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The Canadian Engineer

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KANANASKIS FALLS HYDRO-ELECTRIC DEVELOPMENT

WATER POWER ON THE BOW RIVER—CALGARY POWER COMPANY'S NEW PLANT AND EXTENSIONS TO THE HORSESHOE FALLS DEVELOPMENT — STREAM FLUCTUATION AND STORAGE POSSIBILITIES.

THE Calgary Power Company Limited, of Montreal, has recently practically completed the construction of a new hydro-electric power plant at Kananaskis Falls, on the Bow River, in Alberta, about 50 miles west of Calgary. This plant adds materially to the power previously developed by the company at Horseshoe Falls, two miles distant, and built several years ago.

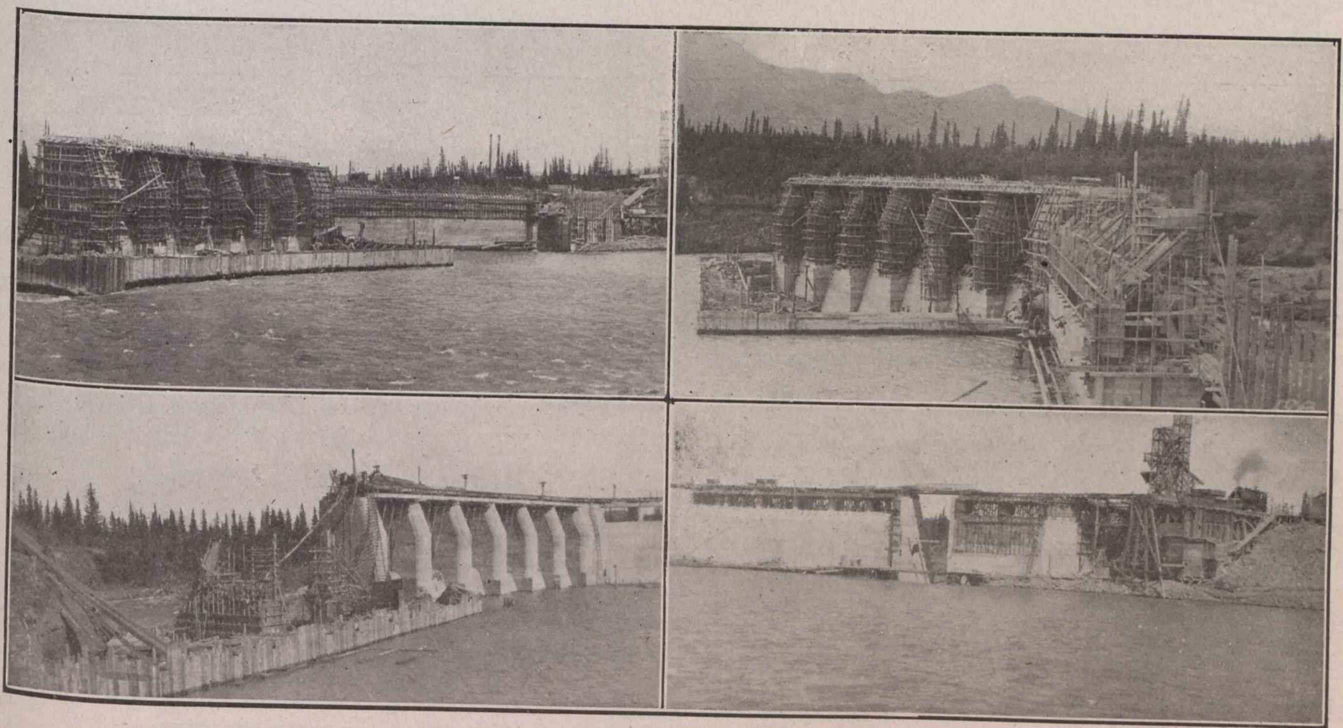

Fig. 1.—Kananaskis Dam, Showing Sluices and Spillway During Construction.

The Bow River.—The Bow River rises in the Rocky Mountains and drains an area of 3,138 square miles, 1,710 of which are above Kananaskis Falls and wholly in the mountain region. It is a typical mountain stream, rising at an altitude of some 6,500 ft. This slope is unusually steep and several falls occur. Its flow, like that of other mountain streams, is subject to sudden variations and is greatly affected by the temperature. During the hot summer months the melting of the snow in the mountains develops floods, while in the winter the cold reduces the flow to a very small proportion. There is, accordingly, a wide variation between high and low water, as evidenced by levels taken by the Canadian Pacific Railway at their bridges over Bow and Kananaskis Rivers, in the immediate vicinity of the development to be described. A flow as high as 45,000 cu. ft. per sec. has occurred at Horseshoe Falls, while a winter discharge of less than 500 cu. ft. per sec. has been recorded at the same place. The section of the river suitable for power development is some 30 miles in length and is well within economic transmission distance of Calgary. The river and the storage possibilities connected therewith, necessitated by the great fluctuation in the discharge, have occasioned very thorough investigation on the part of the water power branch of the Department of the Interior. A study of the power and storage possibilities of the river and its tributaries included the acquirement of copious information respecting run-off, rainfall and stream gauging. Mr. C. H. Mitchell, C.E., of Toronto, acted as consulting engineer to the government in connection with this work.

It should be stated that the direction of flow of the river is southeast from the mountains as far as the foot hills and thence east as far as Calgary. It then flows south and east to its confluence with the Belly River. Its many tributaries, most of them small, include the Kananaskis River, which runs into it at a point 53 miles west of Calgary.

Before entering upon a description of the Kananaskis Falls development, the attention of our readers should be called to the reference in *The Canadian Engineer* of June 4th, 1914, to the proposed hydro-electric plant of the Dominion Government at Banff, Alta. The storage possibilities of Lake Minnewanka were outlined therein. During the winter of 1912 the Calgary Power Company entered into an agreement with the Department of the Interior whereby the former was given the right to create a storage at this point. This involved the construction of a dam in Devil's Canyon, the outlet of the lake. The dam is a solid concrete structure about 100 ft. in length

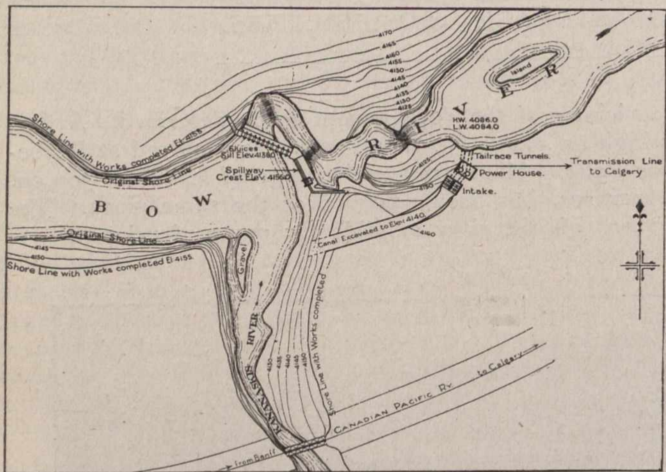

Fig. 2.—General Layout of Power Development.

and 55 ft. at its highest point. It is provided with three stop-log sluiceways and a low level sluice controlled by a gate valve, as illustrated in the article previously referred to. The dam was completed in May, 1912, and storage commenced.

Kananaskis Dam.—In the same year the Calgary Power Company was given the right to develop power at

veys of the site were carried out in considerable detail in the late fall of 1912, and designs for the plant were worked out forthwith. The layout shows a dam across the head of the falls immediately below the point at which the Kananaskis empties into the Bow, a canal

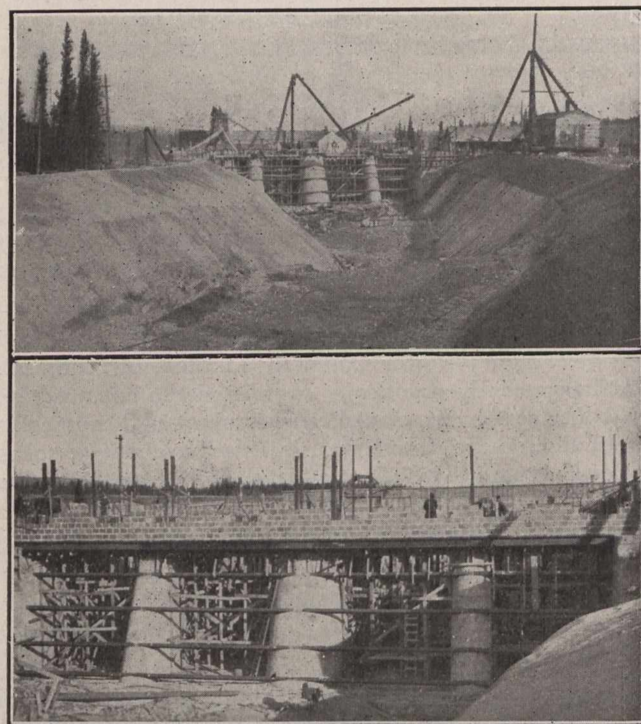

Fig. 3.—Canal and Head Gates Under Construction.

along the south side of the river, an intake, wheel pit, power house, and tailrace tunnels to deliver the water back to the river below the falls. The arrangement is illustrated in Fig. 2. The dam, construction views of which appear in Fig. 1, has a total length of over 800 ft., including wing walls. It is 57½ ft. in extreme height and has eleven stop-log sluiceways 18 ft. in width and 14 ft.

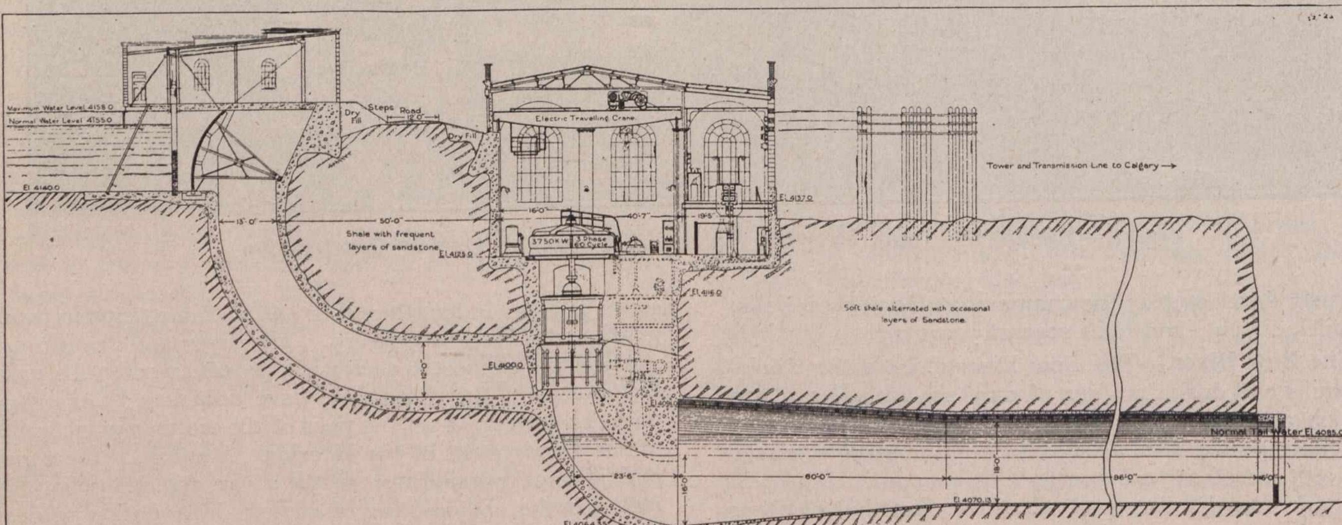

Fig. 4.—General Section of Development.

Kananaskis Falls, about 2½ miles above the then almost completed Horseshoe Falls plant. A total drop of about 40 ft. existed at that point and, by the use of a dam at the top of the falls a total head of 70 ft. is gained. Sur-

below the spillway level. It will raise the water level about 59 ft., backing it up into the Kananaskis River and necessitating the raising of a two-span bridge of the Canadian Pacific Railway on its line from Banff to Calgary with a corresponding elevation of 4 ft. in grade. The spillway section of the dam is divided into twelve 17-ft. openings and there is in addition a low-level sluiceway controlled by a 72-in. valve. This provides for a flood discharge of over 47,000 cu. ft. per second with a 3-ft. overtop on the spillway section. There is 215 lineal ft. of free overflow in the length of the dam, high-level water being 20 ft. above the lowest stop-log opening. The wing walls, which add to the dam proper a length of 75 ft., run well into the banks at either side.

The sluiceway and stop-log sections are furnished with a deck 20 ft. in width, narrowing to 10 ft. in width over the other sections. This deck carries an electrically operated winch for the handling of stop-logs.

Owing to the earth structure below the dam being of soft shale and very seamy in spots, in order to prevent seepage the foundation was grouted. Two-inch holes were drilled about 20 in. apart on both sides of the dam and were filled with cement grout under pressure. In some places the foundation structure was so seamy as to require a very large quantity of grout before leakage ceased.

Canal and Head-works.—The canal itself has been constructed sufficiently large to carry the amount of water necessary for the maximum of the plant at low velocity. It is over 700 ft. in length and is of trapezoidal cross-section, 50 ft. wide at the bottom, 80 ft. wide at the top, with an operating depth of 15 ft. This is where it passes through gravel, as shown in Fig. 3. The canal section in rock is rectangular and approximately 50 ft. wide with a depth of 15 ft. The former portion has been lined with concrete from the forebay to the head-works. The rock portion forms a natural dam for the canal. It is in general of a seamy shale nature and alternating with occasional beds of sandstone. From the head-works two 60-ft. concrete penstocks 35 ft. wide by 13 ft. high at the head gates and 12 ft. by 12 ft. at the wheel-case, feed directly to the scroll chambers. These tunnels are located in solid rock, as are also the draft tubes, tailrace tunnels, etc.

The head gates, which are riveted steel Tainter gates, operated by electric winches in the gate house above, are equipped with stop-logs to allow for repairs to the main gates, as well as with gratings to prevent intrusion of floating debris. Fig. 3 shows them under construction. The concrete-lined pressure tubes leading from the gates develop into scroll chambers formed in concrete in which are set the turbines. The forms and method of reinforcing of these chambers are shown in Fig. 5. The draft tubes into which the turbines discharge are 30 ft. in length, varying in cross-section from 9 ft. square at the wheel pit to 16 ft. by 13 ft. at the tailrace tunnels, from which point the water flows directly into the river, as shown in Fig. 6.

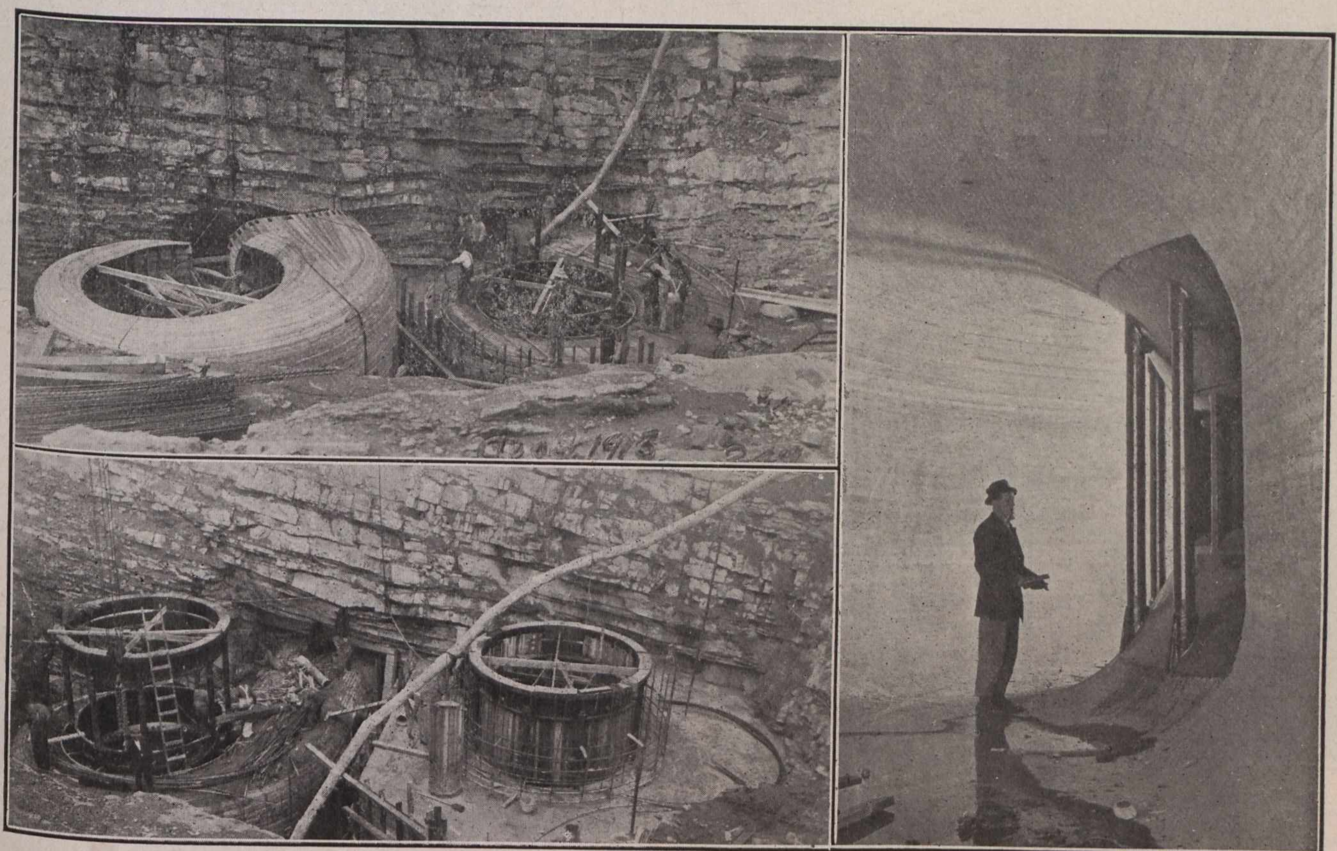

Fig. 5.—Scroll Chambers During Construction. Also Interior View of One with Forms Removed, Showing Turbine Frame in Place.

Construction Details.—The building itself is 90 ft by 60 ft., and is placed on a solid concrete foundation over rock. The lower 15 ft. of the walls are of concrete, while the structure is finished in clay brick. Sand and gravel for the concrete was obtained quite near the site. Mixing was done by steam-driven one-yard mixers in both the construction of the dam and head-works. The building of the dam itself was effected by the construction, during the winter season with low-water level, of a temporary discharge channel cut through the rock, built up with concrete and furnished with stop-log apparatus. A cofferdam was then constructed extending into the river as the current would permit. The flood season, however, discouraged attempts to divert the whole river through the temporary runway. Accordingly a natural opening was left at the north bank until the following winter season with its decreased flow. The construction, owing to the isolated location of the development, necessitated the building of several miles of sidings as well as quarters for 600 men. A steam plant consisting of two 100-h.p. Leonard boilers supplied steam for the pumps and air compressors, as well as for the work-shop and lighting systems. As the work developed, and power requirements increased, the company's transmission line from Exshaw to Calgary was resorted to and transformers installed for the stepping down of the current from 12,000 volts to ordinary working voltage.

