for aldermen to adhere to obsolete ideas and ignore up-to-date requirements on the plea of economy.

When any English municipal authority has decided to carry out any new scheme, the engineer prepares plans, estimates and specifications, and when these have received the approval of the council, the clerk is authorized to forward a copy of the same with an application to borrow the necessary amount of money, to the Local Government Board, which is a large government department controlling almost everything associated with civic affairs.

In due time an engineering inspector holds an official enquiry in the particular town, when the clerk, mayor, aldermen and engineer place full particulars of the town's indebtedness, population, assessment, borrowing powers, necessity for the works involved, and so on. When they have presented the case the inspector calls for evidence in opposition—if any—and at the close of the enquiry he proceeds to the site to make a personal inspection. The inspector reports to the board and that body sanctions or disapproves of the schemes, or it may consider it necessary that a poll of the ratepayers should be taken, before giving any opinion or decision.

If the scheme receives the sanction of the Local Government Board, and it has authorized the period of repayment, the council is at liberty to approach the public works loan commissioner, or any other financial concern for offers or terms.

The Local Government Board, or the L.G.B., as it is known among the officials, is a restraining factor in the control of expenditure of public funds. The borrowing powers of the councils is usually limited to twice the rateable value, which in England is based upon the rack-rent of the properties, and not on the actual values.

The councils can undertake any new work, after its authorization by the Local Government Board at any time of the year, and float so much of the loan as is necessary or deemed expedient at the most propitious moment.

The Local Government Board is a slow moving department, often much criticised, but it is acknowledged to be an excellent organization, free from political influence, and possesses great powers to force recalitrant councils to execute any necessary works. Such powers, however, are very rarely exercised. It can, nevertheless, restrain too ambitious councils in their expenditure of moneys on doubtful schemes, or when their borrowing powers are nearly exhausted. It is somewhat conservative in its methods and adaptation to new development; bacteriological treatment of sewage and reinforced concrete structures, are instances of new methods to which it was for some time not prepared to give its sanction, except for short period loans. It will not consent to radical changes without ample proofs that they are essential in the interest of the public.

Under the English method the town authorities can take the fullest advantage of the financial fluctuations and thus ensure obtaining money on the most economical terms, which must be repaid in the period prescribed by the Local Government Board.

In South Africa, the procedure is different. The council having decided to undertake certain works for which preliminary plans, specifications and estimates have been prepared, calls a ratepayers' meeting and submits the proposals. If the ratepayers present are unanimous in favor, then the works are authorized, but if a certain number rise and demand a poll, then a plebiscite of the ratepayers is taken and the schemes are either agreed to or rejected. No formidable by-laws are necessary. If the schemes are approved by the ratepayers, the council can go on the money market at any time and thus take full advantage of the financial situation. Municipal schemes are decided upon at any time, and it is rare that any of them are suspended, altered, or turned down by new members because the policy is sufficiently established by the constitution of the council. Occasionally a scheme becomes the matter of an election contest, and the decision affords a guidance to the council in that particular case.

In Canada the procedure is different to both the foregoing examples.

The council usually decides what shall be undertaken in any year, so far as is possible. Of course, some schemes require more than one year for their execution, but the council of one year does not often settle what may be done in the next year, because the members are elected for two years and it is quite possible under such conditions to find a large proportion of new members elected at any time. Aldermen are usually busy men, engaged in businesses which calls for their close attention, whilst civic administration also demands a great amount of time which many aldermen can ill-afford. The result is found in the appointment of city commissioners, or the election of controllers, who devote their whole time to civic business, and thus relieve the aldermen of some of the administration.

The new council takes office in January each year, and some time is necessary to get the organization into working order. The aldermen call for reports, plans, etc., of works to be carried out during the year, some of which have sometimes, been considered in the previous year, in which case, if the new council acquiesces, there is a certain ecenomy of time. In due course the council decides to undertake many schemes, by-laws have to be prepared and read twice at the meetings. Then the by-laws, which recite in full various particulars and different legal phraseology, are published. The poll of the ratepayers is necessary and this is taken in ordinary course, and on the result depends whether and which schemes are to be carried out.