The gravel was obtained, as stated, close to the power works. It was moved by a Marion steam shovel with a one cubic yard dipper. From the pit it was

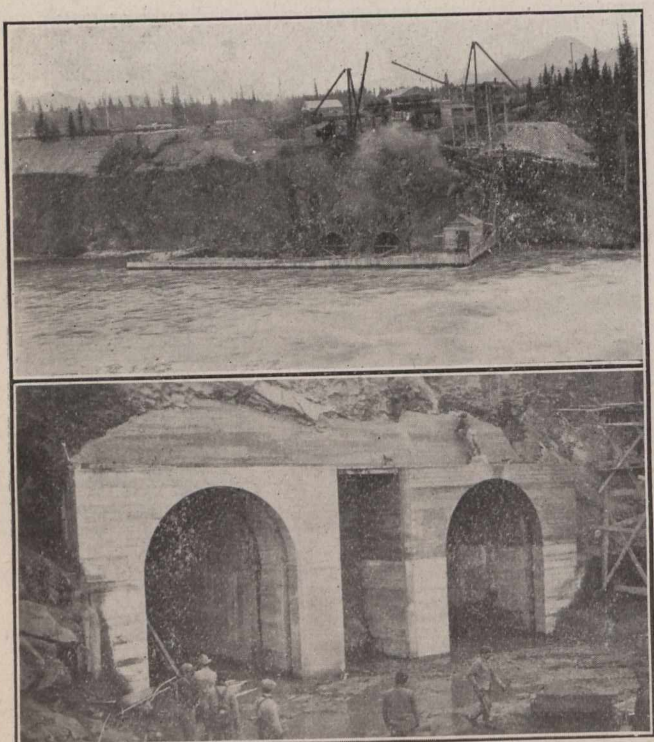

Fig. 6.—Outlet of Tailrace Tunnels.

hauled to the concreting plant in side dump cars of 6 cu. yds. capacity, drawn by Vulcan steam locomotives. The concrete mixers were equipped with hoisting towers and distribution system. They were placed about 30 ft. below the track level. Wooden hoppers with a capacity of 125 cu. yds. received the gravel from the dump cars, and discharged it through sheet metal delivery tubes with arc gates directly into the charging hoppers above the mixers. Cement, in sacks, was received at the mixers through a chute from the storage shed at the top of the bank. The hoisting and distributing towers were two in number, each equipped with Insley hoisting buckets and hoppers. One of them, 40 ft. in height, was used on the construction of the main dam, and the other, 60 ft. high, on the balance of the concreting. Side dump cars, of one cu. yd. capacity conveyed the concrete from the mixers along the deck to the towers. The plant had a capacity of 35 cu. yds. per hour.

An important feature of the construction was the excessive amount of rock excavation necessary. In the canal section a Marion steam shovel with a ⅓ cu. yd. dipper loaded into two 12-yd. and eight 6-yd. Peleter side dump cars. Eight Holman compressed air drills were used in rock excavation in the canal section and in the wheel pit and tailrace tunnels. From the latter, excavation was removed by the use of hoisting engines and 5-ton stiff-leg derricks.

The construction of the tail-race tunnels required a heavy timber cofferdam to be constructed in the river.

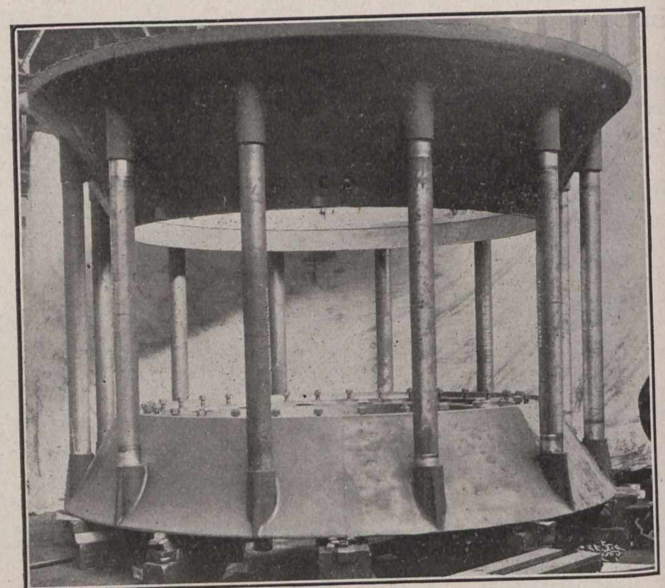

Fig. 7.—Turbine Rings and Supporting Columns. Shop View.

Excavation was then proceeded with from the river base at the same time that the penstock and wheel pit excavation was in progress.

As illustrated in Fig. 5, the forms for the scroll chambers (and the same applies to the forms for the draft tubes and tunnels) were lowered into position from the ledge of rock above.

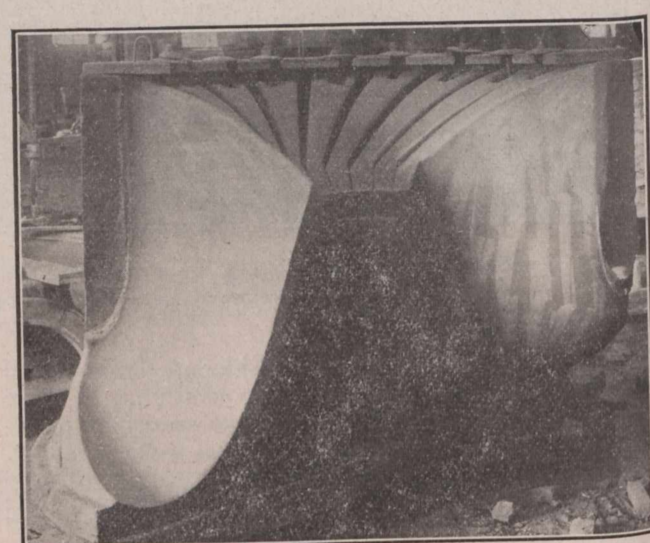

Fig. 8.—Setting Core of Cast Iron Runners for Turbine. Shop View.

The Power House.—The station contains two main turbine units and exciter turbine built by Canadian Allis-Chalmers, Limited. The main turbines are of the low-pressure vertical type set into the concrete spiral casing, described above, the local conditions of the power plant site being most suitable for such a layout. They were constructed for 6,000 h.p. at 164 r.p.m., operating under 70 ft. head. The additional exciter turbine was built for 150 h.p. at 600 r.p.m.

In order to eliminate distortion of any castings due to the heavy shrinkage stresses in concrete work, the designers applied heavy foundation rings bolted together by means of heavy steel columns, as shown in Fig. 7. These rings were installed during the first stage of the concrete work. After all those parts, together with the concrete around it, had settled properly, the wooden forms were removed and the turbine proper was installed.

The turbines in general consist of a solid speed ring and a guide wheel with bearing. The speed ring holds the bottom and top plates, which are designed to hold the cast steel guide vanes. This guide wheel is of the outside gate rigging type. Each guide vane swivels around a heavy shaft which is cast together with it.

is placed upon a rigid cast iron spider, which is resting upon the upper foundation ring already mentioned. All bearings, as well as the spider, are adjustable.

Fig. 8 is a construction view showing the core for the runners prior to casting.

The generator turbine, as well as the exciter turbine, is regulated by means of oil pressure governors. For the generator turbine the oil system is so laid out that any of the motor-driven oil pumps can feed any of the governors alone or both at the same time. Special attention may be drawn to the fact that the oil pressure tanks are of ample design to store enough energy for both governors for the severest conditions, without having the pump working always to its full capacity. The pump is automatically cut out and put into operation by means of a specially designed unloading valve. A hydraulic hand regulation is placed near each governor actuator, so as to enable the operator to regulate the machine in case of a shut-down of both oil pumps. All oil pipes for the complete oil system are made of extra heavy brass with bronze flanges.

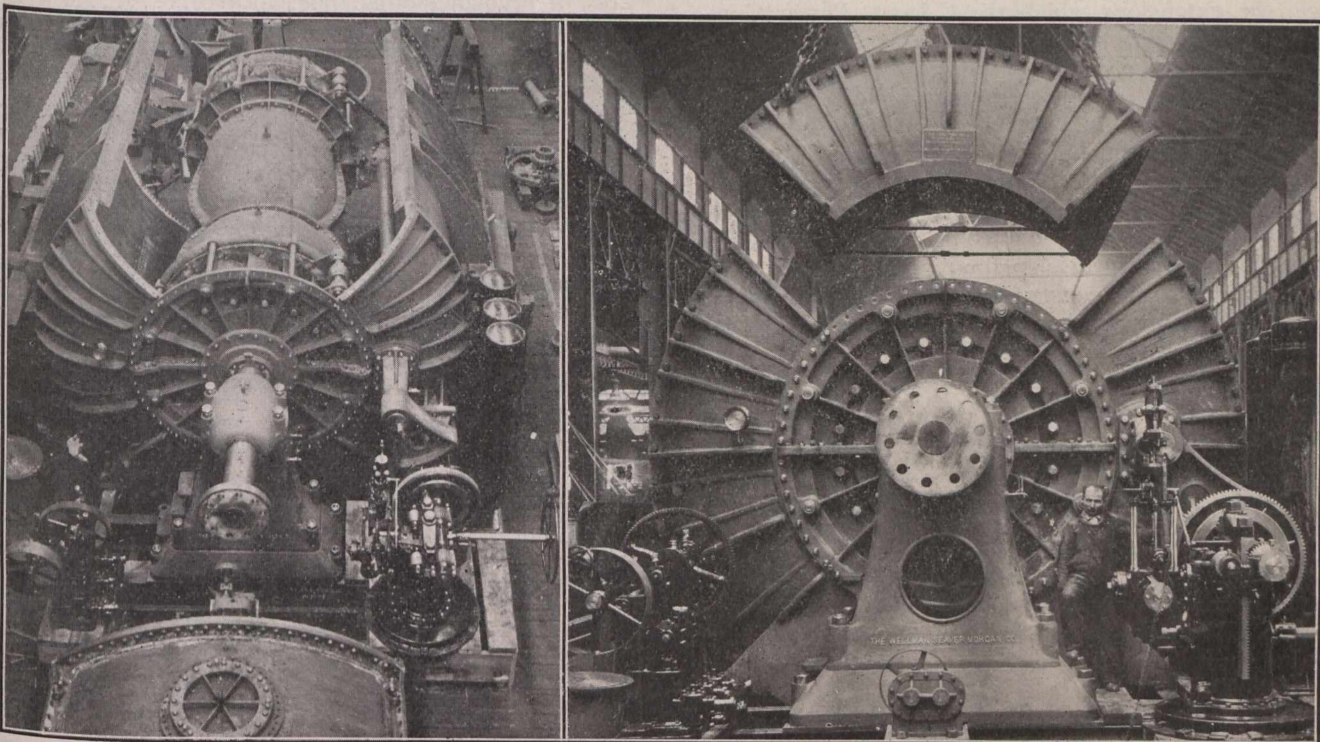

Fig. 9.—Shop Views Showing Construction of Horizontal Turbine for the Horseshoe Falls Extension.

On the upper projecting end a cast steel crank with patented breaking coupling is clamped to the shaft, and the connection to the steel regulating ring is accomplished by means of heavy steel connecting links. All bearings are bronze-bushed and adjustable. The regulating ring is placed around the heavy cast iron frame holding the water-lubricated lignum vitæ bearing for the main turbine shaft. The whole weight of this heavy ring is taken up by a set of steel balls set into oil-lubricated seats and held in place by means of a bronze cage.

The regulating ring, further, is connected to the two oil pressure cylinders by means of the shortest possible connection. These two cylinders are of heavy construction and placed diametrically opposite upon the bearing housing.

The turbine shaft is held in place by two heavily constructed guide bearings, one placed near the turbine runner, and the other immediately under the thrust bearing. This latter bearing is designed for oil lubrication, a small oil pump taking care of proper oil circulation. The thrust bearing is of the pressureless Kingsbury type, and

To the turbines are connected directly two vertical, 12,000-volt, 60-cycle, 4,250-kv.a. generators of Swedish General Electric type. A motor-generator exciter and a turbo-exciter, each of 75 kw., 220 volts, 600 r.p.m., and of the same make, have been installed. The switching equipment was installed by the Canadian Westinghouse Company, and includes a vertical type, remote controlled switchboard of eleven panels, a station and service board, a lighting and a storage battery charging panel. The 12,000-volt bus-bars and electrolytic lightning arresters are situated on a gallery above the switchboard. Above them in turn the five outgoing transmission lines are run through the wall.

The installation of power house equipment was managed by a 50-ton electrically operated crane working over a 40-ft. span. The main floor of the power house has a machine shop at one end.

Capacity.—The new plant generates approximately 12,000 h.p. The station is tied with the 18,000 h.p. plant at Horseshoe Falls by two 3-phase copper-aluminium circuits. At Horseshoe Falls the voltage is stepped up to 55,000 volts for transmission to Calgary.

The Kananaskis development has cost in the neighborhood of $750,000. Mr. H. A. Moore, general manager and chief engineer of the company, has been responsible for its design as well as the entire construction. Mr. H. A. Johnston was resident engineer and had a staff of ten assistant engineers at the site. The superintendent of construction was Mr. A. W. Allen. The installation of the electrical equipment was under the supervision of Mr. E. Barnes, general superintendent.

Horseshoe Falls Plant and Extensions.—In connection with the Kananaskis Falls development, which is now known as No. 2, it is interesting to note the main points of the Horseshoe Falls plant, known as No. 1, and to mention the extensions which the Calgary Power Company has made to it. The plant consists of a dam, intake, power house, etc., all of permanent construction. The head developed is 70 ft., part of which is due to the actual fall and part to the slope of the river.

The dam is of solid concrete construction of the spillway type, measuring 140 ft. in length on the crest. Apart from the spillway, it is provided with four stop-log openings and four sluiceways controlled by Stoney sluice gates, making ample provision for discharging any flood liable to occur. In its construction the same precautions were observed to prevent leakage as have been mentioned in connection with the later development and, whatever leakage there may be is taken care of by a drainage tunnel. The intake, provided with racks and ice-clearing devices, supplies the water to four penstocks, two of which are 12 ft. in diameter and the other two 9½ ft. in diameter. The power station was designed for four units and two exciter units. At first only two units were installed, a 3,750 wh. h.p. Then, upon the storage development at Lake Minnewanka, the third unit was installed. The fourth has recently been under construction, a new 6,000 h.p. Wellman-Seaver-Morgan horizontal turbine, controlled by a Lombard governor, having been installed in connection with a 4,500 kv.a. Canadian General Electric generator, direct connected. For this increased capacity two 3,000-kw., 3-phase transformers have been placed in operation by the Canadian Westinghouse Company, together with the necessary switching apparatus. This installation has brought the Horseshoe Falls plant up to a capacity of 18,000 h.p. This, according to the 1912 report of M. C. Hendry, chief engineer, Water Power Branch, Department of the Interior, cannot be considered as continuous output owing to the wide variation of flow mentioned above. From the records available it is believed, however, that the storage at Lake Minnewanka can be very materially added to by the creation of additional storage at other points in the basin. The chief users of power from the Calgary Power Company are the city of Calgary and the Canada Cement Company, at Exshaw. The city has been, of course, the largest consumer, but the extreme fluctuations in the Bow River flow, which preclude the continuous operation of the plants to their full capacity during a portion of the year, have prevented the company from guaranteeing continuous power throughout the entire year to the many users requiring it. The completion of the Kananaskis development, however, in addition to the other storages, will enable the company, it is believed, to give a guarantee of a continuous output sufficient to meet the needs of its customers.

COST OF HAULING WITH TRACTOR OUTFITS.

The following data from the Fourth Report of the Illinois Highway Commission on the cost of hauling road construction material should be of interest to contractors engaged in this class of work:—

Data on Cost of Hauling with Tractor Outfit at Hinsboro, Ill. Average Length of Haul, Three Miles.

Number of cubic yards of stone hauled by engine	2,590
Number of cubic yards of stone hauled by team	3,980
Number of days outfit was on job	120
Number of days outfit hauled (fractions counted as full)	40
Costs.	
Cost to Illinois Highway Commission of engine operator (salary and expenses, straight time)	$340.00
Cost of fireman (actual time worked)	66.20
Coal, oil and supplies for outfit	181.81
Cost of maintenance of hauling outfit (one-half season)	53.00
Total	$641.01
Total cost per cubic yard for hauling	$0.247
Total cost per cubic yard to township for hauling	.096
Total cost per cubic yard to state for hauling	.151
Actual cost per cubic yard for team hauling (on same work and same length haul)	.560
Cost of hauling by engine per cubic yard mile	.082
Cost of hauling by team per cubic yard mile	.186

Detailed Costs of Engine Hauling per Cubic Yard Mile.

Operator	$0.043
Fireman	.008
Coal, oil, etc.	.024
Maintenance	.007
Total	$0.082

Data on Cost Hauling with Tractor Outfit at Mattoon, Ill. Average Length of Haul, One Mile.

Number of cubic yards hauled by engine	674
Number of cubic yards hauled by teams	2,170
Number of days outfit was on the job	22
Number of days outfit hauled (fractions counted as full)	13½
Costs.	
Cost to Illinois Highway Commission for engine operator (salary and expenses, straight time)	$ 66.00
Cost of fireman (actual days worked)	27.00
Coal, oil and supplies	51.00
Maintenance of outfit	26.00
Total	$170.00
Total cost per cubic yard for hauling	$0.258
Cost per cubic yard to township for hauling	.115
Cost per cubic yard to State for hauling	.143
(Actual cost of team hauling on same work and same haul)	.435
Cost of hauling by engine per cubic yard mile	.258
Cost of hauling by teams per cubic yard mile	.435

Detailed Costs of Engine Hauling per Cubic Yard Mile.

Operator	$0.098
Fireman	.042
Coal, oil, etc.	.077
Maintenance	.041
Total	$0.258

GROUTING AND PENETRATING METHODS OF ROAD SURFACES.*

By George Green, M.Inst.C.E.,
Borough Engineer, Wolverhampton, Eng.

The ideal road would be one suitable for general traffic, which could be made in a satisfactory manner at less expense than an ordinary tar-macadam road, at a quicker rate, and independently of weather conditions, and which would last longer than a tar-sprayed water-bound road. Such a road would be within the more limited means of local authorities who are not blessed with too much money to spend annually upon their roads.

While the author does not pretend that he has found the long-looked-for means of satisfying all these requirements, he desires to draw attention to some results which indicate how partial satisfaction may be obtained; but he more particularly hopes to be able to obtain additional information and experience on this subject which will be of advantage to those who have the somewhat thankless duty of making roads for the public with a too limited supply of funds.

It would not be out of place, and it might be helpful in considering this subject, to note a few points which the road maker is bound to consider, and which sometimes the road users and the public at large do not thoroughly appreciate.

Provision must be made to keep road surfaces, where the gradients are exceptionally steep, with sufficient foothold for horses, and in frosty and muddy weather when the surfaces are greasy, an adequate supply of grit must be at hand. At the same time, these surfaces should be kept waterproof and as free from mud and dust as possible on account of the ever-increasing motor traffic. If motor traffic was all of one kind, a well tarred, sprayed macadam would meet the case in many areas and for many miles of roads; but this traffic again is divided into various classes—e.g., heavy motors, light motors, vehicles driven by steam with broad rough tyres and heavy loads.

These various kinds of traffic require special and often expensive treatment to keep our roads in a satisfactory condition.

This paper does not deal with main roads or county roads, but more particularly with secondary roads in towns and suburbs, which, at the same time, have considerable traffic, and occasionally are liable to have to carry all sorts and conditions of vehicles and tractors.

From a maintenance point of view it has been found that one of the most difficult roads to keep in good condition is the level road, which, on account of its want of proper longitudinal fall, particularly in wet weather, absorbs a large amount of moisture. Even a waterproofed road is more or less liable, partly owing to its position, to retain moisture in its foundations or in the subsoil if the district around is of a low-lying, insufficiently drained character.

A road that has a good gradient is generally self-cleansing with every shower of rain, and has a chance of a much longer life, in addition to being more easily kept clean and in a satisfactory condition. The margins of roads where tram lines are in the centre will not be dealt with. These have caused enough anxiety, and will continue to do so, to their surveyors as long as tram lines exist, and must always require more or less special treatment. Another reason for calling particular attention to the grouting and penetrating methods is the great difficulty, which it is believed is not uncommon, experienced in obtaining the necessary supplies of tarred road materials of various kinds in the quantity and at the times when they are most urgently needed.

One frequently has the misfortune to have a long and important road undergoing reconstruction, and to be hampered and harassed with the difficulty of obtaining a sufficient quantity of these materials to continue and complete the work in anything like a reasonable time.

All these difficulties make it desirable and necessary for road makers to have more than one string to their bows, and to be able to turn to fresh sources of supply and to use various materials and methods when emergencies of this nature occur, in order to complete their road making and repairs in a reasonable time with as little inconvenience to the public as possible.

Two points that road engineers have to deal with must be emphasized: Road surfaces must not only be able to stand the suction which is the result of rapid motor traffic, with indiarubber tires, which removes the dust, grit, sand, mud and water out of the water-bound roads, and sooner or later the small and then the larger stones themselves as they become loosened by disintegration, but consideration must be given to the provision of surfaces which will withstand the vibration from heavy vehicles—horse-drawn, steam-driven, and otherwise—which, with the continual hammering of the horses' hoofs and the solid iron tires, often shake the crust of the road and also its foundations.

It is obvious that a tar-sprayed road cannot last long under all these conditions. If the traffic were uniform, the problem would be simpler, and less expensive methods might be more easily adopted. All these points have to be considered in the construction or reconstruction of any road, and, as a rule, a road crust has to be constructed on such foundations as will be able to withstand all these conditions in a thoroughly satisfactory manner.

So far, difficulties common to all road engineers have been dealt with, among which that of an adequate supply of materials is by no means the least at the present time.

It no doubt arises largely from the fact that tarred materials of one sort or another have been recognized as one of the chief and best methods of road making, and road authorities—county, urban and rural—are all, without exception, making great efforts to meet the road problem of the day, and partly also on account of the fact that tarred materials can best be laid in dry weather, as most of these new surfaces and reconstruction of roads are done in the few months in the summer which can be relied upon as most suitable for this purpose.

If anyone can discover a material which can be used as satisfactorily in wet weather as in fine, or in winter as easily as in summer, no difficulty would be found in obtaining a ready sale for it.

It seems almost superfluous to reiterate here the great advantage of tar-spraying on well-constructed macadam roads. Most engineers have found that this is of immense advantage not only in the prevention of dust and mud in main roads subject to heavy and rapid traffic, but also that it adds considerably to the life of those roads, and is a distinct advantage from a health point of view in second-rate residential roads made of macadam in which many of the poor in our towns have to live. These streets often swarm with children who use them

*Paper read at the annual meeting of the Institution of Municipal and County Engineers at Cheltenham.

as their playgrounds. The sanitary advantage of tar-spraying in these roads can hardly be over-estimated.

Leaving the difficulties of the situation generally, stress must be laid on the great importance of having proper foundations and good drainage to all roads which are to be treated with waterproof surfaces and have to bear heavy traffic. Many roads which have for years been subject to heavy traffic have been found to consist almost entirely of a number of coats of macadam laid one upon the top of the other, the whole mass resting on a clay underbed without foundation or drainage of any kind. It is impossible for roads constructed on such lines to last, and in such cases the old macadam has invariably had to be removed, and below that, to the required depth, the surplus soil excavated and removed, and in its place a foundation of 6-in. or 8-in. slag pitchers laid upon a properly formed and well-rolled bed consisting of several inches of rough, hard clinker. The advantage of this layer of clinker is to prevent the clay or underbed working through the pitchers towards the surface, and consequently causing the foundation to give way and become uneven. This usually forms an excellent drainage, and remains of lasting benefit to the newly constructed road. Upon this foundation several types of grouting or penetrating methods have been tried, the first which naturally suggested itself being that of ordinary tar. The first trial of this kind was made some five or six years ago on a road which had a natural and sufficient gradient longitudinally; there were tram lines in the centre, the whole surface on either side of the tram lines was scarified and regulated, and after that coated one stone thick with cold blast-furnace slag, carefully and sufficiently rolled in dry. After this a mixture of 40 gallons of gas-tar (not distilled), 6 cwts. of pitch and 4½ gallons of creosote oil, as the constituent parts of the grout, was poured on the surface through cans and rubbed in with squeegees; the surface was then coated with a thin layer of slag chippings and gently rolled in with a 10-ton roller, after which a second and thinner coat of the tar mixture was spread over the surface and another layer of finer grit to spread upon the top. This road surface, which is subject to a fair amount of traffic of various kinds, has lasted up to the present time with hardly any repairs except for trenches and occasional small repairs.

This class of road, provided it is constructed in dry, suitable weather, answers a very useful purpose, and, of course, is more lasting than tar-spraying and very little more costly than ordinary water-bound macadam, provided the same road material is used. Of course, a road of this kind could only be made in suitable weather, and should a period of wet weather follow the commencement of the work, completion might be delayed for a considerable time.

Experiments have been made on a similar form of road, with other forms of binding material, with varying success; in some places the earlier work has stood for a number of years, and has a very satisfactory surface, in others there have been less satisfactory results owing to the heavier nature of traffic and to a level surface. A year ago a more elaborate experiment was made with this material. The road in this case was laid in two coats; the first coat was treated similarly to the one made of slag referred to above, and after it had been thoroughly grouted and rolled in, a second coat, one stone thick, of basalt was laid upon the top, and the process repeated with the binder and chippings until the final surface was finished.

This was only done a year ago, and the length of its life cannot be estimated. The carriageway is narrow, the surface is a level one, with hardly any gradient, and the traffic of a heavy nature, mostly with iron tires, such as railway drays and vehicles of that kind. The surface to-day is almost as good as when it was laid down, but time alone can say how long it will last. Ordinary water-bound macadam in this road only lasts a year.

Roads grouted with Rocmac and with Glutrin have also been laid in an experimental manner, also with various results, but the latter experiments, made about twelve months ago, when the materials in both cases were mixed on boards in the form of concrete, have been much more satisfactory, and promise to make a more lasting surface, and one which affords at the same time a most excellent foothold for horses. The great advantage of these two materials is that they may be laid in wet weather even better than in fine weather, and consequently the work is not interrupted for any outside causes, as is the case with tar roads sometimes.

Beyond the fact that Rocmac and Glutrin grouted roads can be constructed in winter, they afford a much better foothold for horses. A coat of tar dressing in the summer will prevent them being dusty, and add to the length of life generally.

There may be other forms of grouted roads equally good and useful, but there is still room for further progress in this direction, and the inventor, if the method be not an expensive one, might easily make a fortune. Most engineers would be glad to have a longer period, extending through the winter, in which to continue their road work, especially as sometimes it is difficult to find sufficient employment for all their good and useful men during the winter months when work is most needed.

On July 16, in London, England, the foundation stone of the new offices of the Agent-General for the Province of British Columbia, was laid by Prince Arthur of Connaught. The building is being constructed as a further means of stimulating the general development of the province.

Chas. T. Schoen, formerly of Pittsburg, Pa., the pressed steel car inventor and manufacturer, announced recently that he is planning to establish a plant for the manufacture of pressed steel cars at Leeds, England. As yet no decision has been reached as to when the plant will be established, nor what will be the name of the projected company. But Mr. Schoen has been in communication with Betts Machine Company, of Wilmington, Del., regarding equipment for the proposed British works.

The Vancouver syndicate which purchased the Monarch Collieries at Taber, Alta., about a year ago, has decided to install a complete new plant, costing in the neighborhood of $50,000; and it is expected that the company will be ready to recommence operation in the near future. The new superintendent of the mine will be Ralph Smith, ex-Liberal member of the Dominion Parliament for Nanaimo. The company has also completed arrangements to have the spur track extended to its property from the present terminal near the Rock Springs Coal Co.'s mine.

On July 14, at Washington, in a letter from Secretary Garrison to the House Foreign Affairs Committee, it was advocated to remove the restrictions upon the importation of electric power from Canada and to retain the present limit of 15,600 cubic feet per second upon the amount of water diverted for power purposes from the Niagara River, above the falls on the American side. With the letter Mr. Garrison sent a report by Brigadier General Kingman, chief of the army engineers, declaring that the enormous commerce of the lakes probably soon would demand a ship canal between Lakes Erie and Ontario on American soil. As to the situation below the falls, Secretary Garrison said there seemed to be no reason for an express limitation upon water diverted there. He endorsed in a general way the Smith and Cline bill which, he said, "closely approached the legislation needed for the protection of Niagara River, and for the best and most economic use of its water for power development not inconsistent with navigation interests."

SPECIFICATIONS RELATING TO COMPRESSED AIR IN TUNNEL WORK.

THE construction of additional subway tunnels under the East River, New York, has required the preparation of specifications covering the new contracts. These are very comprehensive and specific and embody details of requirement suggested by the latest experiences in similar work. The requirements relating to the use of compressed air and the safety of the workers under pressure are much extended, and embody important requirements beyond those found in existing laws. These, it is understood, were specially prepared by Mr. Frederick C. Noble, division engineer, and appeared in a recent issue of the Compressed Air Magazine.

There are nearly two miles of double lines of single track tunnel excavation under compressed air, most of it shield work with cast iron lining. A large portion of the work is in sand at a maximum depth of 90 ft. below mean high water.

The first requirements are as to the sufficiency and the reliability of the mechanical equipment. The contractor must install air compression, hydraulic and electrical machinery, hoists, pumps and all other necessary apparatus of the highest grade in use for the work to be performed and having a capacity sufficient to meet not only unusual conditions but emergencies, and to afford a margin for repairs at all times. Provision must be made for storing in tanks at the boiler house enough feed water for twelve hours' supply, unless connections can be made with two independent and separately sufficient sources of supply. If electricity is used for operating compressors supplying air to the tunnel headings, the supply cables shall be in separate lines and shall each connect, if possible, with two independent and separately sufficient sources of current.

The compressors shall be capable of furnishing simultaneously to each heading an air supply sufficient in volume and pressure to enable work to be done as nearly as possible in the dry, and to afford the specified degree of ventilation. At each heading where the shield is used the air supply pressure of 45 lb. per square inch above atmospheric pressure must equal at least 10,000 cu. ft. of free air per minute as measured by piston displacement, unless both tunnels are operated from the same compressor plant, when this air supply may be reduced to 8,000 cu. ft. of free air per minute. The plant, in addition, must be capable of furnishing to all parts of the work a sufficient air supply at a pressure of 100 lb. or more if required for operating drills, grouting machinery and other pneumatic tools. The air for the compressors shall be drawn from pure outside sources and protected from fouling by lubricating oil.

The compressor revolutions shall be registered by mechanical counters, and the pressure in the air receiver shall be continuously registered. Cooling apparatus shall be provided to maintain the temperature of the air in the tunnels and caissons always at a moderate degree. All buildings for the compressor plant and in the immediate vicinity shall be as nearly as practicable fireproof and all reasonable precautions shall be taken to prevent and extinguish fires. A water line shall be extended into each heading, 200 ft. of hose, and nozzle connections shall be maintained ready for constant use at each bulkhead and no lighted candles or matches will be allowed near roof timbering in compressed air.

Medical and Sanitary Rules.—The workmen's quarters shall be well lighted, heated and adequately provided with running hot and cold water, showers, lockers and facilities for resting, for drying clothing, and for providing hot coffee. Care should be taken to keep all parts of the tunnel in a thoroughly sanitary condition and free from refuse or decaying matter. There shall always be on duty a competent physician and surgeon experienced in the treatment of the physiological effects of compressed air, and he shall care for the health of the employees and supply treatment and medicines to them whenever needed.

There shall be maintained in close proximity to the shaft at each side of the river a completely equipped hospital room with an attendant constantly in charge. Each hospital room shall include in its equipment a commodious hospital lock in two compartments, where men can be subjected to the regular working pressure if attacked by caisson disease. Such locks shall contain cots, a telephone, air gauge, and arrangements for ventilating and heating. Provision shall be made for the immediate removal and hospital treatment of any employee who may be injured or become ill. No person shall be employed in compressed air until after passing a satisfactory medical examination, and any employee absent for ten or more successive days shall be re-examined before being permitted to resume work in compressed air.

All reasonable facilities shall be afforded for the investigation of the physiological effect of compressed air, including the conduct of experiments and the collection of records in connection therewith, to be undertaken by such scientific bodies of individuals as may be designated for the purpose by the commission.

Air Chambers.—Air chambers shall be formed in the tunnels by brick, concrete or steel plate bulkheads of sufficient strength to safely resist a pressure of 15 lb. per square inch. Whenever the air pressure in the heading exceeds 22 lb. per square inch above atmospheric pressure, two air chambers shall always be in use, except when headings are being started from shafts, and the pressure in the outer one shall not exceed one-half the pressure in the heading. The distance from the heading to the nearest bulkhead shall not exceed 800 ft. during the progress of the work.

Three metal airlocks are to be firmly set and anchored in each bulkhead. These shall consist of two main locks not less than 6 ft. in diameter, heated and ventilated if required, and an emergency lock not less than 5 ft. in diameter, which shall be located as high up from the bulkhead as practicable and shall be large enough to hold an entire heading shift. When not occupied, the emergency lock shall be kept open toward the heading and ready for instant use at all times. Lock doors must operate easily. A heavy glass bull's-eye must be set in each end of each lock.

Air valves must be arranged to be controlled from inside the lock. One of the main locks shall be connected to the main air line so that it may be locked from outside. Each lock shall be provided with an air gauge and a clock. An 8½-in. air gauge shall be placed in an accessible position on the outer side of each bulkhead. A recording air gauge shall be placed on each main and shall be locked and the key kept by the engineer. A lock tender shall be on duty at all times at each lock bulkhead. A watchman shall be on duty at all times in the heading and when for any reason the work is suspended.

Safety Screen.—In each heading chamber, when the same extends beyond the river bulkhead line, there shall be provided a safety screen extending from the springing line of the tube to the track. It shall be made of substantially braced steel plates with airtight joints. It shall be moved forward as the work progresses so as never to be more than 115 ft. in the rear of the shield. In each heading chamber, when the same extends beyond the bulkhead line, the contractor shall provide about the middle of the height of the tunnel a substantial runway, at least 3 ft. wide, leading from the shield platform to a platform at the emergency lock. The runway shall be provided with a handrail and steps or ladders at frequent intervals for access from the track level. A telephone connection shall be maintained in service from each heading and each lock to the power house and to the office of the commission's engineer corps near the shaft.

The air supply through the shaft and tunnel in each heading shall be through two pipes, each at least 10 in. in diameter, with sufficient capacity to prevent excessive drop in pressure in regular working. Each supply pipe shall be provided with a pressure-regulating valve in each air chamber and with suitable valves arranged for by-passing at a convenient point between the power house and the shaft. Special devices shall be used to deaden the noise of air supplied or exhausted.

The supply of fresh air shall be sufficient to permit work without danger or discomfort, and where work is in compressed air such supply shall be sufficient at all times and places to prevent the accumulation of carbon dioxide to a greater amount than one part in one thousand by volume. A foul-air vent pipe 6 in. in diameter shall be carried back from each heading under pressure to the ordinary atmosphere and shall be provided with a suitable regulating valve so placed as not to be readily tampered with. The compressors must be so run as to maintain at all times a change of air through the regulating valves. Special means must be provided for the rapid removal of blasting fumes.

PRIZES FOR HIGHWAY STUDY.

Awards have been made in the competition announced several months ago by the Barber Asphalt Paving Company, for papers from engineering students on the subject of asphaltic materials for highway construction. The judges of the competition, E. J. Mehren, Editor of "Engineering Record," and H. P. Gillette, Editor of "Engineering and Contracting," have made awards of prizes of $100 each to the following contestants:—

Name of Student.	College.
Frederic O. X. McLoughlin	Columbia University, New York City.
Harry Schindler	Cornell University, Brooklyn, N.Y.
B. J. Fletcher	University of Georgia, Parrott, Ga.
John W. Hill	University of Illinois, Chicago, Ill.
Robert S. Johnson	Iowa State College, Ireton, Iowa.
M. V. Holmes	University of Kansas, Kansas City, Kansas.
F. P. Gilbert	Massachusetts "Tech," Beverley, Mass.
Harold J. LaLonde	University of Michigan, Sault Ste. Marie, Mich.
Benjamin Wilk	University of Minnesota, Virginia, Minn.
Alvin C. Smith	University of Nebraska, Lyons, Neb.
O. H. Gosswein	Purdue University, St. Louis, Mo.
Alfred A. Berkowitz	Scheffield Scientific School, New Britain, Conn.
W. J. Campbell	Syracuse University, Cohoes, N.Y.

The purpose of the competition was to turn the attention of engineering students to street and road construction as a promising field of work. The company offering the prizes believes that the plan was successful in this direction.

The Mobile and Ohio Railway Company is preparing to erect a bridge across the Ohio river at Cairo at a cost of $5,000,000.

MODERN CONCRETE WORK WITHOUT FORMS.*

By James E. Payne, Assoc.M.Am.Soc.C.E.

THE art of building concrete roofs, walls and floors without forms and with fewer shores and temporary supports than has been customary is still in its infancy. In the past few years there have been a large number of roofs and floors built using for forms and reinforcement some one of the many types of ribbed metals now on the market. As the cost of wood for form work is steadily increasing and the cost of steel is decreasing, we may look for rapid developments along this line.

These ribbed metals can be divided into two general classes, those that are expanded between the ribs and those that are merely stamped, cut or bent. The expanded ribbed metal sheets which we will consider first are made in widths of from 10½ to 28 inches and in lengths up to 12 feet. The ribs are spaced from about 3 to 7 inches apart and are from ¾-inch to 1½-inch in depth. The metal used is what is known to the sheet mills as soft open heart steel and has an elastic limit before working of 30,000 to 40,000 pounds per square inch.

As these ribbed expanded metals not only act as reinforcement, but take the place of the wood forms, in a cost comparison to determine which is cheaper, ribbed expanded metal or wood forms and wire mesh, the increasing cost of lumber is a big factor. This point, coupled with a stationary or falling steel market, is one reason why ribbed expanded metal slabs have grown so popular the last few years.

Another reason is the time saved in the erection and as wood forms are not needed, several floors can be placed and poured at the same time which is usually a costly method when a complete set of wood forms are used for each of several floors.

The saving in cost by using ribbed expanded metals for roof work is still greater than for floors as the complete cost of the wood framework for a roof frequently has to be charged up to the roof alone and it cannot be distributed over several floors. Roofs are built by laying these sheets on top of the purlins, lapping about 2 inches over the supports. The sheets are held down by clips fastened over every third or fourth rib and the side ribs of the sheets are fitted one over the other and punched together, making the roof a monolithic slab. Some of these sheets are stiff enough to carry 2 inches of concrete without any vibration for spans up to 4 feet, but with spans above that, one and sometimes two temporary supports are needed. These temporary supports are built by hanging a 2 x 6 or 8 across the under side of the purlins held up by wire slings wrapped around the purlins, or wedged up on the lower flange where I-beams are used. These cross pieces held up one or two planks on edge which stiffen the metal while the concrete is being poured and while it sets. This is essentially a short span light load system and 14 feet is the maximum span, with the most economical span between 6 and 8 feet. For a span of 7 feet, No. 24 or No. 26 gauge sheets with 2 inches of concrete on top with ½-inch of cement between 15 and 20 cents per square foot, exclusive of structural steel and waterproofing. As floors are usually thicker than roofs, the cost increases proportionally.

The concrete is specified to be made of a 1:2:4 mix with stone or gravel to pass a ½-inch ring with the dust

*Abstract of a paper read before the 10th annual meeting of the American Concrete Institute.

screened out, but is usually made according to the accepted standards for concrete work in that locality. When the concrete has set enough to carry itself the wires are cut and the supports dropped, leaving the under surface of the slab ready for plaster. These temporary supports seldom cost more than 1 cent per square foot, including lumber-placing and removing. The plaster used is a cement plaster mixed about 1 to 2½ with a small amount of hair and only enough lime (not more than 5 per cent. of the volume of cement and sand) to make the cement work easily under the plasterer's trowel. For factory buildings this finish is sometimes floated, but for offices, hospitals, hotels, etc., the white coat is frequently added. The trouble of making the plaster stick to a reinforced concrete slab, usually experienced, cannot occur with ribbed expanded metals because the concrete projects through the mesh to some extent and that with the mesh formation makes an excellent key for the plaster.