When the routine has been carefully observed, then the by-laws are read a third time, and advertisements are issued for bids, the most acceptable of which are selected.

All this means time, if any preliminary consideration by the council of the preceding year has taken place it permits of more expedition, provided the present council agree to such proposals.

The above procedure has to be strictly observed, otherwise the work is null and void, and the correct formalities have to be gone through and more time absorbed. As this routine must be followed by every council at about the same time, it is evident that the work is complete from March to May each year.

In Saskatchewan, the authority of the commissioner of public health is necessary before any schemes relating to public health can be submitted to the ratepayers for their approval.

In Canada, therefore, the town authorities are on the market for money about the same time, with the result that the aggregate amount appears enormous. The occasion may, however, be most inopportune, owing to financial stringency, caused by political events, abnormal industrial requirements, and perhaps by popular momentary wave of preference for securities of other countries or class. It is well known, that there is a fashion in investments as in other mundane matters, and this induces a fluctuation in the value of Canadian municipal loans, etc.

The almost simultaneous demand of many Canadian cities for money, is not to be commended. It does not usually occur in any other part of the world. It constitutes a flood of investments which cause financial indigestion and takes times to overcome.

There is a need for a greater continuity of municipal policy which can probably be attained by a longer period of election, say for three years instead of two as at present. Then fewer men will retire each year and councils will have a more established programme. If the present procedure is essential for the safeguarding of public interest, then it is a question whether the election should not be held at another time so as to permit the aldermen organizing their plans earlier. This, however, will not remove the disability due to the demand for money at practically the same time.

The character of the loan is a matter deserving of careful consideration. Instead of selling debentures required for various works in one class, they would possibly yield better average returns if those required for waterworks, electric works, street railways, and other reproductive works were disposed of individually. This is the usual practice in England and South Africa. Moreover, it is worthy of consideration whether ordinary debentures are as saleable as stock.

Many cities find it profitable to obtain funds by selling stocks of $500 and upwards.

Reverting again to the matter of procedure, it would appear that something more elastic on the one hand and more rigid on the other is necessary. This may seem paradoxical, but it is not so. The procedure should be sufficiently elastic to enable the councils framing their public works programme so as to permit them taking advantage of the financial fluctuations. It should also enable the councils to decide what works should be carried out and what money is required and come on the market at any time of the year, so that not too many of the Canadian authorities will do so simultaneously. It should be elastic enough to allow the councils to submit proposals to the ratepayers, at any time of the year, if such a procedure is really necessary. The ratepayers have elected their representatives and they might be given more freedom of action in this respect.

The procedure should also be rigid so as to protect the ratepayers and investors alike. One section of the ratepayers may have sufficient influence to force a scheme which might not be essential to the general public as another one might be. Some ambitious new aldermen may want a scheme delayed so that his may have a chance. The investor also wants safeguarding, for he is usually away from the place where the money is required. At present he has documentary evidence of the city officials supplemented in some cases by the government official. It would seem that the procedure could be made more rigid by adapting the English Local Government Board method, to suit Canadian conditions. To adopt the Local Government Board plan would no doubt be too drastic, and perhaps too great a restraint on the enterprising western Canadian councils. But to the British investor, (for most of the money comes from Great Britain), some independent and impartial investigation and sanction is desirable.

The Board of Railway Commissioners of Canada is reputed to give satisfaction to the public. The Public Utility Commissioners of Manitoba and Quebec are also said to fulfil their functions impartially and have done good work. Would it not be an advantage if similar organizations were instituted to facilitate and regulate municipal loan schemes? The fact that all municipal schemes were considered, investigated and sanctioned by such boards would doubtless have a great influence on the opinions of financiers, for it would be a satisfaction to them as well as to the ratepayers to know that all schemes have to be sanctioned or rejected by independent official authorities, who shall be absolutely free from political control. If such boards were constituted the town authorities would be able to prepare and submit any scheme at any time, and having got the necessary sanction of the board, with the period of repayment fixed, the councils could then arrange to secure the funds at the most opportune moment and on the most favorable terms. The present cumbersome procedure would then be unnecessary as there would be every safeguard in the interest of the ratepayers.