Usually the first question asked by a stranger to this material is, "How do you keep the concrete from running through?" This is a natural question considering the care taken to make wood forms water-tight, but the concrete used with open mesh ribbed expanded metal is dryer than that used with wood forms. The mix is sometimes known as a quaking mixture and when dumped from a barrow tends to stay where dumped and is spread with a shovel or hoe. The material that drips through the mesh is principally water and contains very little cement. In a factory building erected this summer in Youngstown, 290 feet long, the contractors sprinkled sand on the finished cement floor below the roof, and as the roof was poured a man below shoveled up the sand and carted it out. The drip from the roof was not enough to set up the sand. It seems as if the mesh curls the mortar around itself something like the way metal lath does with plaster. In a test conducted recently to determine the amount of loss through dripping it was shown that the loss amounts to from 36 ozs. to 80 ozs. from an area of 3½ sq. ft. In percentage, this ranges from 2.6 to 4.3 per cent. loss, depending on the style of mesh between the ribs.

One of the most important advantages of using these steel sheets for combined forms and reinforcing, is that there is no waiting for the removal of forms from one floor to start the construction of another, and the delay in pouring concrete, occasioned by the time taken to place and wire the reinforcement, is saved entirely, as the concrete is poured as soon as the expanded metal forms are in place.

In the Youngstown City Hall having 6 floors—an attic and roof—all the sheets were placed and floors poured in 30 days, an average of less than 4 days to a floor. This is an important matter on penalty jobs, and also in the fall, in order to get the roof on before the snow flies. Scarcely a month goes by without the newspapers reporting a failure in reinforced concrete somewhere in this country and in practically all of these cases, the too early removal of forms is a contributing cause, if not the sole reason for the collapse. This great danger is eliminated by using materials that combine the two functions of forms and reinforcement. Another use for ribbed expanded metal is in the construction of inclined slabs. They have been built having an angle of as much as 60 per cent. from the horizontal. Formerly to build a slab like that, it was necessary to have forms on both sides. By using a dry mix and running the ribs in a horizontal direction each rib acts as a baffle to prevent the concrete from sliding down the slope. The roof over the new hotel of the Union Stock Yards and Transit Co., in Chicago, is an example of this kind.

It sometimes happens that ribbed expanded metals are used for forms only—and no attention is paid to the reinforcing value. In the roof over the Washington Theatre in Detroit, the cost of erecting and removing wood forms would have been very high as the roof was 50 or 60 feet above the pit. Ribbed expanded metal was used on top of the purlins and rod reinforcement placed above the metal. The concrete was poured and the under surface left unplastered. To plaster the underside of that roof, scaffolds would have been hung from the roof beams or built up from below at the time the roof was poured or shortly afterward. The cost of the additional reinforcement of rods was much less than the cost of the other alternative which necessitated the scaffold remaining in place several weeks or possibly months waiting for the building to reach a condition which would permit the use of the scaffold by the ornamental plasterer.

For large areas the objection has sometimes been made that these materials could not be used in connection with the gravity system of distributing concrete, because of the large amount of water needed to properly work the gravity system, and consequently the large loss through the expanded section of the mesh. For example, a roof 100 feet square needs theoretically 61.7 yards of concrete for a roof 2 inches thick. With 5 per cent. loss through the mesh, we would lose 3 yards of concrete, which at $6.50 per yard amounts to $19.50. Probably a fair average of saving secured by using the gravity system over wheelbarrows and dumpboards is 75 cents per yard, or a saving in this roof of $46. These figures show the falsity of the idea entertained by some engineers that the gravity system must be discarded if ribbed expanded metals are used as forms.

The above remarks have referred entirely to flat sheets, but the use of curved sheets is almost as large. It frequently happens that a curved or arched floor is wanted, but heretofore it has been almost prohibitive because of the excessive cost of labor in making arched or semi-circular forms. By arching these sheets and resting the ends on the lower flanges of the steel beam or on the wood sides, or bottom of the beam box, the sheets take the place of curved forms and also stiffen the concrete in the arch. These arched floors are quite popular in breweries and also other warehouses where heavy loads are liable to be applied. They are also well fitted for highway bridges.

In the Buhl Country Club at Sharon, Pa., the beams were 8 feet 8 inches apart and 24 gauge curved sheets were placed resting on the lower flanges of the I-beams. The rise of the arch was 16 inches and the concrete was poured with no temporary supports. This system is well fitted for cases where the under surface is difficult of access, as the concrete arch carries the load, the steel sheets acting only as permanent forms, and also for cases where heavy loads will be carried.

Cement non-bearing partitions are erected more cheaply by plastering cement mortar on ribbed expanded metal than by a double wall of wood forms with poured concrete between. The time lost in waiting between the time of removal of the wood forms in one place and their erection in another is saved completely as the sheets are ready to be plastered as soon as erected. Almost all competing fireproof partitions are at least 4 inches thick when finished, some as much as 6 inches. Solid plastered partitions are only 2 inches thick, which means that every lineal yard of partition erected adds a square foot to the floor space. When made of cement, these 2-inch solid partitions are as fireproof, if not more so, than any other partition in common use.

In Cleveland, at the laboratories of the Associated Metal Lath Manufacturers, a 2-inch solid partition 7 feet wide by 9 feet high was built plastered on ribbed expanded metal. On November 20, 1912, it was tested, the fire burning for two hours with a temperature averaging 1,849 degrees after the first half hour. While the partition showed some deflection toward the fire, and a number of cracks on the side away from the fire, no smoke came through and when the panel was swung open, there were but two small cracks on the side exposed to the fire. Water at Cleveland city pressure was then turned on for 2½ minutes, and while sections of plaster were washed off on the fire side, the water did not go through the partition, and it was evident that a new coat of plaster was the only thing needed to render it as fire proof as ever.

Twenty-eight gauge sheets and 2 inches of solid cement plaster has proven entirely satisfactory for interior partitions up to 12 feet high and 26-gauge sheets and 2½-inch of concrete for partitions up to 17 feet. The sheets are fastened to the floor and ceiling with a runner bar or angle which has been previously placed and lined up, the sheets being wired or clamped to the angle. 2 x 4 temporary stiffeners are wired to one side of the sheets about 4 feet apart, and are then braced back to the floor. When the opposite side is scratched in, the supports are removed and that side of the partition is plastered. The baseboard chair rail and picture mold are nailed into small blocks which are wired to the steel between the ribs at intervals and used to hold the grounds.

Some of these metals are made in such a way so that a ¾-inch electric conduit fits in between the ribs and is imbedded in the plaster. The metal is cut away as much as necessary to allow the outlet box to be placed. The average cost is between $1.25 and $1.75 per square yard complete in the populous sections of the country and we find this coat is usually less than the cost of burned clay tile partitions.

Probably the least expensive silo of all the fireproof silos now on the market can be constructed of ribbed expanded metals plastered with cement. The sheets are curved at the factory and temporarily held in place by wood uprights on one side which are removed as soon as the scratch coat hardens. By punching the ends of the ribs together so that the joint is as strong as the rib, and lapping the ends enough to develop the full strength of the mesh, the steel sheets have sufficient sectional area to resist the bursting pressure developed by the ensilage. This same method is used for small water tanks, but for larger tanks, it has been found that a better job is secured by building two walls of curved ribbed expanded metal, and pouring between with concrete. In this way, enough additional reinforcing can be introduced to take up the stress over and above those taken care of by the ribbed metal.

Floor and roof slabs are designed according to accepted engineering practice, except that they are usually considered to be simply supported at the ends and are not reinforced against negative bending stresses over the supports. A test was made on October 26, 1912, under the control of the Cleveland Building Department, on two spans of six feet each. This test was expected to prove that the accepted methods of design could be applied to slabs reinforced with sheet metal of certain patterns. Slab No. 1 was 2 inches thick and designed to carry a working load of 126 pounds. When loaded to 2½ times that, or 329 pounds per square foot, the deflection was .16 of an inch, which increased to .20, 24 hours later. Slab No. 2 was 2½ inches thick and designed for a working load of 156 pounds. Its deflection at 2½ times that was .16 of an inch, and .20, 24 hours later.

In a sheet of No. 24 gauge expanded ribbed metal, the surface of steel in contact with the concrete is about five times the surface of a round bar of equal cross-sectional area. In ordinary bar and slab construction where the bond stress on the bars seldom equal 125 pounds per square inch, the bond stress in the ribbed metal would be only 25 pounds per square inch of surface. This low bond stress is taken advantage of, by shipping painted sheets instead of plain, which prevents incidental rust during transportation. The expanded section of the street is also gripped by the concrete so practically all sides of the metal in the mesh is covered and this will reduce the bond stress still lower than 25 pounds per square inch. Numerous attempts have been made to increase the efficiency of those different metals by the spacing and height of the ribs and also changing the type of mesh between the ribs. It will readily be seen that to increase the depth of the ribs is to stiffen the sheet so the temporary supports can be spaced further apart, but when the ribs are made deeper, the centre of gravity of the steel is raised, requiring an increased thickness of the concrete slab, and the saving in the cost of temporary supports is more than offset by the additional concrete required. In conclusion, it appears that the high quality of this type of construction, with its low cost coupled with the fact that the features of design are so simple and sure, would warrant the careful consideration of all engineers and architects.

Indications seem to be that the Alberta Clay Products Company of Medicine Hat, will manufacture its brick, tile, sewer pipe, and other clay products in Saskatchewan as soon as natural gas has been found and can be the means of furnishing cheap power. This company secured the material for the manufacture of its products in Saskatchewan, though its plant is now located at Medicine Hat, where the natural gas affords cheap power for its operation.

On July 8, the new docks at Hull, England, were opened by King George. These have been constructed by the North-Eastern, Hull, and Barnsley Railway companies of Hull. This port was already third largest in the United Kingdom, and now has 11 docks with a water area of 211 acres. The quays have a length of 8,162 feet. There are 154 cranes, with a maximum lifting capacity of 100 tons, 34 coaling appliances, with a total rate of shipment of 9,980 tons an hour, and 57 warehouses having a combined storage capacity of 211,150 tons.

A report from Adelaide, South Australia, gives the following account of railway construction upon that island. Tenders for the construction of the railway from Karoonda to Peebinga were received by the South Australian government a short time ago. This is the last of the four new lines which were initiated by the government for the purpose of serving the River Murray lands in South Australia. The only other one not finished in this country is that to Wailerie, an irrigation settlement on the river, but that line is nearly completed and will be opened for traffic shortly. The two lines already working are those from Brown's Well to Parings, near the Renmark irrigation settlement, and the Railway from Alawoona to Loxton. The length of the line for which tenders have now been received will be 69 miles, and its estimated cost is $263,000. The area which will be served by the four railways when completed totals 3,113,000 acres, and the lines have been planned so that no settler in this large stretch of country will be outside a convenient distance from a railway. Good progress is also being made with the new railways authorized by Parliament to be built on Eyre's peninsula which should result in the successful cultivation of many thousands of acres. Near the capital the line to Willunga, designed to serve an old-settled district, is now being worked as far as Brighton, and it is anticipated that the whole length will be open for traffic before the end of the present year.

THE USE OF TURNED SECTIONS IN TENSION TESTS OF REINFORCING BARS.*

By E. P. Withrow and L. C. Niedner.

IN conducting tests on reinforcing bars at the Municipal Testing Laboratory of St. Louis, our attention has frequently been drawn to the increase in the values of yield point and ultimate strength, caused by the removal of material in machined test specimens. Our experience has shown that in any one type of deformed bar, this increase exists as a variable quantity, the percentage increase often reaching an amount many times greater than the percentage of material contained in the deformations. This phenomenon was found to occur in "constant-section" deformed bars, and even in plain bars.

Since the standard specifications of the American Society for Testing Materials for billet-steel concrete reinforcement bars permit the use of turned test specimens of deformed bars, it is thought desirable to submit certain facts for consideration. It will be noted that the greater portion of the data has been taken from tests on a certain type of "constant-section" bar. The manufacturer's claim for the "constancy of section" of this bar has been practically substantiated by this laboratory, by comparing the elastic moduli of the bar before and after the removal of the deformations. In the computation of these moduli from their respective stress-deformation ratios, the areas of the rough bar was computed from its entire weight per foot, while in the case of the machined bar, its calipered section was used. The tests referred to cover several sizes of both round and square bars, and show an agreement well within 0.5 per cent.

In the study of the phenomenon under consideration several factors were suggested as possibly contributory. The effect of grips, the reinforcing action of large ends, and the effect of non-uniformity of steel due to segregation were among them.

Still another factor, namely, rate of application of load, could not be neglected, because working conditions in most laboratories will introduce it secondarily when reduced area specimens are tested. This factor can cause a variation of indicated yield point and ultimate strength of 1 or 2 per cent. As this amount is of the same magnitude as the percentage of steel in some types of deformations, it should not be neglected.

Many testing machines have only one motor speed with three or four speeds of pulling-heads obtained by gear shifts. One of these is usually the most convenient and is used for this purpose in testing specimens of all sizes. It has been our experience that in the case of turned specimens, if the speed of pulling-head is unchanged, the rate of application of unit stress may be increased to two or three times that found in testing the rough bar. There exists, with good lubrication, a slipping of the grips in the pulling-heads as the load increases. This is equal to the product of the wedge ratio and the approach of the jaw surfaces as they take hold of the bar, and is, in general, a function of the total load. If the bar does not slip in the grips, the rate of elongation is, therefore, the rate of separation of heads minus a function of the total load.

From the data given by Campbell in his "Structural Steel" an increase of 100 per cent. in the speed of the pulling-head could cause an increase of 1 or 2 per cent. in yield point. In this reference the term "elastic limit" has been used, although the tabulated values are yield points. As this gives the speeds of pulling-heads, it is impossible to estimate the corresponding rates of application of load. For reasons previously given, this would be different for each machine and size of bar. In Fig. 1 is shown the effect of varying rates of loading, using a ¾-in. round bar. Each point represents the average of three or four tests. The highest speed shown is below that at which inertia and error of observation could enter to any great extent.

Therefore, the average rate of application of stress has been kept constant up to the yield point in each series of tests. The differences are, therefore, somewhat smaller than those which would be reported for the same material if tested in the usual manner. Owing to the fact that this precaution was not observed in testing for the ultimate strength, the differences in ultimate strength may be too great by a small amount. This is probably not over 0.5 per cent., and is due to the change from 5,000 to 10,000 lbs. per sq. in. per minute, as may be seen from Fig. 1.

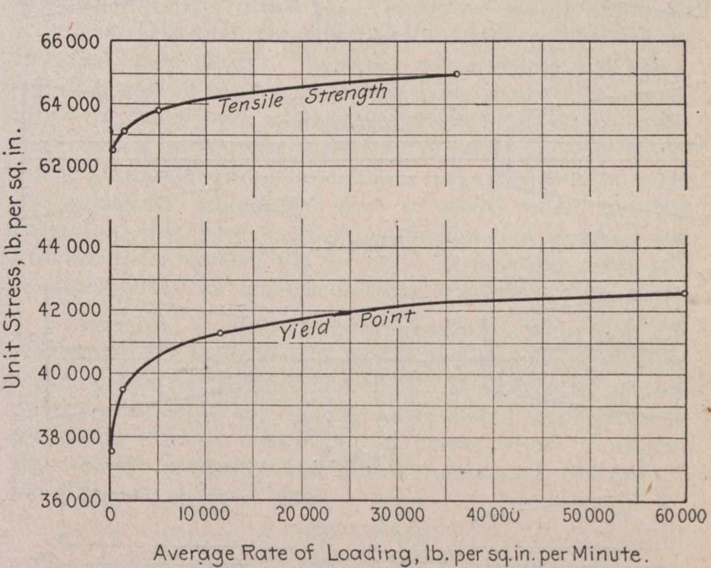

Fig. 1.—Effect of Varying Rates of Loading.

In a search for references giving comparisons of tests on machined and rolled sections, some data were found which seemed to neglect the influence of certain variables of such magnitude as would obscure the one sought for. As an example Campbell compares ¾-in. round bars with specimens made by turning ⅞-in. bars down to a ¾-in. diameter. Therefore, in the tests here described such methods were selected as would avoid the obscuring influences which destroy the value of much data of this nature.

The effect of the large ends of machined specimens could be either protection of the specimens, or reinforcing action. That the reinforcing action becomes negligible in its effect on the yield point, when the length exceeds the small diameter, has been shown by Johnson, "Materials of Construction," p. 513. As turned specimens used in the present investigation had a length about eighteen times the diameter, the only effect of large ends, if it existed, would be that of protection from the grips. The data exhibit no evidence of such protection.

To secure comparable data, several long bars were secured and from each were made various types of specimens. The different types are designated as Nos. 1, 2, 3, 4 and 5. The dimensions and method of gripping are shown in Fig. 2.

In the plain bar the yield points of types Nos. 3 and 4 agreed within about 0.5 per cent. As types Nos. 1 and 3 had received an equally severe treatment in the

* Extract of paper read before the Atlantic City convention of the American Society for Testing Materials.

grips, it was evident that the increase of the yield point of type No. 4 over type No. 1 was not due to the influence of large ends. It was seen also that type No. 3 of another bar, although badly crushed by the grips, showed a yield point 4.2 per cent. higher than that of type No. 1. It also showed an increase of 2.9 per cent. in the ultimate strength. In this bar the ultimate strength and yield point of types Nos. 1 and 2 were practically the same, although the specimens of type No. 2 were decidedly flattened by the grips.

On examination of the data from other bars, the behavior of the yield point of specimens embedded in concrete was found to agree closely with that of the same steel held in wedge grips. Owing to the impossibility of cutting many of these long specimens (type No. 5)

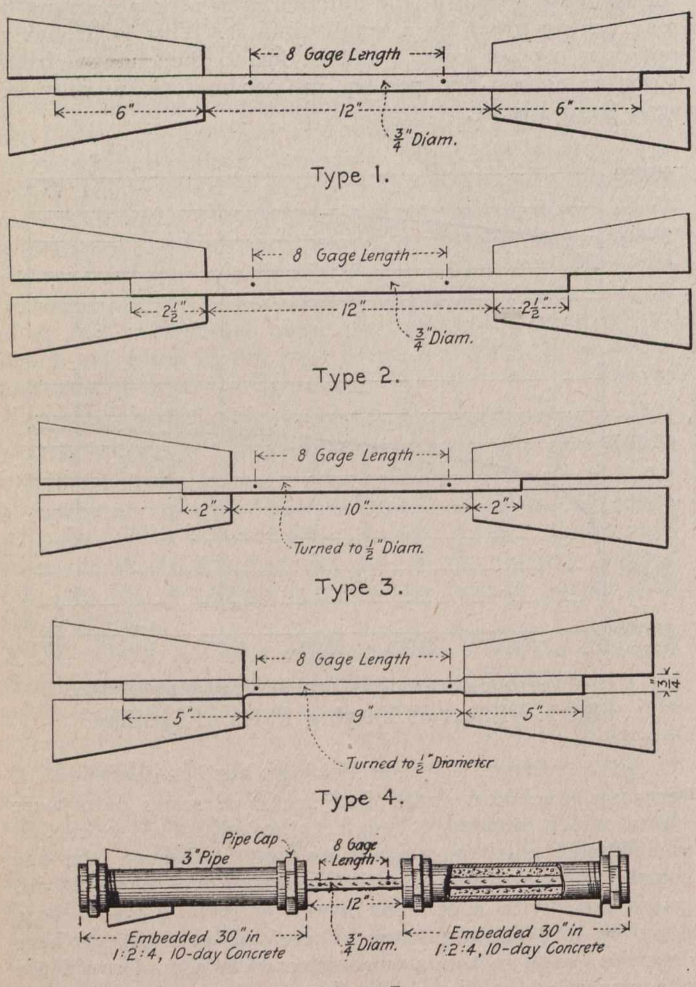

Fig. 2.—Types of Specimens.

from any one bar at our disposal, the following method of comparison was used:—

Bar No.	Percentage increase of Yield Point in concrete grips over that in wedge grips.	Number of specimens in concrete.	Number of specimens in wedge grips.
7	+ 1.5	3	7
4	— 1.1	2	4
6	— 0.5	3	6
Average	—.03		

In the investigation of the influence of grips, this method seems to effect the elimination of practically all other variables. Lack of time prevented a more extended study with type No. 5 of the effect of gripping. The ultimate strengths of specimens of type No. 5 cannot be compared with those of type No. 1, because the elongation and slip in the concrete grips after the yield point was passed made the rate of application of load uncertain. This was in evidence to such an extent that the intention of keeping it near that of type No. 1 was abandoned, and the bars were broken at a high speed. The comparison of ultimate strengths offers little interest at this point, because the soft grade of steel used showed fracture near the central portion in nearly all cases.

The appearance of a 1-in. plain, square bar, which was being examined microscopically, suggested non-uniformity of metal as one of the causes contributing to the raising of the elastic limit by machining specimens. There was a decided segregation of pearlite in the centre as well as a very marked change in the arrangement of grains in lines parallel to the axis of the bar. The macrograph of the entirely etched, longitudinal section showed the distribution and the axial arrangement of structure referred to.

The non-uniformity of steel probably offers the principal reason for the fact that most bars, plain and deformed, are known to show some increase when machined to a smaller diameter, and that this increase is known to be irregular in bars having the same kind of deformations. An examination of the photomicrographs of the specimens showed that in most cases there exists a difference in the structure of the central and marginal portions of the bars. The greatest uniformity was evident in bar No. 2. The turned sections of this bar showed the least increase of yield point and ultimate strength of any bar, about 2 per cent. and 1 per cent., respectively.

The effect of non-uniformity of structure was evidenced by bars Nos. 3 and 4. The yield points of the turned section of both of these bars showed practically the same increase—6.5 per cent. and 6.7 per cent., respectively—while the ultimate strengths are higher by 1.4 per cent. and 8.2 per cent., respectively. A marked segregation of pearlite in the centre of bar No. 4 probably explained this difference in ultimate strength.

That segregation exists over a large central portion of this bar was clearly shown. This was verified by chemical analysis on material from a 3/8-in. hole drilled axially, which analyzed 0.24 per cent. of carbon, as against 0.17 per cent. of carbon in a sample turned from the margin after the removal of mill scale and 1-32 in. of the metal. This observed difference in ultimate strength is not far from that which would be expected to accompany the difference in carbon content. Particular attention was paid to carbon because of the ease with which small variations in its distribution are detected by means of the microscope.

There has been no attempt to determine the magnitude of the effects on the physical properties caused by segregation of various elements. It has been shown, however, that large and variable differences may exist, and that these differences, probably due to non-uniformity of steel, may, even in a constant-section bar, be greater than the reduction of section due to the removal of inactive deformations.

Besides the effects of non-uniformity of chemical composition, non-uniformity of grain size and arrangement could have a marked effect on the physical properties. As the heat and mechanical treatment determine both the grain size and arrangement, and also, in a large measure, the yield point, an observed variation in one might be expected to accompany a difference in the other. Some of the photomicrographs, especially those of the longitudinal sections, show that the granular arrangement of the marginal and central portions differ greatly. This difference does not require the presence of decided segregation, as was seen in bar No. 3, where segregation was not evident, but where a more decided axial arrangement of grains in the central portion than in its margin was found. The observation of a much greater increase in the yield point than in the ultimate strength of this bar when turned sections are used, seems to point to the reason why this increase in turned sections is rarely the same in both yield point and ultimate strength.

TRACK CONSTRUCTION AND MAINTENANCE.*

By Martin Schreiber,
Engineer, Maintenance of Way, Public Service Railway.

EVERY railway company should have approved plans and specifications for all the different elements that make up track construction as well as proper organization. Beginning with the proper rail, we find this subject has been well covered by the American Electric Railway Engineering Association, for both high T and girder rail. An important work at the last convention at Atlantic City was the final development of standard girder rail for tangent and curved track in paved streets. The Lorain Steel Company has already prepared rolls for the new 7-in. rail recommended by the association and which will be known as Section 122 No. 467. Our modern present rails all conform in a way to the new design, as to their tendency to offset the gauge line to the centre of the web, thereby causing the rail to be better balanced when under influence of wheel loads. The principles for increasing the thickness of the web and depth of groove are apparent. The new standards are only four in number and it is the writer's firm opinion that we still will see a further reduction in the type of rail used on account of the tendency to eliminate the 9-in. rail.

As far as the composition of the rail is concerned, it is now recognized that the use of open-hearth steel is the best practice. The new standard specifications of the American Electric Railway Engineering Association, which have also been ratified by the American Society for Testing Materials, provide for two schedules for carbon content. Many engineers are now strongly endorsing the higher schedule for carbon, but it seems that when welded joints are used it is better practice to use .60% to .75% carbon content to prevent binding near the joint.

The subject of proper rail joints is one of the most difficult which we have to solve. Indeed, it has been the burning question of the past, but in the writer's judgment the joint question has been eliminated to a large degree by the success which we have obtained with the modern welded joints. Besides the straight welds, very good success has been obtained with certain combination welded and riveted joints, and now we have seen a new joint coming from Europe which consists of an ordinary plate electrically welded at the edges.

Sometimes electric railway engineers follow too closely the custom of the steam roads in the matter of rail fastenings. For example, some are now advocating the screw spike, instead of the cut spike. A little consideration, however, will show that the conditions of the electric railway are entirely different from those of the steam road. There is a vast difference between a 50-ton car operating on a street railway track, which is not only spiked down but also has a solid encasement of paving, and where you have a 200-ton locomotive operating over an exposed track.

*Abstract of address presented at regular monthly meeting of the New England Street Railway Club at Boston, Mass., on May 28, 1914.

Most electric railways now recognize the economy of using treated ties and other timber. For permanent track construction the 6-in. by 8-in. by 8-ft. yellow pine tie, treated with 10 lb. creosote oil per cu. ft., seems to cover the requirements very well, and ties so treated will probably last 25 years. If you consider the pressure treatment too expensive, at least a superficial treatment of some high-grade oil should be used.

The steel tie is a good competitor of the wood tie, except that it is more expensive. We must also recognize the cushion effect of the wood tie and the advantage of shifting and aligning the rail. A number of concrete ties have been introduced, but so far experience has not demonstrated their practicability.

A few years ago many street railway companies laid their tracks with concrete foundation. Now some of them are going back to broken stone, because they find broken stone ballast lasts about as well, is just as satisfactory and a good deal cheaper than concrete. Broken stone provides excellent drainage, is easier on rolling stock, as it is less rigid than the concrete foundation, and may be installed under traffic. Besides, any shifting and aligning of tracks in the future is less expensive where broken stone has been used. Although certain kinds of soil make it necessary to provide some sort of beam support to the track through the foundation, in a large majority of cases the sub-grade which has been properly rolled and has spread upon it good sharp stone ballast that is rolled and tamped under traffic, will provide a foundation which will be satisfactory for electric railway operation.

Municipal engineers now generally recognize the wisdom in the omission of any monolith paving next to the rail, such as concrete or asphalt. If a perfectly smooth pavement is required, it is better to install wood block in preference to any manufactured block, brick or others. But, for life of service and ultimate economy, the granite block seems to stand alone.

It has not been so long ago that it was considered by even high officials in the electric railway industry that any kind of equipment was good enough for track construction. It was not uncommon to see practically no accommodation for storage yards for shipping and receiving of materials, and old and dilapidated cars were reconstructed for work cars. Track work carried out under these conditions is bound to be a business failure, and it is far better to contract the track work out.

A canvas which the writer recently made has led him to believe that very few companies know just what track work is costing them. Seldom the cost for power, interest on equipment and overhead expenses are taken into consideration, and these items should be, if you compare what the work is costing with what actual moneys a contractor would require to produce it.

Assuming that you have proper specifications and organization, along with right facilities to execute track construction, in order to get the best product for the expenditure you are making, careful inspection is a necessity. Many roads to-day are doing the work and only give the material a "once over," and are hiding behind the illusion that they are saving money. All track materials should be carefully inspected, not only the rail but joints, tie plates, track bolts, tie rods, track spikes, cement and paving materials.

From experience, the writer does not see any grounds for contention that the solid manganese is not superior to manganese inserts, if it is properly applied. Undoubtedly it does not pay to buy solid manganese at a possible 30%

increase in price over the manganese inserts, if traffic does not demand it. Besides, a great deal of solid manganese which has been cited as not altogether coming up to expectations (as we have in Chicago) was the crop of the first experiments. Now we have the pieces made up in sections, instead of the tendency toward an all-unit casting, so that if a part fails it is not always required to throw away the entire piece. In the city of Newark, at Broad and Market Streets, we have one of the busiest electric railway crossings in the country. Approximately 5,000 30-ton cars pass over this intersection every 24 hours. Previously insert crossings were good at this location for 16 to 20 months. The first solid manganese crossing which was installed stood approximately three and one-half years. I leave it to you if there is any economy in the solid manganese crossing at a cost of approximately 30% over the insert crossing. The writer has found that a very economical construction for steam road crossing is to use the old bolted type with solid manganese running and bearing rails. This crossing has an advantage of being cheap, easy to repair under operation, and still the most vulnerable point is of the best material that is known, inasmuch as the running and bearing rails in steam track are rolled manganese and here in the old type breaks generally occur.

Another important consideration in connection with special work design, which I would like to call your attention to, is the way the engineer is called on now to work on account of the varying equipment design. First, you have the city and interurban flanges; second, old and new cars with wheel bases from 4 to 6 ft., and third, steel wheels. An ideal curve design would be one which would be traversed only by cars with the same size wheel flange and the same wheel base. The proper groove of the curve is a function of the contour of the flange, length of the wheel base and the radii of curves. Theoretically every time you change the radius of a curve and the size of the wheel flange, or the length of the wheel base, the design of the groove in the curve should be altered to suit. Again, most of our special work to-day is designed for flange bearing, and it is not possible to properly design special work for two depths of flanges, still we are constantly called on to provide special work to take both city and interurban cars that have two types of flanges. It is easily seen that with special work designed for ¾-in. flange, the ⅞-in. flange cuts out the floor of your frogs, switches and mates. On the other hand, if you design the special work for ⅞-in. flange and operate ¾-in. depth flange on it, the wheel treads are pounding and destroying the points in frogs, switches and mates.

COMPARATIVE STRENGTHS OF BLASTING EXPLOSIVES.

IN the course of its investigations of blasting explosives, the U.S. Bureau of Mines made tests to determine the potential energy, the disruptive effect and the propulsive effect of some of the explosives in common use. The potential energy was measured by means of the bomb calorimeter in water. The disruptive effect was measured, using the Mettegang recorder, detonating fuse, Trauzl lead blocks and small lead blocks. The propulsive effect was measured in the Bichel pressure gauge and by means of the ballistic pendulum. The tabulated results are given herewith, together with the approximate composition of typical examples of the various explosives. The percentages figured are rated against the effect of 40% straight nitroglycerine dynamite taken at 100%.

The figures are fairly consistent with general practice, and it is believed that the classification will serve as a useful guide for comparing the practical value of explosives. It is worthy of note that the potential energy of 40% strength ammonia dynamite and of 40% strength gelatine dynamite, that is, the theoretical maximum work that these explosives can accomplish, is higher than that of 40% straight nitroglycerine dynamite, but that the disruptive and propulsive effects, which represent the useful work done as shown by actual tests, are less. Accordingly, straight nitroglycerine dynamite is more economical for general use in blasting operations if the conditions and character of the work are such as to permit its use; nevertheless, the ammonia dynamite and the gelatine dynamite are more efficient and economical for certain kinds of work that require explosives having a large propulsive effect and a comparatively small disruptive effect. For example, in blasting soft rock, 40% straight nitroglycerine dynamite, which has a very high percussive force, may be too quick in action, whereas the ammonia dynamite or the gelatine dynamite having practically the same heaving and pushing action and less percussive force will be more suitable. The tests also show that 60% strength low-freezing dynamite is not quite equivalent to the 40% straight nitroglycerine dynamite. It is worthy of note that black blasting powder has little disruptive effect, only about one-third that of granulated nitroglycerine powder.

Typical Analyses and Strengths of Common Blasting Explosives.

	Percentage Composition									Percentage Strength		
	Nitro-glycerine	Combustible Material	$NaNO_3$	ZnO $CaCO_3$ $MgCO_3$	Nitro-substitution Compounds	NH_4NO_3	Nitro-cellulose	S	C	Potential Energy	Disruptive Effect	Propulsive Effect
Dynamite:												
Straight nitroglycerine, 30%	30	*a*17	52	1	..	..	..	..	..	93.1	84.1	96.8
Straight nitroglycerine, 40%	40	*b*15	44	1	..	..	..	..	..	100.0	100.0	100.0
Straight nitroglycerine, 50%	50	*b*14	35	1	..	..	..	..	..	111.0	109.2	107.4
Straight nitroglycerine, 60%	60	*b*16	23	1	..	..	..	..	..	104.0	119.8	114.9
Low-freezing, 40%	30	*b*15	44	1	10	..	..	..	..	.....	.....	.....
Low-freezing, 60%	45	*b*16	23	1	15	..	..	..	..	60.2	93.5	91.2
Ammonia, 40%	22	*a*15	42	1	..	20	..	..	..	101.8	67.9	99.1
Gelatine, 40%	33	*a*13	52	1	..	..	1	..	..	105.7	78.4	95.8
Powder:												
Granulated nitroglycerine, 5%	5	*c*35	60	..	..	..	..	..	..	67.6	21.6	53.3
Black blasting	..	...	73	..	..	..	..	11	16	71.6	6.8	58.6

a Wood pulp, flour and sulphur.
b Wood pulp only.
c Sulphur, coal and resin.

LOGGING FLUME CONSTRUCTION.

IN a bulletin, entitled "Flumes and Fluming," issued by the United States Department of Agriculture, the use of flumes in lumbering operations is discussed, with instructions concerning their construction, and some valuable data concerning volume, velocity, etc., of water to use in different sized flumes.

Of the two types in general use the V-shaped flume has proved more satisfactory, both in cost of construction and efficiency of operation, than the box or square, upright-sided flume.

The square flume is usually constructed along the general lines of the well-known mill flume or artificial conduit used to convey water from the mill pond to the mill for water-power or other purposes, but with this difference, that the uprights on the sides of the square or box timber flume are rarely braced across the top of the flume, but instead the top of the flume is left open to afford free passage for logs, wood, or lumber, and the sides are held in place by uprights fastened on the sills or crosspieces on which the bottom of the flume rests, and braced from the outside.

This is the oldest type of wooden flume in use, and is employed to some extent at the present time where economy in the use of water is not of any particular importance. However, the square flume requires more water to operate successfully with the same class of material, and, generally speaking, requires more lumber for construction than does the V-shaped flume. Furthermore, the material being handled is more apt to "jam" (especially the short material) in the square-box type. Owing to the form of its construction there are more joints in this type that are liable to open up and cause "leakage," in case the flume is allowed to stand without water running in it for any length of time, and, except where it is desired to combine in one flume the two objects of carrying a large amount of water to be used for some purpose other than fluming below and at the same time to use the flume for the transportation of lumber or timber, it is generally more advisable to use the type of flume which requires the least amount of water and the least average amount of repair. Up to the present that is the V-shaped wooden flume, but it is, perhaps, not a flight of fancy to predict that it is only a question of time when strong and light "sectional" metal flumes, semicircular in form, that can be quickly taken apart and transported from one point to another and put together and set up again, will be in common use. Metal semicircular conduits, made in sections and easily put together, have already been used in hydroelectric and irrigation projects.

The V-shaped flume is at present the type of flume most generally used in the western portion of the United States, and it has given the most general satisfaction for the transportation of manufactured lumber or timber in its different forms of logs, railroad cross-ties, cordwood, etc.

Some of the salient points in which the V-shaped flume excels are:—

(1) It can be successfully operated with a less volume of water than any other type, since, owing to the V form of construction, the water is always held confined or "compact," and, therefore, has the greatest carrying power for the amount used.

(2) There is less likelihood of jams forming, since the narrowness of the flume prevents the material from getting partially crosswise and forming a "brace," through the ends "wedging" or pressing against the sides of the flume. This is a feature especially desirable when handling short material. The narrow formation of the V-shaped flume keeps the timber running "straight," and according as the volume of water in the flume is reduced the formation of the V keeps the water confined in the smallest possible triangle down which the sides of the flume compel the material to travel.

(3) In fluming logs or round timbers the rounded portion of the log settles well down into the V. The water thus confined between the bottom of the stick and the sides of the V constantly tends to lift the log, and this keeps the stick from settling down or rubbing hard against the sides of the flume. In a square flume, on the other hand, the same amount of water could run on both sides of the log and not beneath and would so lose the tendency to "lift" through lack of proper confinement.

Thus if a log or stick of timber is large and heavy, it may sometimes nearly fill the V-shaped flume and occasionally touch both sides. But whenever this occurs the log has the pressure of the full volume of water which the flume can carry backed up behind it to force it along, and the V formation keeps the stick running "straight ahead," so that there is very little opportunity for the water to spread out or run around or get by the stick without taking it along with it. Its transportation is further aided by the uplift of the partially confined water, running around and under it, that is trying to find an outlet or relief from the pressure of the water behind, which must either aid in forcing the stick along or run over the top of the flume.

(4) In cases where it is necessary to have an unusually abrupt descent in some portions of the grade, the V-shaped flume is best adapted to serve as a "slide," or "slip," or "chute," since it is less likely to become jammed, while the material being handled is held by its own weight in proper position in the centre of the V. In a great many localities this particular feature of control of the log or stick of timber when it is "coasting" will be found very necessary in handling material from the higher mountain slopes, especially in places where it is impossible to maintain a steady and equable grade from the top to the bottom of the mountain without too great expense, and where it may be necessary to have a form of construction that will carry logs or timber safely for a long distance when the grade is so abrupt that it is impossible to maintain a sufficient volume of water in the flume to prevent the material from rubbing or sliding along on the sides and bottom. In such localities and under such conditions the V-shaped flume, when strongly constructed so as to combine both the objects of flume and chute, has been and will be found altogether the most desirable.

In the construction of flume sections angles of from 70 to 110° have been tried; but the consensus of opinion favors 90°. Construction methods are dependent upon the kind of material to be handled. The sections vary in length from 6 to 20 ft. Sometimes only one thickness of board is used, but more often two thicknesses are employed, with joints broken or staggered. The details of the box construction is largely a matter of individual opinion. The aim almost always is to keep down leakage.

A triangular section of wood, sawed to fit snugly into the bottom of the V on the inside in sometimes employed for purposes of reducing the amount of water necessary and strengthening the flume itself. The value of this measure is, however, disputed on the ground of too great cost.

Size of Flume.—The kind of material to be handled is a prime factor in determining the size of a flume. If a 30-inch V-shaped flume would satisfactorily handle the material, there would be nothing gained by going to the extra expense of constructing a flume with a V of 48 inches. On the other hand, it is always good policy to construct a flume large enough to carry sufficient water to handle the material desired with certainty and dispatch. For railroad cross-ties, cants, poles, cordwood, etc., the 30-inch flume is usually large enough, wherever there is a sufficient volume of water available to fill the flume two-thirds full, while for the handling of logs, piling, long timbers, or "brailed" sawed lumber it is usually advisable to have the flume constructed with the sides of the V from 40 to 60 inches in height, according to the volume of water available and the size of the material to be handled. This is also a feature in flume construction in which the prospective operator can save money by not constructing his flume larger or in any more expensive form than is actually needed, since every additional inch in height means the use of more lumber in construction, and is consequently an added and unnecessary cost.

Grades.—The matter of grade in flume construction is one of great importance. Flume operators have found the question of satisfactory grade to be one of the most important features of successfully fluming material, since where there is a stretch of comparatively flat grade the supply of water may be ample to nearly fill the flume, but upon arrival at a point in the flume line where the descent is very abrupt, the accelerated speed of the water reduces its volume to a small amount in the bottom of the flume, and, consequently, results in the flumed material "rubbing" or "sliding" down the descent for a long distance on the sides of the V. Such action wears out the lining very rapidly, necessitates its being frequently renewed, and produces a dangerous condition through the liability of the material to jam and pile up, and either be thrown out of the flume or break it down as a result of the increased weight.