With the establishment of such boards, and a revision of the constitution of the town authorities, so as to secure a greater continuity of policy, Canadian authorities would be in a better position to obtain capital and to better arrange their programme of public works. Schemes could then be dealt with individually instead of collectively at any period of the year.

In conclusion it may be instructive to describe German municipal procedure. The city council consists of deputies elected by the ratepayers for three years; they appoint the Ober-burgermeister and a Vice-burgermeister at salaries for twelve years, and a number of stadräte or councillors, some of whom are salaried and correspond to our city commissioners. The burgermeisters and stadräte have a right to vote in council. When the council of deputies and stadräte presided over by the burgermeister has decided to embark on any scheme, the same is remitted to the burgermeisters and stadräte in charge of the branch controlling that particular work. The ober-burgermeister, vice-burgermeister and stadräte first settle all details in conference—called the magistrate collegium—and a report is presented to the council of deputies, when they finally decide the matter. The money is obtained either from an "operating fund" or by loan; but if it involves a large amount it ultimately means a loan. This is arranged with financial houses and the work proceeds. It is maintained that the ratepayers having elected their representatives it is left to them to use their judgment as to what is advisable to be done in the interest of the citizens. The government has certain powers of restraining municipal authorities, where it is felt that injudicious expenditures are incurred, otherwise the city authorities have complete independence in the administration of civic affairs.

ROCK SALT IN BRITISH COLUMBIA.

An extensive bed of rock salt has been discovered on the Skeena River, about 45 miles from Prince Rupert. Five holes have been drilled, about a mile apart, and salt has been struck in every case at depths varying from 50 to 250 feet. About eight tons of salt has been raised. The product is absolutely pure and of the best quality.

The Halifax Power Co. is planning to develop two sites on the Indian River, 18 miles west of Halifax. The upper station will include two units of 1,200 K.V.A. each. One operates on 90 ft. head from the Indian River watershed and the other on 160 ft. head from the North-East River watershed; the latter water is carried over to the Indian River by means of a long pipe line. The lower station will include two units of 1,200 K.V.A. operating on 90 ft. head; in this station the step-up transformers and high-tension gear will be placed. These developments will render 5,600 H.P. available in Halifax, which will be carried over a duplicate transmission line by two separate routes. Transmission will be at 33,000 volts. It is the intention of the company to sell this power for lighting and industrial requirements in Halifax. Plans are well under way for the upper development, one transmission line and receiving station, and it is expected that this portion of the work will be proceeded with immediately.

The exhibit of Canadian Allis-Chalmers, Limited, at the convention of the Canadian Association of Stationary Engineers held at Owen Sound, included a perfect working model of ⅜" size Squire's trap. Water was supplied to it by a small centrifugal pump driven by an electrical motor and a great deal of interest was taken in its operation.

Announcement is made by the B. F. Sturtevant Company, of Boston, that the plant which they have purchased at Galt, Ontario, is in such a condition that they can begin almost at once the manufacturing and assembling of their more important lines. Fans, blowers, planing mill exhausters, propeller fans, heating and ventilating apparatus, fuel economizers, mechanical draft, steam turbines, vertical engines, generating sets and stokers will be built for Canadian business and also for export to England, Australia and other countries. The manufacturing, engineering and sales will be handled by men trained by the Boston company. Arrangements have been made providing for growth up to ten acres of plant.

COAST TO COAST.

Montreal, Que.—The claims of ship owners, confirmed to a certain extent by records, that the level of the river and great lakes is being constantly lowered, principally by drainage operations, is about to be subjected to a practical test which should prove convincing to the most skeptical. According to information obtained to-day, the gauges between Port Arthur and Quebec, which are to be used in making the test, are now all in position by a special commission consisting of Prof. Haskell, of Cornell University, V. W. Forneret, chief engineer of the ship-channel and W. J. Stewart, chief hydrographer to the marine department. As the United States minister of war did not grant the application made by the Chicago drainage authorities last year for permission to increase the quantity of water they are entitled to take from Lake Michigan, the results of the tests are awaited with interest in shipping circles.