In general, the lowest grade that is considered satisfactory for successful operation is approximately 1 per cent., or 1 foot in 100 feet, but it is better to maintain a grade of from 2 to 5 per cent. when possible. The maximum grade that can be used runs up to a very high pitch; some flumes have been successfully operated for a short distance at a grade of 30°, but such a steep grade is very undesirable, as it is usually impossible to maintain a sufficient volume of water in the flume. The most satisfactory results in fluming will be obtained at from 2 to 10 per cent. grade, and it should be held below 15 per cent. whenever possible.

Curves.—In the location of a flume line, for obvious reasons a sharp curve is inadvisable. It throws the weight of the material and water to the outside of the curve, with a tendency toward jamming. The degree of curvature should be kept as low as practicable, and should rarely be permitted to exceed 20°. Shorter "boxes" and the closer spacing of supporting bents, arms and bracing are very necessary in sharp curves.

Feeders.—Feeders constructed at various points along the line are necessary in order to maintain the requisite amount of water on different grades.

A Glasgow, Scotland, publication announces that the select committee of the House of Lords has passed the bill promoted by the corporation of Glasgow with reference to the building of a new bridge over the Clyde, at Glasgow, between Oswald Street on the north side of the river and Commerce Street on the south. The new bridge, with the necessary alterations to provide a suitable approach to it, will cost about £300,000. The bill permitting the bridge to be built will be proceeded with, subject to certain restrictions. A delay of 1½ years has been added to the five years in the original proposal.

PROPOSED RAILWAY VIADUCT, TORONTO.

By W. H. B.

Is the proposed railway viaduct along the Toronto waterfront a mistake? In 1907 the city had an investigation and report made by Wm. Barclay Parsons, of New York, an engineer of international reputation, Chief Engineer of Subways in New York, etc., and the late Cecil B. Smith, who also was a well-qualified and experienced engineer, acting with Mr. Rust, the City Engineer, on the general question of traffic facilities along the entire front of the city.

The main feature of this report was the consideration of elimination of level crossings, particularly along the central part of the city. Two schemes of doing this were worked out and considered in all their bearings:—

Scheme 1. Elevating the tracks.

Scheme 2. Placing the streets on overhead bridges.

As to elevating the tracks, four main running tracks only were considered (the viaduct scheme as adopted), and not the great network and ramification of existing surface tracks. For operating surface tracks retained it had been proposed—not by the engineers making the report—in recognition of the great danger of running trains close to, and, therefore, obstructed by, the masonry of the viaduct, that shunting on these tracks be limited to the night hours, or that the shunting engines be preceded by a man on foot carrying a flag—a rather fatuous scheme for handling the traffic on the numerous private sidings to shops and warehouses and the harbor traffic of a city of 500,000 population.

Summarizing, the report gave for Scheme 1:—

Advantages:—

Every street would be carried through to the waterfront at its existing elevation.

Disadvantages:—

First—The raising of the station would place the tracks westerly of it at such a height as to require the abolition of the John Street bridge.

Second—The existing freight yards would have to be reconstructed.

Third—The shifting and delivery facilities on the Esplanade would have to be reduced.

Fourth—Crossings of the shifting tracks on the Esplanade would still remain.

Fifth—Greater cost.

For Scheme 2:—

Advantages:—

First—No interference with existing tracks.

Second—Delivery facilities on the Esplanade could be increased.

Third—A lower cost.

Fourth—Better appearance to persons approaching from the water.

Disadvantages:—

That some streets would be cut off before reaching the water.

Scheme 2 is elimination of level crossings; Scheme 1 is not. In fact, with the inevitable growth and further ramifications of local distributing tracks as business and consequent traffic increase the expected relief by a viaduct eliminating the four main running tracks only will be found to be largely visionary. The report strongly advocates Scheme 2, the retention of steam railway tracks on the surface and the placing of street lines on overhead bridges as the only practicable elimination of level crossings at this location.

The city report as printed is accompanied by a report on the same question made to the Toronto Board of Trade by the late R. M. Berrian, who was a well-known Boston engineer, and by J. W. Moyes. This report advocates the viaduct as against street bridges.

For some reason not clear the viaduct scheme found popular favor, was loudly acclaimed by the daily papers without thought of technical analysis of the situation, and was adopted.

Several features not considered in either report are pertinent to this inquiry.

Traverse by street cars along the passenger landings, which, though numerous, are practically all along a short section of the waterfront, during the season of navigation at least, is an urgent requirement, and a car line will in any event be wanted along the new harbor street, outside of the railways, shown in the Waterfront Development plans (1912) of the Toronto Harbor Commissioners. Tracks for such cars would have to cross the remaining surface steam railway tracks at grade. The required protection by interlocking derails and signals at such complicated level crossings would be intricate and costly, and a great hindrance to traffic.

The bridges to carry streets over railways contemplate the clearance of 22 ft. over top of rail, specified in the Dominion Railway Act of 1904. A statement of facts will be of interest in this connection. The Railway Age Gazette of Dec. 12, 1913, gives a tabulated "Resume of City Requirements for Grade Separation Work" for various States in the United States and for Canada. Clearance requirement for overhead bridges varies from 15 ft. to 22 ft., the latter the Canadian requirement, which is the highest of all. In the city of New York, where electric traction is used exclusively for railways, within the electric zone, extending beyond the city limits, the clearance requirement is 16 ft. 6 in.

The recently renewed Milwaukee Avenue and Desplaines Avenue double viaduct in Chicago traversing a trackage width of 460 ft. and crossing main tracks of the Chicago, Milwaukee and St. Paul, the Chicago and North Western and the Pennsylvania Railways, has clearance over top of rail of only 15½ ft.

In main line crossings over the Pennsylvania and other railways in Pittsburg, with all steam locomotive traction, bridges with clearance over top of rail as low as 17 ft. 2 in. have long been in use, and the same may be said of crossings in many cities in the United States.

Rolling stock and railway conditions generally are practically identical in the United States and Canada. In fact, rolling stock, which determines clearance requirement, is constantly interchanged.

With clearance of 17 ft., or even 18 ft., over top of rail, instead of 22 ft., the Toronto problem would assume an entirely different aspect, and the only plausible argument for a viaduct instead of street bridges, even by Mr. Berrian in the Board of Trade report referred to, would disappear.

A consideration that has important bearing on this inquiry is the electrification of steam railways, within the city district at least. With electric traction control of trains, short or long, is better, and the need of brakemen on top of car less, making for material reduction of overhead clearance.

In cities such as Toronto smoke abatement is one strong reason, among others, for electrification. Careful observers claim that in the city of Chicago 47 per cent. of the city smoke is caused by railways.

Notwithstanding the recent very material improvements in economy and power of the steam locomotive, during the past ten years or less, electrification of steam railways is steadily progressing throughout the world, particularly at terminals and at other places of congested traffic. In and about London and elsewhere in England vast schemes of electrification have been already accomplished and are under way. The same may be said of almost every country in Europe. As one instance, the Giovi railway, running from Genoa, a line with heavy grades and long tunnels, has demonstrated an increase due to electric traction of 100 per cent. in capacity during the past four years. To come nearer home, and considering progress of the past year or so only, mention may be made of electrification of New York, New Haven and Hartford lines out from New York, of Pennsylvania lines in and about Philadelphia and Pittsburg, of parts of the Norfolk and Western, the Chicago, Milwaukee and St. Paul, the Atchison, Topeka and Santa Fe, the Southern Pacific and other lines. The success attending the electrification of the Butte, Anaconda and Pacific, in economy and general improvement in operating, has resulted in power contracts being placed for 440 miles of the Chicago, Milwaukee and St. Paul. The Canadian Pacific Railway has planned large electrification in British Columbia.

The advance in the past seven years, since presentation of the reports referred to, in the availability of electric energy in south-western Ontario, due mainly to the activity of the Hydro-Electric Power Commission of Ontario, has been greatly beyond expectation. It is not yet four years since this commission began transmitting electricity, Oct. 11th, 1910. It was then thought the distribution would not reach 100,000 h.p. in forty years, while now it is already 90,000 h.p., with all difficulties of the beginning period practically overcome. Electrification in such contiguous cities as Buffalo, Hamilton and Toronto will in the near future have to be seriously considered, and who will say it will not prevail throughout the district from Windsor to Toronto, if not to Montreal, with the greatest available source of hydro-electric energy in the world alongside.

This electrification feature alone merits reconsideration of the whole question of Toronto transportation facilities.

A few odd figures have been taken at random from the 1913 annual reports of the C.P.R. Company, showing accounts for additional improvements to the system have been $29,000,000; for rolling stock and machinery, $30,000,000; for construction of acquired branch lines, $9,113,050; for Ogden shops at Calgary, $2,446,035; for dividends paid up to June 30, in round figures, $15,000,000.

Particulars recently published by the C.P.R. company in connection with its policy of bridge construction, gives the following interesting figures of dimension and cost for four outstanding structures, e.g., the Lethbridge viaduct, the Outlook, the Edmonton, and the Lachine bridges. The first is 5,327 feet long and 314 feet above the water level, with a weight of steel of 25,000,000 pounds; and cost $1,500,000. It was made up of 44 through plate girders 67 feet long, 33 girders 100 feet long, and one 167-foot truss span supported on 33 steel towers. It required 645 cars to transport steel used in construction. The second bridge, across the South Saskatchewan River, is 3,004 feet in length, 140 feet above water level, and has a weight of 5,737,000 pounds of steel; and cost $900,000. It has 240-foot truss spans, supported by concrete piers, with approaches consisting of three 80-foot, seven 60-foot, and nine 45-foot plate girder spans on steel towers. The third, over the North Saskatchewan, is 2,550 feet in length; is 152 feet above the water level; has 16,204,146 pounds of steel; and cost $1,400,000. The fourth bridge—the Lachine, across the St. Lawrence—has 3,657 feet of length; is 60 feet above water level; has 28,462,931 pounds of steel; and cost $2,000,000—that is, both for converting into double track, and for the original cost of the structure, which was something like $1,500,000. It has three 80-foot, nine 120-foot, four 240-foot, two 270-foot, and two 498-foot spans; and 19 piers, 3,500,000 rivets; while 3,500 cars were required to handle the material employed in the entire structure.

SOME LARGE CYLINDRICAL VALVES FOR HIGH WATER PRESSURES.

THE valves or water-gates used or projected to be used by the United States Reclamation Service under great heads at reservoir outlets are described as follows by Gen. W. L. Marshall, United States Army consulting engineer to the Secretary of the Interior, in No. 27, Vol. VI. of "Professional Memoirs" of the Corps of Engineers. They are slide gates for guard valves and automatic plug, or needle, valves for closely regulating discharges. Under great heads the slide valves are difficult to operate, and when of considerable size are not practicable under pressures due such heads, especially since roller bearings applied to them have failed in practice. The use of slide valves must then be restricted to sluice gates operated under moderate or low heads, and to guard gates for regulating valves, to be operated in still water.

The regulating valves, designed and used in the Reclamation Service, form a distinct cylindrical class wherein the cylinder is closed at top, which top projects beyond the cylindrical body and forms a hydraulic piston in direct connection with the valve. The bottom of such type is also closed by a conoidal or concave surface of revolution terminating in a point at the axis of the cylindrical body prolonged. The projection of the top surface or "bull-ring" closely fits the surface of, and moves smoothly into and out from a hood or housing, just as

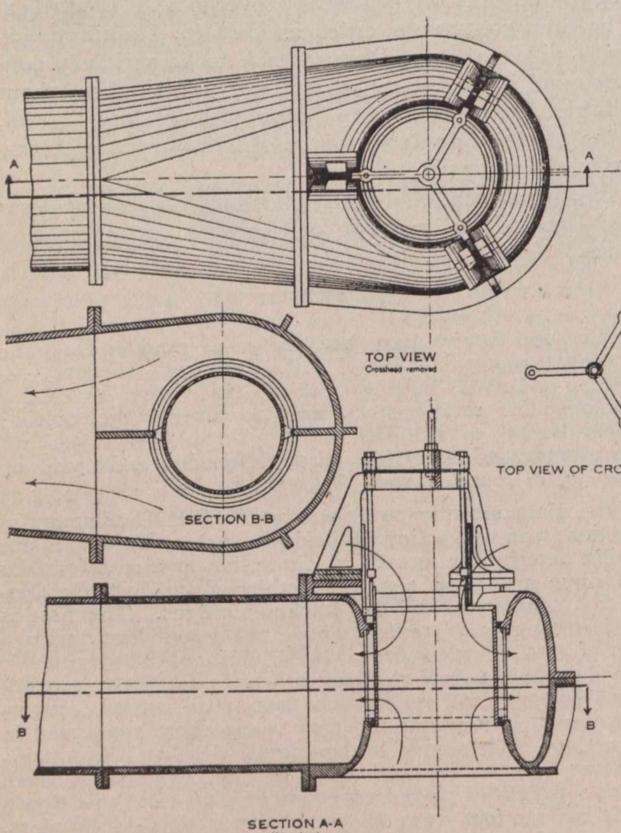

Fig. 1.

a piston of a hydraulic engine moves in its cylinder; and carries the plug or valve to and from its seat.

These automatic but controllable plug or needle valves are in many of their principal features, if not all of them, the inventions of Mr. O. H. Ensign, Chief Electrical Engineer, and of Mr. F. Teichman, Engineer in the United States Reclamation Service, and are very interesting, useful, and scientific applications of the laws of the mechanics of fluids, correct in principle and extremely ingenious. Quite a number of the Ensign valves have been in use for several years. The Teichman type has not yet been tried, but has been contracted for to be placed in the Elephant Butte Dam on the Rio Grande.

The regulating plug valves are automatic but controllable, and are used under heads up to and greater than 100 feet quite successfully. They still have some minor defects, but all such defects seem to be remediable, and doubtless will be remedied shortly.

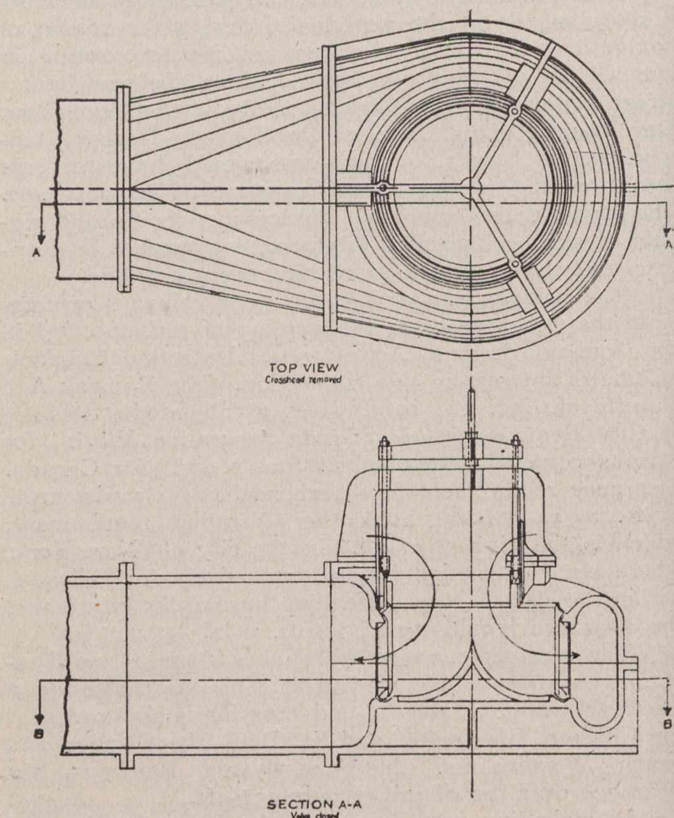

Fig. 2.

In operating these valves not only is hydrostatic pressure used and controlled, but auxiliary forces such as "suction" from artificially produced partial vacuums in the housing, and "reaction" due the change in direction of the discharge by the curved surface of the bottom of the plug. The main differences between the Ensign and Teichman types consist in the relative intensity of these forces employed and relative importance of or reliance placed in the three forces named, and in methods of control and operation. Each type has distinctive good points.

Notwithstanding such defects as have been met in plug valves (up to 10 feet diameter), they are believed to be the best regulating valves under great heads now in use, and certainly will be the best when the new models come out. There is no detailed scientific description of these valves as far as known to the writer.

In designing the cylindrical valves now in question there was not in view to devise a valve or type of gate to take the place of the regulating valves, or to be used as regulating valves at all, but to arrive at some type of gate or valve of medium cost, upon the surfaces of which fluid pressures in every direction may be balanced or in equilibrium, to be used as sluice and guard gates under considerably greater heads than practicable for slide gates; and especially adapted for use for guard gates to the Ensign or Teichman regulating valves, and which may be capable of being conveniently operated under all heads for which slide valves are designed and used. They are not yet (experimental data wanting) considered by me as suitable for use in intermediate positions between open and closed; in other words, for regulating discharge, on account of disturbances that may be expected to be set up by partial vacuums due tortuous course of water through them under high velocities, and the probable hammering due the formation, destruction, reformation, etc., of such vacuums about the edges of the cylinders if not very securely held by close-fitting guides. They can, however, be opened and closed in front of the regulating valves in high-current velocities,

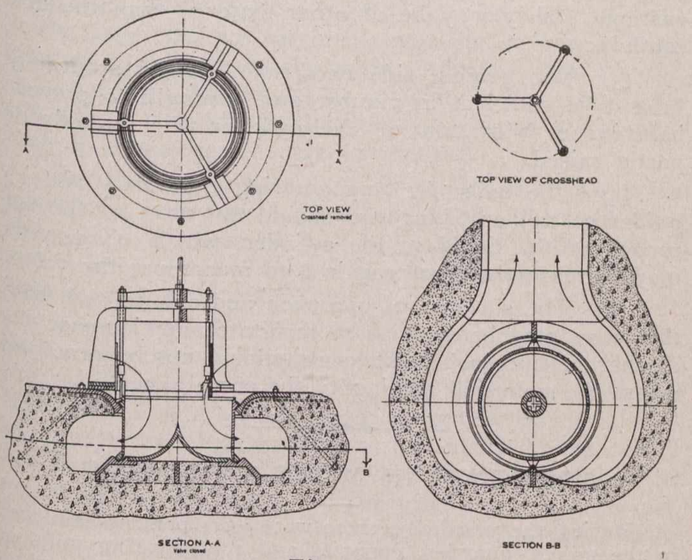

Fig. 3.

if it be found necessary on account of wedging or failure of such valves, under circumstances where slide valves or gates are impossible of operation, and also for emergency discharge gates and sluices, when close regulation is not necessary, or when for any cause the corresponding regulating valve is awaiting repairs. They may all be made water-tight when closed by very simple devices already in use with cylindrical valves.

The single discharge types, and the double-acting valves shown in concrete setting are designed for small heads mainly, but in all types, except that one shown as attached to a pipe elbow (see Fig. 5), the discharge is through the hollow cylinder, and there is no housing or hood required in any of them as in the Fontaine low cylindrical valves used at Panama and for forty years or more elsewhere in this country or abroad. The drawings show types only, and all minor things, like packing, etc., are omitted to avoid confusion. It is unnecessary to show devices well understood to be common to all close-fitting valves.

None of these valves is in use; in fact, they are novelties published just now for what they may be worth in considering projects requiring guard and sluice gates of large capacity under considerable heads. They will doubtless be used, if found useful and advantageous, otherwise they will remain as part of the record of attempts at solving a serious problem in hydraulic engineering that must be solved in some way. The writer believes that the slide gates for large sluices, and for guard gates, under high pressures must go, and that some form of plain, positively operated cylinder or balanced gate will be substituted therefor for closing outlets greater, say, than 20 square feet under high heads, but any of the known cylindrical valves may be made automatic if the expense justifies.

Of the valves proposed herein one form only is of any considerable interest, that is, the "double entry" valves (Figs. 1 and 3), wherein a section of a hollow right cylinder with circular bases is inserted in an annular housing, and closes or opens the inner sides of the inclosing hollow ring. When the cylinder (supposed submerged in water) is raised from its seat a distance equal to one-half or more of its diameter, the liquid discharges into the hollow ring and out through the discharge pipe not only through the interior of the hollow cylinder, but also through the hole at the bottom of the ring heretofore closed by the surface and the base of the cylinder, giving a discharge equal to that of two orifices of capacity equal to the inner section of the cylinder. This form is interesting in two ways:—

1. It may give the greatest possible discharge with the least possible valve movement, and with minimum weight of moving parts and with least frictional resistance. 2. Under very high heads the disturbance at the bases of the cylinder and in the ring might be found dangerous to the material and the surface of the caning might be rapidly eroded by gritty water under the increased velocities, if the full discharge under such head were allowed to pass the valve. In such case the velocities in the valve and casing can be cut down to any extent by reducing the size of the discharge pipe so as to cut down the discharge through the valve itself when wide open to well below the capacity of the valve under that head.

Thus, if the valve were barely capable of safely and smoothly discharging to it full or duplex capacity at 100-ft. head, and it be in question to use it at, say, 400-ft. head, under which head the velocity would be

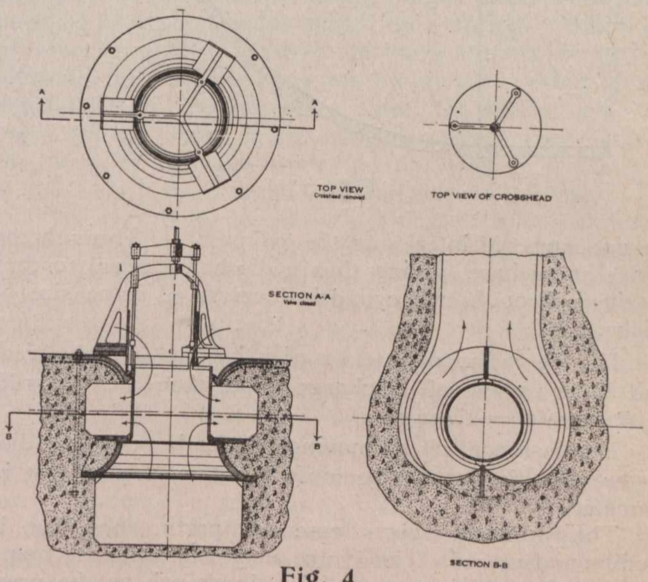

Fig. 4.

doubled and the wearing energy quadrupled, it would be necessary for safe and smooth action to reduce the capacity of the discharge pipe to one-half the capacity of the valves under the full head of 400 feet. This would result in bringing down the velocities, pressures, etc., in the valve and casing when fully opened to the same values as at 100-ft. head, with precisely the same discharge, the velocity in discharge pipe being doubled and the capacity of the pipe at same time reduced one-half.

In similar manner the valve may be adjusted to its greatest safe discharge capacity, at any head, by adjusting the capacity of the discharge pipe or conduit.

The valve is, therefore, practicable through a wide variation in maximum heads due its position in the reservoir, by varying the discharge pipe to give equal discharges at such varying maximum heads, or positions. Other types, of course, may be treated likewise, but under similar conditions of adjustment, etc., the form in question will always give approximately twice the discharge of any other type of cylindrical valve of same diameter.

Referring to the drawings, Fig. 1 shows a balanced valve for high or low heads, giving maximum discharge with minimum material and with least movement possible in proportion to discharge. The moving part is a section of a right cylinder, open at both ends, and actuated positively by hand or otherwise. When valve is lifted through a distance equal to or greater than the radius of the interior of the cylinder (if submerged) the liquid in which it is immersed may discharge: 1. Through

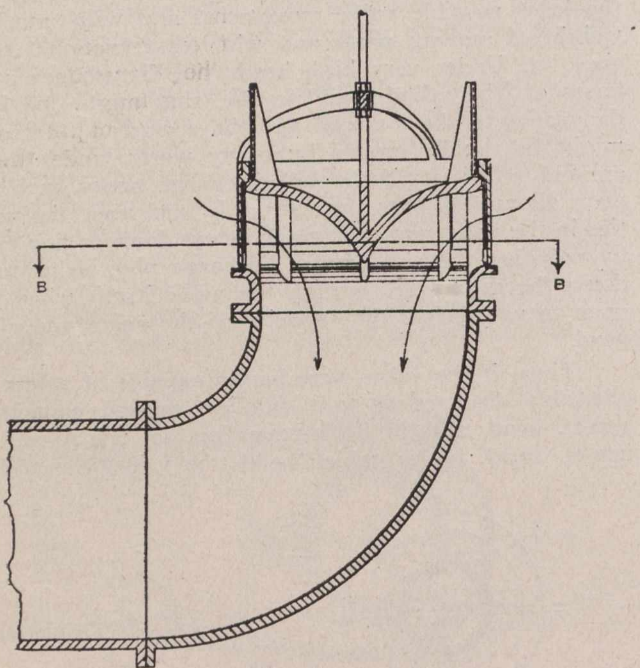

Fig. 5.

the unobstructed interior of the cylinder. 2. Through the orifice at its base, giving thus a discharge equal to that obtained through two cylindrical valves of same size of orifice.

If r be radius of interior of valve and of valve seat and R be radius of discharge pipe, then $2\pi r^2 = \pi R^2$ or $R = r\sqrt{2} = 1.414\, r$.

For instance, if the moving clinder be 5 feet in diameter, the discharge pipe must be at least 7.07 feet in diameter.

The drawing shows essential parts only, but is readily understood. The valve may be made of many forms and of various materials. Inasmuch as the pressures in the valve produce stresses of tension only, the barrel or cylinder may be of ordinary thickness of boiler plate, with flanges if necessary for valve seats. If its weight be counterpoised the valve may be very easily moved by any positive acting force.

To increase efficiency of valve and prevent possible violent shocks under high heads suitable deflecting valves may be constructed in valve casings.

Fig. 2 shows a design for a hoodless cylinder valve discharging through one end and under the other end of an open cylinder, which constitutes the movable part of the valve.

Fig. 3 illustrates a balanced valve of the same type as that shown in Fig. 1, only showing the application of the valve to a setting in concrete.

Fig. 4 is similar to Fig. 2, except that it also shows the valve in a concrete setting. Fig. 5 shows another application of the hoodless cylinder valve, this time to a setting on a pipe below.

All these valves are proposals of Gen. Marshall for the Reclamation Service. In connection with their presentation, he submits the following cautionary notes respecting large valves:—

(1) Care must be taken that the valve is balanced in direction of its axis, to insure ease in operation.

(2) Valve seats may better be separately constructed rings, carefully machined to fit, and attached to valve castings. They may be of other material than the exit conduits.

(3) The guides, side bars, etc., should accurately fit and be sufficient in number and strength to prevent balloting or vibration of the cylinder when wholly or partly raised.

(4) The bails for manœuvring the valve and as guides to tail or lifting rod should not obstruct the approach of the liquid to the cylinder, which obstruction may increase the force required to manœuvre the valve.

(5) The surfaces of approach and exit to and from the valve may be such as to facilitate and increase the discharge, but such refinements should not be practised where the gain will not justify the cost.

ACCIDENTS IN MINES IN QUEBEC.

During the year 1913, there were 8,611 persons employed in the mines, quarries, clay-pits and concentrating mills of the Province of Quebec. This number is not the actual number, which was somewhat higher, but it is a reduction to a basis of 300 days work per man per year, from the actual number of days work performed, which totalled 2,583,673. The total sum paid in wages during the year amounted to $5,401,702, or an average of $626 per person per year. This may perhaps appear low, but it must be considered that all the mines and quarries are situated in the settled parts of the province, where unskilled labor commands a much lower rate than in the average northern mining camp, and also that a certain proportion of the employed are signal-boys in the asbestos open pits, girls in the mica trimming shops, and in the asbestos sorting sheds.

Throughout the year, sixteen deaths occurred through accidents in mines, quarries, clay pits, in the province. Taking the basis of 8,611 persons employed, this gives a general proportion of 1.86 per 1,000 men employed. In the mines proper, asbestos, copper, graphite, mica, etc., the proportion was much higher; of 3,444 men, 11 were killed, or a proportion of 3.19 per 1,000 men employed. In the quarries proper, clay pits, brick-yards, etc., there were 5,167 persons employed, 5 of whom were killed, or a proportion of 0.97 per 1,000 employed.

BUFFALO RAILWAY TERMINALS.

Railway terminal work in Buffalo, N.Y., calling for an expenditure of $15,000,000 to $17,000,000, will be placed under construction in the next year or two. Plans for a new station and other improvements for the Lehigh Valley, to cost about $5,000,000, have been approved by the Buffalo Terminal Commission. The Lehigh facilities will be shared by the Grand Trunk, Erie, Nickel Plate and Wabash. The New York Central lines are developing a scheme for a new terminal, which according to present plans will cost close to $10,000,000. In addition work is now progressing on the new Lackawanna station which will cost about $2,500,000.

On July 11, the Port Dover Brick and Fire Works were destroyed by fire, entailing a loss of $20,000. It is proposed to rebuild the plant next year.

COMPRESSION MACHINE FOR TESTING STRUCTURAL MATERIALS.

WITH the increasing recognition of the necessity for laboratory tests of concrete has come a demand for a simple machine for testing the compressive strength of specimens as large as 8 and 10 in. in diameter. Engineers and builders are beginning to appreciate the fact that a great deal of money can be saved on a large concrete job, amounting often to thousands of dollars, by proper selection and proportioning of the aggregates. To compare the qualities and proportioning of different materials, it is necessary to make fairly large concrete specimens with the cement and aggregate to be used on the work. Advance tests are also essential from the standpoint of safety, and to determine the allowable working compressive strength of the concrete in a reinforced-concrete structure.

In addition to these tests of specimens made in the laboratory, it is now required on important construction that blocks of concrete shall be made up in the field at stated intervals, and tested for compressive strength at ages of, say, 7, 14 and 28 days.

Compression machines of from 100 to 150 tons capacity for testing concrete specimens would be in much greater demand were it not for their high cost and their bulkiness. There are two types of compression machines on the market: Screw machines and hydraulic machines. For very large work the screw machines are preferred to the hydraulic machines; but for small work, the former have the disadvantages of high cost, heavy weight, large floor area required, and mechanical power necessary to operate.

The hydraulic machines now on the market lack some of the objectionable features of the screw type, being less in cost and in weight, requiring less floor area, and being generally operated by hand. However, they are still out of the reach of the smaller laboratories and of construction jobs where concrete specimens of 6 or 8 in. in diameter are made up for testing. The small hydraulic machines on the market at the present time within the reach of laboratories and construction jobs from the standpoint of cost and size, are not of sufficient capacity to test specimens of mortar or concrete larger than 3 in. or less in diameter. To obtain a good average sample of concrete, specimens should be cast at least 6 in. and preferably 8 in. in diameter. A machine to test specimens 8 in. in diameter must have a capacity of at least 100 tons. A capacity of 125 to 150 tons is still more preferable as affording a slight excess capacity and also providing for cases where it is desirable to test an old piece of concrete such as is sometimes cut from a wall. Such a piece, even after sawing the faces true in a power saw, is apt to be irregular in shape and may run a trifle over 8 in. in one dimension.

With a view to obtaining, particularly for tests of mortar and concrete, a reliable, accurate, and efficient machine of a capacity up to 125 tons, at a low cost, and requiring comparatively small floor space, a design was developed by W. H. Weston, under the supervision of Mr. W. O. Lichtner, consulting engineer, Newton Highlands, Mass., and described by the latter at the recent convention of the American Society for Testing Materials. His description is as follows:

This machine consists of an ordinary hydraulic jack like those used in ship-yard work, set in a frame consisting of a heavy base and top. The top of the frame is provided with a head block having a ball-and-socket joint with about ½-in. play in the joint, so as to adjust itself to the specimen and give it a square bearing.

To cover the range required by small specimens of mortar and large blocks of concrete, two gauges are necessary. These gauges are calibrated to read the total pressure on the ram. The small gauge registers up to 20,000 lb. by 100-lb. intervals, and the large gauge registers up to 250,000 by 1,000-lb. intervals, with possibility of interpolation for finer readings. Specimens of small sectional area will break under a comparatively small load on the ram, so it was desirable to be able to take readings by 100-lb. intervals when reading on the small gauge. When the pressure on the ram exceeds 20,000 lb. the stop-cock on the small gauge is turned off, which prevents any further pressure coming on this gauge. This arrangement has been found to work very satisfactorily. Both gauges are equipped with a "maximum hand" which consists of a wire held on the main stem of the gauge hand by a spring in the form of a bent wire. This leaves the wire loose enough to be pushed around the dial of the gauge, but not so loose as to be jarred out of position when the specimen breaks. The top end of the wire is bent outward so as to be caught by the gauge hand as it moves around the dial when the pressure is applied. When the pressure is released, the gauge hand returns to zero and leaves the maximum hand to indicate the pressure which was reached when the specimen broke. The gauges have been carefully calibrated and register accurately at all points.

In order to protect the large gauge from the sudden release of pressure occurring when the specimen breaks, it was found necessary to design a check valve to be inserted in the pressure line to the gauge. This check valve consists of a small valve seated by a spring. When the pressure is applied, it forces the valve against the spring, allowing the water to pass into the gauge. When a sudden release in pressure takes place, the spring seats the valve and the water in the gauge gradually runs back to the pump by means of a very minute by-pass, which is in reality only a small scratch on the seat of the valve.

The jack is equipped with a single-stroke compound pump. The large plunger is used in raising the ram to a height sufficient to tighten the specimen in the machine, and then this plunger is thrown out of service, which allows the small plunger to operate. The large plunger raises the ram about 0.08 in. per stroke, while the small plunger raises the ram about 0.02 in. per stroke. The load should be applied to the test specimen uniformly. This cannot be accomplished with quite the same uniformity in a hydraulic machine that can be obtained in a screw machine on account of the upward stroke of the pump handle. It has been found, however, that with care the pump can be so operated as to apply the load very evenly and without a jerk, and that by making a quick return stroke of the handle the pressure may be considered as being increased continuously. In applying the load, the ram should be raised at the rate of 0.026 ft. per minute, which can be done by operating the pump handle so as to make a stroke and return in 3½ seconds. A clock arrangement is being devised to strike every 3½ seconds, so that the man operating the machine can accurately regulate the pumping. When the load on the ram reaches the vicinity of 125,000 lb. or over, a pipe extension about 3 ft. long is put on the end of the 3-ft. pump handle. This gives the operator the necessary leverage to operate the pump without the assistance of another man.

A guard should be placed around the working parts of the machine to protect them and also the operator of the machine from injury when the specimens break. Concrete specimens having a height twice the diameter often break very suddenly, throwing small pieces of the specimen around in all directions.

The frame of the machine measures 20 by 32 by 60 in. high, outside dimensions, and the total weight is about 1½ tons.

The machine described has been in operation now for some time and has been found to give accurate and reliable results. The results have been checked several times by a series of check tests on a large expensive screw machine.

THE PREVENTION OF THE SUBCRUST MOVEMENT IN ROADS.

The behavior of roads subjected to heavy traffic has been under the observation of road engineers everywhere, and in several instances certain experiments have been initiated to determine, as far as possible, the lateral and longitudinal movement of material forming the subcrust of highways. One of the investigators, Mr. E. S. Sinnott, M. Inst. C.E., county surveyor of Gloucestershire, Eng., read a paper before the recent Cheltenham convention of the Institution of Municipal and County Engineers, concerning his work. It is largely descriptive of observations made as a preliminary to more precise investigation under way, the former comprising the opening and inspection of various sections of grass verge adjoining the principal roads.

Speaking generally, these indicate that lateral movement, in some instances to a considerable extent, has been taking place, and such movement seems to call for special consideration.

The following examples will serve as illustrations: (i.) On main road (Gloucester to Bristol) at Whitfield, near Falfield. At this point the grass verges were opened on both sides of the road, and on the west side there was found, at a depth of about 4 in., a bed of broken limestone having a width of 3 ft. from the metalled surface, varying in thickness from 7 in. nearest the road to 4 in. at the 3 ft. distance. On the east side a somewhat similar state of affairs was found to exist, the width in this case being 2 ft. 6 in. from the verge. The subsoil is a hard, red clay. (ii.) On main road (Bristol to Malmesbury) near Chipping Sodbury. In this instance the lateral thrust is shown in the movement of a line of channelling formed of three stones on edge put in to protect the foot of a bank: originally laid with a horizontal face of 13 in. in width, the stones having been forced into a vertical position, having moved through an angle of 90 deg. In several instances the upper stones have been forced completely over, having rotated through an angle of 180 deg., and have fallen backwards into the highway, their movement away from the road being arrested by the bank they were put in to protect. The subsoil is clay.

(iii.) On the main road (Gloucester to Bath) between Hardwicke and Stonehouse. In this case metalling and pitching have been found from 3 ft. to 5 ft. from the metalled surface, and about 18 in. in thickness. The subsoil consists of clay and sand.

(iv.) On the main road (Cirencester to Cheltenham) at Baunton Hill. The opening at this place showed that the original pitching and oolite macadam had been forced for a distance of 4 ft. from the edge of the metalled surface, the outer end showing an upward movement. The subsoil is clay.

The results above described indicate generally the position of affairs upon roads where traffic is heavy, although in a small minority of cases investigated little or no movement could be detected. It appears evident, however, that where lateral spread does occur it cannot fail to be ultimately destructive, as without substantial and immovable support the top coating cannot be kept up to its work, particularly after some wear has taken place, and it becomes a question how far new surfaces of an expensive character are justified before the subcrust movement referred to has been arrested.

With a view to obtaining more accurate information, the writer has lately placed a number of iron bolts below the surface of certain roads, and has fixed their position exactly by steel tape measurement, so that any movement can be definitely ascertained on a future occasion.

He has also inserted measuring instruments at various places, which consists of two rods arranged to slide one over the other, having iron plates at their outward extremities, which will enable any movement, either lateral or longitudinal, to be recorded.

As a means of preventing the action above described, the writer has recently designed and put into use a rigid framing, the essential feature of which is that longitudinal and cross members placed at a suitable depth below the surface preclude any movement of the subcrust, and at the same time provide a means of constructing an impervious arch of tarred macadam to carry the traffic, great additional strength being provided by the longitudinal members for the support of the heaviest road vehicles.

For various reasons, the writer thought it best to construct the frames in reinforced concrete, although timber or other material could, if preferred, be used.

The longitudinals are 12 in. by 3½ in. (average thickness) by 12 ft. long, and are slightly tapered from top to bottom. The ends of the longitudinals are securely housed at the extremities of the cross-ties.

The reinforcement consists of expanded metal 3 in. mesh ¼ in. by 3-10 in., weighing 11½ lbs. per superficial yard, cut into strips 9 in. wide—in the case of the cross-ties this is supplemented in a minor degree with wrought iron round bars of small section at the ends of the same.

A further modification consists of making the longitudinals slightly curved on the inside, in order to withstand lateral thrust more effectively; also, where difficulties due to traffic may be anticipated, in placing the cross-ties in position they can be made in two parts and connected in the centre with a bolt or bolts.

In the experimental frames which have been put down, the width between the longitudinals has been fixed at 8 ft., but there is no particular reason for adopting this dimension, other than that it appears suitable for dealing with the traffic conditions of rural roads in Gloucestershire, where most of the heavy weights are carried in the central portion of the highways.

If considered advisable, a greater width than 8 ft. may be adopted between longitudinals, or where traffic conditions justify it, the central pair can be supplemented by longitudinals on either side, connected thereto by cross-ties similar to those previously described.

The frames have been placed, the top edges of the longitudinals being 6 in. below the finished road surface, which, from the information at present at the writer's disposal, appears the most suitable position for arresting the lateral movement, also at this depth there would be little or no interference with pipes, and with 6 in. cover over the top side of the longitudinals there appears to be sufficient cushion to avoid any damage thereto.

Editorial

EXPERIMENTS WITH ROAD MATERIALS.