Victoria, B.C.—"The most important thing which the forestry convention did when it met at Winnipeg recently, was to pass a resolution urging upon the various provincial governments the importance of making provision for the teaching of forestry in the new universities."

That is the opinion of Mr. H. G. McMillan, the chief forester of the provincial government, who has just returned to the city after making an extensive visit of the forestry station in the interior, in company with Mr. O. W. Price, consulting forester to the government, who is here in connection with his engagement to assist in the establishment of the new department.

"What the future will demand in this province is forestry engineering and the university must provide the men and the methods. We have to develop trained forest rangers and make a study of forest engineering, for by the present look of things it appears inevitable that the logging of the future will be done by machinery. That I think was the most important thing the convention did, at all events so far as this province is concerned. There were two notable subjects discussed, namely, the extension of the civil service idea as applied to forestry and the encouragement of tree planting on the prairies. The prominence given to the last mentioned subject is perhaps best explained by stating that the convention took place in Winnipeg, where tree planting is a business.

"Since attending the convention I have been making a round of the interior stations, including Vernon, Cranbrook, Nelson, Kamloops and Vancouver and I must say that everything appears to be in good shape. The fire period is now upon us; the vegetation is extremely dry in places and the danger imminent. It will require the very closest application to business to prevent losses. Pretty good work is being done all along the line in the making of permanent improvements. You must understand that our trouble does not end at this season with merely telling people that they must not light fires. Fires will exist and it is our business to keep as close to them as possible in order to prevent them from spreading over large areas. Communication is our best weapon in this work and during the past few months we have been perfecting as far as possible our system of communication."

Quebec, Que.—After many complaints of the poor condition of the road, leading from the city to Lake Beauport, the Hon. J. E. Caron, Minister of Roads and the Hon. C. Delage, Speaker of the Legislative Assembly, have gone over the road with a view of securing some improvement. Lake Beauport is a beautiful spot, but the wretched roads prevent the extensive use of carriages or motors.

Vancouver, B.C.—For the purpose of taking up the question of a municipally owned power plant, Ald. McSpadden and Ald. McMaster were appointed by Mayor Baxter to act on a joint committee of representatives from the municipalities in Greater Vancouver.

The latest of numerous resolutions from ratepayers' associations, urging civic action towards a municipal power plant, came before the city council recently, from Kerrisdale Ratepayers' Association. It suggested a committee to gather information as to the operation of such a plant and the profits that might be derived from it, from cities which had made the experiment. Ald. Crowe favored a similar commission to that taking care of the sewerage system. He later, proposed the motion that the mayor appoint two delegates to a joint committee. Ald. McSpadden was chosen as chairman of the British Columbia Electric committee of the council.

At the last meeting of the city council, when a similar resolution came in from a ratepayers' association, it was referred to Mayor Baxter, who had intimated that the government was making a survey and a record of the water powers of the province. It was said that Mayor Baxter might look out for one for Vancouver.

Calgary, Alta.—Ald. M. C. Costello has signified the intention of proposing that the city take steps to investigate the question of filtering the water so that it will be pure and clean all the year around.

"Though the medical health officer tells us that even when the water is muddy the bacteriological count is very low, it seems to me that it is a bad thing to have muddy water at all. It must make a bad impression on visitors who come here and bad impressions are bad advertising. When we were in Saskatoon at the convention of the union of Canadian municipalities we had an oportunity to look over the filtration plant of that city and it struck us as being a most excellent scheme.

"A filtration scheme is greatly needed in Calgary, I think," he continued. "There is nothing like getting pure water. Though I hardly think there is any danger from the muddy water we have at times, it is my opinion that we should take no chances. The clearer and purer the water is, the better. The dirt should be taken out. Dirty water does not look pure and visitors to the city who turn the tap and are rewarded by a flow of dirty water, carry away a bad impression. It would pay the city in a great many ways to establish a filtration plant.

"In Saskatoon they have a small plant of small capacity, but Calgary would need one five or six times as large. Calgary needs eight or ten millions of gallons of water per day, while they get along in Saskatoon on one-fifth of that.

"I believe the very best possible system should be installed, if the scheme is viewed favorably. What that system is would have to be found out. Sand, charcoal, gravel, etc., are used in such systems."

Calgary, Alta.—City Water Engineer A. Ellison Fawkes reported to Commissioner A. G. Graves that the survey which the city is running to determine the cost of a pipe line for a mountain water supply has now been completed to within two miles of the present intake on the Elbow River. Mr. Fawkes estimates that it will require about two weeks more for the survey gang to get down to the present city reservoir, when the survey will be complete.

The work of compiling the data to secure estimates of the cost of the line is already under way and when finished will be most voluminous and complete.

"It will require two or three weeks longer after the survey is finished," said Mr. Fawkes, "to complete the estimates. Then we can take up the question of whether the city desires to go into the scheme proposed by Dr. Ings and take water from the tail race of the power plant he proposes. If the city does that, it will not have to build a dam. If it decides not to, a dam will have to be built. The difference in cost would be about $300,000."

Mr. Fawkes already has figures practically complete on the alternative cost of establishing Calgary's future water supply on a pumping and filtration basis instead of running the pipe line to the city forty-four miles from the Rocky Mountains. His preliminary figures on the pumping plant and filtration plant show that such a scheme would cost less than a million dollars, speaking in round numbers. The pipe line scheme will cost much more than a million, but the cost of maintenance in years to come would not be so great. These figures are on a forty million gallon per day basis.

Toronto, Ont.—Concrete bridge construction, while progress may be made in the future, has passed into stages of standard methods and is no longer experimental in so far as assured results are concerned, states F. A. McLean, in his annual report on highway improvement in Ontario for 1912. Past discussion has centred around the relative values of broken stone and gravel; wet and dry mixtures; methods of mixing, types of reinforcement and other details which now belong to settled practice.

Whatever specification is determined upon, however, should be carried out with intelligence, and in good faith. To this end, capable inspectors are necessary. Carefully drawn plans and specifications are of little value if their interpretation is left to men who have no proper knowledge of the properties of Portland cement and its use. Inspectors should be selected by the engineer, and should be carefully instructed before being placed on the work. Inspectors appointed by Boards of Works and councils, because of their influence, can rarely be expected to develop the skill, interest and enthusiasm that properly belong to the position and which are essential to best results. The writer has in the past found young engineering students of the second or third year to be in many respects well qualified, while the experience and training is of much value to them and ultimately to the public.

Better results could in many cases be had, were engineers to give more attention to form-work. Too frequently this is left to the rule-of-thumb methods of the foreman or contractor; whereas it is of vital importance that forms of adequate strength and of exact dimensions be provided if the strength and beauty of the structure is not to be jeopardized. Economy and perfect results will be greatly facilitated by detailed drawings for well-designed centres and forms.

Victoria, B.C.—Experiments will be made, under the direction of Water Commissioner Rust, to purify the water in Beaver Lake, which at present, owing to the presence of vegetable growth, is possessed of an offensive odor and color. An effort to precipitate the algae permeating the water, to the presence of which is ascribed the trouble, will be made by Assistant Engineer Foreman and City Analyst Birch. Recently they visited Beaver Lake and made arrangements to undertake the experiments. It is proposed to treat the water with sulphate of copper, bags of this substance to be pulled through the water. The chemical action consequent upon the introduction of the sulphate into the water, will, it is expected, precipitate the vegetable substances and thus clear the water.

The city has not yet been able to secure a full supply of clean sand for the renewing of the filter beds at Beaver Lake, but a small quantity has been secured and the filters can be used to some extent. It is expected, however, that the filter beds will be cleaned and renewed, when this method of cleaning the water from Elk and Beaver Lakes will be in full working order.

With these improvements, the supply from Elk Lake will be much more palatable, and can be mixed with the supply from Goldstream without any deterioration in the water supplied to consumers.

Toronto, Ont.—A special telegram received here from Boston, says efforts are being made by the Canadian Northern Railway to gain a terminal at Portland, Maine.

It is believed here that this step is only preliminary to an attempt to bring its lines into Boston in order to take advantage of the opportunity that the Grand Trunk failed to accept.

A company has already been organized and has obtained a charter to construct a railway from Portland to South Portland and to erect whatever terminal facilities may be needed there. This location offers the only available ground for a terminal at the Maine seaport and would make it possible for a transcontinental line to acquire a Portland entry to tidewater at comparatively low cost.

It is no secret that for some time the Canadian Northern Railway has long desired to enter Portland. Its effort to gain a terminal on United States territory and a share in New England trade led them to take steps toward acquiring rights to build south through Canada from Quebec and into the State of Maine.

Montreal, Que.—According to A. P. Davis, the contractor for the sub-structure of the Quebec bridge the work will be completed by November 15th. The St. Lawrence Bridge Company, which has the contract for the superstructure, will then commence. Mr. Davis expressed the opinion that it will take another four years to complete the bridge, and that it will not be ready for operation until 1917.

Toronto, Ont.—The International Joint Commission at Washington, which is making an investigation to determine what would be the most practicable level at which the Lake of the Woods should be maintained to best serve the interests of navigation, agriculture, power development, and fishing in that region between Canada and the United States, has sent out requests for certain information, the notices having been distributed widespread through the State of Minnesota. The Commission seeks information upon the following matters: The regulation, if any, of such secondary controlling works as exist in both Canada and the United States constructed for the floating of timber to the Lake of the Woods or tributary waters. When such works were installed, and the authority for them, the areas controlled by timber interests, and the extent to which timber has yearly been taken off such lands, and generally all information that would enable a concise report as to the progress of denudation, as well as any work, if any, in the way of reforestation. Data as to operations of all corporations engaged within the watershed of these boundary waters with the history of such corporations, conservation of the fisheries, and the possibilities of the future development of the region for tourist traffic.

Col. Geo. W. Goethals, chairman of the Isthmian Canal Commission and Chief Engineer of the Panama Canal, has consented to accept the honorary presidency of the International Engineering Congress, and will preside in person over the general sessions to be held in San Francisco, September 20-25, 1915.

PERSONAL.

HON. DR. ROCHE, Minister of the Interior, will begin a western tour of investigation about August 15th for the study of irrigation developments and necessities.

ARTHUR J. CANTIN, formerly sales engineer with the German Clancey and Grindley Company, Limited, of Edmonton, Alta., has been appointed superintendent of the Electric Light and Power Department of the town of Melville, Sask.

STANLEY LIGHTFOOT has taken over the Toronto business of Lloyd, Blackmore and Company, Ottawa, patent attorneys. The business will be owned by Mr. Lightfoot and conducted under his own name. The same office will be maintained in the Lumsden building.

L. C. GRAY, Ph.D., of Wisconsin University, and at present engaged in research work at the Carnegie Institute at Washington, has been appointed to a professorship at the University of Saskatchewan, Saskatoon. The research work of the institution will be in his charge.

The following members of the staff of the Faculty of Applied Science and Engineering, University of Toronto, have attained the rank of assistant professor in the department indicated: C. R. Young, structural engineering; W. M. Treadgold, surveying; J. R. Cockburn, drawing; M. C. Boswell, organic chemistry, and E. G. R. Ardagh, chemistry.

COMING MEETINGS.

ONTARIO MUNICIPAL ASSOCIATION.—Annual Meeting to be held in Toronto, August 28th and 29th. Secretary-treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ont.

THE NEW ENGLAND WATERWORKS ASSOCIATION.—Annual Convention to be held in Philadelphia, Pa., September 10th, 11th and 12th, 1913. Secretary, William Kent, Narragansett Pier, R.I.

THE ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Sixth General Annual Assembly will be held at Calgary, Alberta, September 15th and 16th. President, J. H. G. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chaussé, 5 Beaver Hall Square, Montreal, Que.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Third Annual Meeting in Regina, September 18th, 19th and 20th. General Secretary, Major Lorne Drum, Ottawa; Local Secretary, R. H. Murray, C.E., Regina.

AMERICAN ROAD CONGRESS.—Annual Session will be held in Detroit, Michigan, from September 29th to October 4th. Secretary, J. E. Pennybacker, Colorado Building, Washington, [illegible]

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—Twentieth Annual Meeting to be held in Wilmington, Del., October 7th to 10th. Secretary, A. Prescott Folwell, 15 Union Square, New York.

UNITED STATES GOOD ROADS ASSOCIATION.—Convention will be held at St. Louis, Mo., November 10th to 15th. Secretary, J. A. Rountree, L021 Brown-Marx Building, Birmingham, Ala.

AMERICAN ROAD BUILDERS' ASSOCIATION.—Tenth Annual Convention to be held in First Regiment Armory Building, Philadelphia, Pa., December 9th to 12th. Secretary, E. L. Powers, 150 Nassau Street, New York, N.Y.

AMERICAN CONCRETE INSTITUTE.—First Annual Convention to be held in Chicago, February 16th to 20th, 1914. Secretary, E. E. Krauss, Harrison Building, Philadelphia, Pa.

THE INTERNATIONAL ENGINEERING CONGRESS.—Convention will be held in San Francisco in connection with the International Exposition, 1915.

POWER DERIVED FROM REFUSE.

Those who have not followed the more recent developments in the disposal of city refuse, will find something instructive in a paper read by E. H. Foster before the American Waterworks Association at Minneapolis, Minn., in June. They will be surprised to learn that in a number of places part, if not all, of the steam used in driving steam pumps at waterworks pumping stations is derived from burning waste material. As a result of the development in the incinerator method of disposing of mixed refuse in England and in continental cities, several plants have been installed in this country, and, in all probability, the older and less sanitary methods hitherto in vogue will gradually give way to this more modern method, particularly as our cities increase in size.

Having produced the effect of destroying refuse in a sanitary and inoffensive manner, the question of how best to utilize this heat is answered by combining a steam boiler with the furnace and producing steam at any desired pressure. Steam so produced is available for running engines to produce electricity, but, as a rule, the amount which could be produced is but a small proportion of the total amount consumed by the community, also, the operation of the destructor does not lend itself to the requirements of peak loads which are incident to all lighting and power stations. A pumping load, however, is ideal for a destructor because of its uniformity and constancy, and it is in this direction that a municipality has its greatest opportunity for conserving this energy.

It would hardly be expected that the exact amount of steam available from the destructor would coincide with the exact amount of steam required at the pumping station, but the almost invariable condition is that the destructor steam is somewhat less than required by the pumps. Therefore, the difference is made up by auxiliary boilers.

The steam may be passed direct from the destructor to the steam range of the pumping station or converted into electricity and used to drive motor-driven pumps. Instances where steam from a destructor is used directly for driving pumps are found at Montgomery, Alt.; Westmount, Que., and Savannah, Ga., while instances where the power is first converted into electricity and the current used to drive motor-driven pumps to furnish the water are found at Milwaukee, Wis., and Savannah, Ga.

RUST-PROOF COATING FOR IRON OR STEEL.

This new rust-proof coating is a paint that is applied to the surface of the article to be coated and is then baked. The ingredients are mixed in the following proportions: Linseed oil, 25 parts; calcium resinate, 36 parts; manganese borate, ½ part; lead acetate, 1 part; naphtha, 37½ parts; artificial graphite, 25 parts. These are mixed and applied to the metal by brushing or dipping or any other method. The article is then baked at 300° F. for 1 hour and 40 minutes. The coating is stated to be highly lustrous and resistant to corrosion. No other form of graphite gives satisfactory results.