An English contemporary has the following to say about research experiments in connection with highway engineering: "Is it not time some one entered a protest against the waste of money in a lot of laboratory experiments on road material? The results of these tests are about as valuable as a knowledge of the canals of Mars. The sum and substance of road work is summed up in one word—'conditions.' Two roads constructed similarly of like materials, but upon the two opposite sides of a hill, will wear differently, and no amount of laboratory experiments will alter the fact. Again, a material which will serve admirably in an open country will not wear similarly if used through a woody, damp district. Further, there are materials admirable in certain positions used on the flat which are useless and dangerous if used on a gradient.

"This flinging of laboratory experimental results is a fad of faddists wanting to stereotype practice and to issue red-tape orders from a central office as to what is to be done in every corner of the land. Standardization and red tape are refuges for the destitute in common sense and the conceited empiric who believes that the result of an experiment upon granite, syenite, slag or other material is a solution of the problem where and when they should be used. No laboratory experiments will give relative values of various methods of road surfacing unless all the varying conditions of climate, soil, gradients, aspect, surroundings, character of traffic, etc., are known. The factors in the problem are too numerous to be solved by a laboratory experiment. You cannot get even some preliminary indication of probable results in the laboratory. The question of standardization is a wider one, but in most cases the result is to stereotype practice and to prevent men using their brains. It assists the degeneracy of a profession. There is no incentive to progress. What is, is, and is good enough."

What is, is not good enough; hence the field of experimental research. To ascertain, by experiment, the materials best suited for the conditions which prevail on either side of the hill, or for the conditions to be found in open country, in woody and damp districts, on the flat or on a gradient, entails the expenditure of some money, of course. But the saving to the country as a result of such experiments, and the comfort and other benefits that also accrue, cannot be reckoned in dollars and cents. The difference in cost of maintenance (and even of construction) between the scientific methods that are being so keenly investigated and the rule-of-thumb practices that have too long prevailed will be as evident, a few years hence, as a result of experimental research, as it has in so many other phases of municipal development.

"PROPOSED RAILWAY VIADUCT, TORONTO."

In view of the many arguments favoring the electrification of steam railways within city limits, as well as other points which it raises for consideration in connection with the proposed railway viaduct along the waterfront of the City of Toronto, we publish on another page a discussion submitted by a well-known consulting engineer and railway manager. Apart from the electrification feature, the question of clearance is one that merits further attention, as so much expenditure hinges upon it in an undertaking of this kind. Doubtless those not conversant with Canadian railway specifications will be surprised to learn that the requirement of 22 feet over top of rail, as in force in this country, is higher than any similar requirement in the United States or Great Britain.

CONSIDERATION OF TENDERS.

Tariffs are imposed on nearly all lines of importation into Canada, designed to equalize conditions between Canadian firms and foreign firms. When a foreign firm answers a formal call for tenders, and underbids a Canadian firm, despite the duty burdens imposed upon the foreign firm, the Canadian firm has no right to expect favoritism merely upon the made-in-Canada argument. Should the Canadian firm be able to make better deliveries or should the quality of its product be superior, then it is entitled to prior consideration even though its tender be higher, but not too high in proportion to the greater service it is prepared to render.

To a far less extent is any one section of the Dominion warranted in favoring local firms at higher figures in preference to other Canadian firms more distantly situated. The city of Vancouver recently bought a number of valves. Three tenders were finally considered. A United States firm bid $8,405; a Walkerville, Ontario, firm bid $8,485; a British Columbia firm bid $9,700. The waterworks engineer and superintendent recommended the acceptance of the Walkerville tender. The waterworks committee of council favored the lowest tenderer, but the city council—by the mayor's vote—awarded the contract to the local firm.

This is dangerous practice, but in line, so far as engineering ethics are concerned, with other recent actions of the same council. It is reported that there is a general campaign in British Columbia in favor of using home-made goods in preference to goods made in other provinces or countries. This is said to be urged in the matter of requiring contractors for the Second Narrows Bridge across Burrard Inlet, which will cost approximately two million dollars, to specify that British Columbia-manufactured steel be used in the construction. The adoption of such a policy would have a very depressing effect upon British Columbia's credit in the money markets. Petty, narrow-visioned economics of this sort will surely not be allowed to prevail in the province that is ordinarily the most unselfish in Canada.

Before the United States Senate has appeared Senator Bryan's good roads bill, under the terms of which the federal government would issue 3 per cent. bonds to the amount of $500,000,000 in instalments of $100,000,000 each for 5 years, for road development. Before States could participate in the funds they would be required to issue an equal amount of 4 per cent. bonds, which, when deposited in the treasury department, would be exchanged for cash. The 1 per cent. difference would make up a sinking fund to aid the States in retiring the bonds. Creation of federal highway commissions to supervise the expenditure of highway funds is a feature.

PRODUCTION OF STRUCTURAL MATERIALS FROM QUEBEC MINES DURING 1913.

THE structural materials appear for a preponderating part of the total value of the mineral production of the Province of Quebec. In 1913, their value amounted to $8,187,917, which represents 62 per cent. of the total production. Under this heading are grouped cement, limestone, brick, granite, lime, building sand, clay products (tiles, drains, pottery, etc.) in the order of their importance. The following information is from the report for 1913 of the Mines Branch, Department of Colonization, Mines and Fisheries:—

Cement.—The cement manufactured in the Province of Quebec is exclusively Portland cement. The manufacture of cement is now an exact science, and it is almost impossible to find a natural mixture of clay and limestone which will give the results expected from a Portland cement. The natural cement industry in Canada has been entirely replaced by the manufacture of Portland cement, in which the raw materials are mixed in fixed proportions, according to a strict chemical control.

The composition of Portland cement is, therefore, definite, and, although the mixture of raw materials may vary within narrow limits, it should normally contain 75 per cent. of lime carbonate, 13 per cent. silica (soluble), 5 per cent. alumina, 1½ per cent. iron oxide (Fe_2O_3), and the remainder allowed for impurities, magnesium carbonate, alkalis and inert substances. The raw materials used in the Province are Trenton limestone exclusively, for the lime constituent, and Utica shale, or Leda marine clay, for the argillaceous component. These substances are very abundant. All along the north shore of the St. Lawrence River deposits of both limestones and clays are common.

In 1913, the cement mills of Quebec shipped 2,881,480 barrels, valued at $3,361,292. In fact, the value of the cement production was over 40 per cent. of the total value of the structural materials. Ten years ago, in 1904, the recorded production of cement of our province was 40,000 barrels, valued at $66,000.

Limestone.—The limestone industry is well developed in the vicinity of Montreal, where quarries have been opened at Mile End, at Outremont, Côte St. Louis, Longue Pointe, Villeray, Sault-au-Récollet, on beds of the Chazy and the Trenton limestones, both of which are well developed in the Island of Montreal.

At St. Vincent de Paul, St. François de Sales, where a great deal of the limestone is produced, the quarries are in the Trenton. The same formation is also worked at St. Marc des Carrières, Deschambault and Lachevrotière, in Portneuf county, as well as at Beauport and Château Richer, immediately below Quebec. Trenton limestone is also quarried in Hull, opposite Ottawa.

From returns received from producers, the limestone extracted in 1913 reached a value of $1,704,207. This, however, does not represent the whole production, for it is almost impossible to keep track of all the small operators who work spasmodically. From the 162 names of limestone producers to whom we sent return forms to be filled in, only 84 answers were received, many answering only after the second or third request. Of these 84, there were 44 who reported a production, and 40 whose quarries had been idle during the year.

Granite.—The Laurentian area, which extends to the north of the Ottawa and St. Lawrence Rivers, affords an unlimited supply of granites of various colors and textures, but, owing to the limited market, very few quarries have been opened. The main operators in the Laurentian granite are the Laurentian Granite Company, whose quarry is situated at Staynerville, in the county of Argenteuil; M. P. and J. T. Davis, who are working a quarry at Rivière à Pierre, north of Quebec, the stone being used altogether in the construction of the Quebec bridge.

Another source of granite is found in the various igneous intrusions which penetrate the rocks of Ordovician age in the Eastern townships, and large quarries on such occurrences are worked in the township of Stanstead; in the township of Whitton; on Mount Johnson, near Iberville Junction. The production of granite reached $496,588 in 1913, as compared with $358,749 in 1912.

Other Structural Materials.—There are no new developments in the other materials of construction. Brick and lime show very small increases as compared with the previous year, which may be accounted for by the fact that concrete construction is on the increase, as shown by the large increase in the production of cement. The sand which figures in the table of production only represents a very small proportion of the sand actually used in building operations, as we only keep record of the sand which is worked under mining licenses. Most of this sand is dredged or pumped from the beds of rivers.

PROGRESS ON THE C.N.P. RAILWAY.

A recent statement made by D. O. Lewis, divisional engineer of the C.N.P. company in British Columbia, announces that the work being done between Parsons Bridge and mileage 100 will be completed by the last of August. Mileage 100 is a point about 4 miles from Cowichan Lake and about 5½ miles from the Nitinat River. This means that before the end of next month the grade for over 100 miles will be ready for the sleepers and rails. The steel bridges, which are to be put at mileage 54, 68, 73 and 75, will be constructed as the rails are laid. The grade from mileage 100 to mileage 121, a point in close proximity to Alberni Canal, will probably be completed at the end of the year.

From mileage 121 to mileage 136½ the road is practically finished. Mileage 136½ is within 6½ miles of Alberni, so that, when the line from mileage 100 to 121 is finished, the road will be in condition for the rails as far as Alberni.

The wooden bridges beyond mileage 101 will not be built until all the grading is done and the rails are laid so as to avoid danger of their destruction by fire.

The line which will run from Patricia Bay down the Saanich Peninsula, round Swan Lake and Portage Inlet to Parsons Bridge, has been almost completed as far as the grading is concerned.

At Patricia Bay, where the rails are to be landed, a contract for the erection of the approach and pier has been awarded to S. Doe, of Victoria. The work is to be completed in 70 days. The steel for the small bridges will probably come from Vancouver; that of the larger structures, from Eastern Canada. The first cargo of steel will arrive at Patricia Bay between October 10 and 15; and another shipment is expected by the middle of November. These two cargoes will be sufficient for the road to mileage 100.

Plans are being prepared and considered in Denmark and Sweden for a channel tunnel between the two countries. The greatest depth at which the tunnel will run will be about 100 feet, and it is estimated that the undertaking can be completed in 5 years at a cost of about $25,000,000. The tunnel will be worked by electricity, and will be driven through the stratum of grey chalk underlying the northern European continent.

MOVABLE CRESTS FOR DAMS.

THE accompanying drawings show some types of automatic and hand-controlled flashboards, intended for use by the U.S. Reclamation Service. They were proposed by Gen. William L. Marshall, consulting engineer to the Secretary of the Interior, were described in an article in the May number of the "Professional Memoirs" of the Corps of Engineers, U.S. Army. The author calls attention to the fact that the two types shown at the top of the drawing are new but were patented by him some years ago, the straight or plane gate type (upper left-hand figure) having been in use since 1907 on one of the feeders of the Illinois and Mississippi Canal. Altered to suit local conditions, it is placed horizontally in the bottom of the feeder as an emergency stop gate, to rise and retain the canal level in case of a break in the banks. The particular gate was designed by Christopher Holth, mechanical engineer, and constructed by L. L. Wheeler, assistant engineer. The canal bank broke in 1910 and the gate automatically rose and closed the feeder, retaining the level in the feeder canal. It then repaid its cost.

The second type, at the top of the drawing (without the wooden drift shield and siphon), has also been in use since 1907 as upper gates on fourteen locks on the Illinois and Mississippi Canal, but the lower leaves or aprons of those gates were designed of sufficient size only to depress the gates automatically when the locks are filled to within 10 in. or less of the surfaces of the upper pools. Those gates have worked successfully since 1907, although there were defects in workmanship that were corrected, and at least one uncorrected defect in design that is of no practical importance so long as the canal levels are maintained. These gates were also designed under General Marshall's patents by Christopher Holth, but the completed designs were not submitted to him for correction. This type requires flotation or auxiliary power to raise it until its nose is above water, when the current may act. It may be readily modified to be applicable to spans up to 100 ft., but is peculiarly adapted for use as an upper gate to a canal lock of 40 ft. or less span and not exceeding 10 to 12 ft. depth.

Later Types.—The two types at the bottom of the plate are believed to be novel, and have now been published for what they may be worth. They may be used by the United States freed from patent claims. Any one familiar with bear-trap dams will understand at a glance their working. The only features worth special remark are:—

1. The care taken to so arrange the hydraulic chambers as to cause mud and sediment to be swept by the motion of the gate into or near numerous water supply and exit pipes or "scruppers," and sufficient leakage to keep mud from accumulating. This leakage may be reduced to any extent by well-proved means.

2. The arrangement of piping for above purposes, and to secure uniform distribution of water pressures along entire length of gates by making main conduits of much greater capacity than that of all distributing pipes or conduits combined.

3. The siphon for automatic control of the gates during floods, in connection with, or rather, in addition to, hand control. These siphons "bleed" the supply mains before water in them may reach under pressure the small distributing pipes leading into hydraulic chambers, and have discharge capacities nearly equal to, but less than, the main conduits, so that (if the hand-operating devices be closed) whenever during a flood the water level above a dam reaches the level of the siphon throat or top, the siphon at once so "bleeds" the supply main that the preponderance of water pressure is at once changed from one side to the other of the axis of rotation of the gate, and it will fall and remain flat until the level in the reservoir falls below the air inlet to siphon, whereupon the siphon action is broken, the full pressure is again exerted

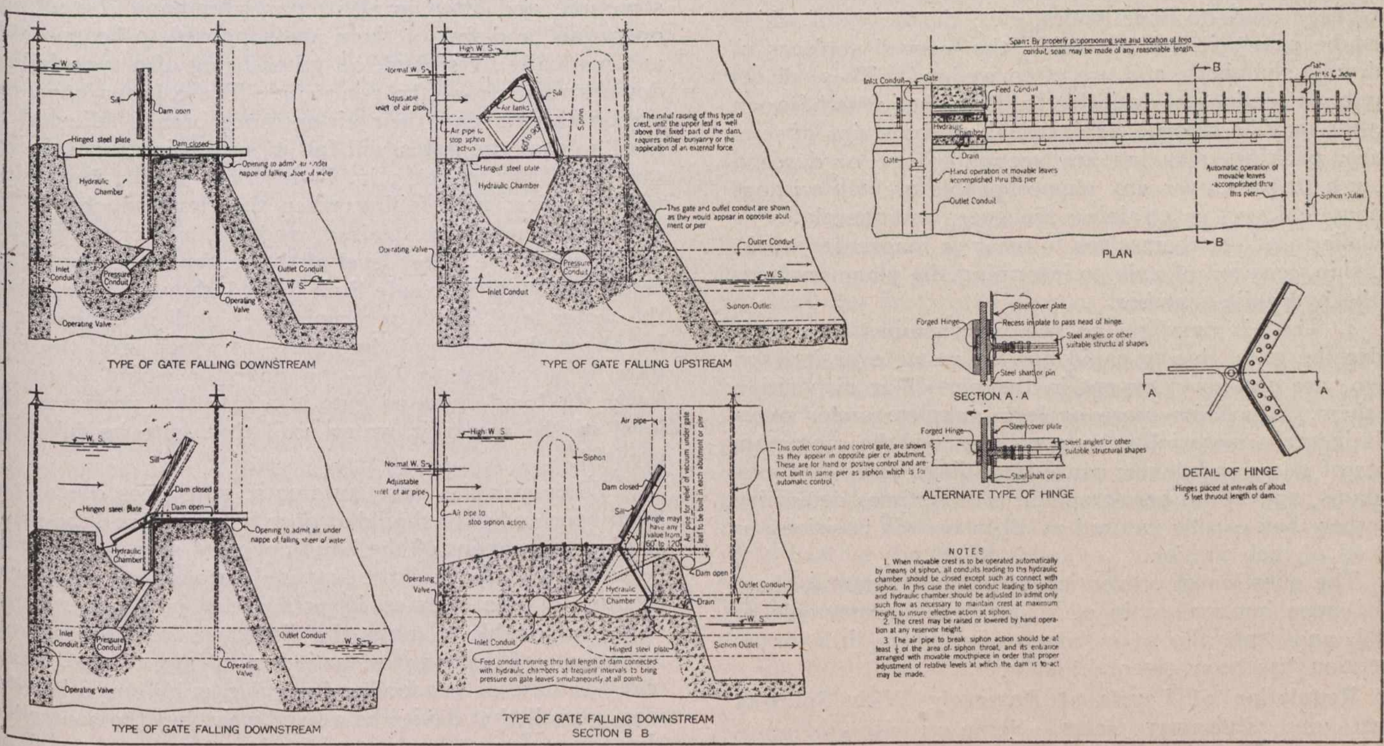

Fig. 1.—Types of Movable Dam Crests.

throughout the surface of the gate, the preponderance of pressure is again shifted from one side to the other of the axis of rotation, and the gate rises.

The type with siphon control falling down stream admits trussing or bracing, etc., so that it is possible to make it very light and at the same time strong and stiff against warping and of any reasonable length. It may be advantageously used up to 10 to 12 ft. lift on high spillways and dams. The width of that part below the axis of rotation in any of these movable crests should be not less than five-eighths the width of upper section, exclusive of width of flap leaf; the relative proportions of parts of gates should be computed to meet the special conditions in each case.

Steel plates are hinged to edges of lower sections and move along inclined planes in order that there shall be elasticity in the system even under considerable wear at axis and inaccurate work. The gates will not be subject to wedging and obstruction by gravel, chips, etc., and these narrow leaves remove most of the objections that have been made to drum weirs, etc., the leaves of which must be nearly in contact with the curved surfaces of hydraulic chambers, and are often wedged. These plates may be in sections of desirable lengths, the joints between lengths may be stopped against leakage by strips of pure rubber packing, allowing any section to rise or descend enough to pass over any chance pebble or chip without serious leakage, or straining the gate, and the plates as a whole to adjust themselves to wear or inaccurate workmanship, location of axis or informing the plane surfaces of the hydraulic chamber.

4. The air passages to remove vacuums that form under the gate, due to rapid flow of water over it when down, are not novel except in the particular disposition of them. Vacuums more or less complete under overfalls increase materially the pressures on the upstream faces of gates and dams; cause tremblings and vibrations in dams, and in old bear-trap forms sometimes determine whether they can be worked at all in certain positions or phases of their motion.

The question of prevention of partial vacuums, then, is of some importance in all dams, whether movable or fixed, and especially so in bear traps, where little or no attention has been given the subject.

Regulation of Levels of Reservoir With Spillway Crests and Sluiceway Gates.—Some criticisms of automatic movable sluice gates have been based upon the opinion that their movements are so rapid that there would be thrown into the stream below the reservoir large amounts of water en masse, thus creating waste of such magnitude that damage to animal life, or to property, might result.

This objection is well founded, but, when it is considered that the movable crests, or spillway gates proposed are in fact hydraulic engines, capable, if properly constructed, of as smooth, gradual and certain movement and control (and by similar methods) as any other hydraulic press or engine, the point is of small importance.

It is necessary for this purpose in a series of sluiceways controlled by automatic gates to provide one and only one sluiceway of the series, with a hydraulic gate to be operated carefully by hand, in order to make the increase in discharge as gradual as it would be over a fixed or movable horizontal weir of suitable length, by filling in by gradual increase in discharge the differences in total discharge caused by the sudden periodic gate movements.

For instance, suppose there is an available site 350 ft. in length for a spillway to be used in connection with a large reservoir, and that the maximum flood to be wasted is about 25,000 sec.-ft. and it be desired to store all water practicable in the reservoir, with a fluctuation in its water level of about 2 ft.

The effective depth of the sluiceways, if 50 ft. wide each, must be 9 ft. at maximum flood level, and there must be six of such sluiceways of that width to discharge the maximum floods of 25,000 sec.-ft.

The sluice gates or movable crests may be made of 7-ft. lift each, and the water levels in the reservoir must be so controlled as to rise not more than 2 ft. above their crests when raised.

Each 50-ft. sluiceway 7 ft. deep will discharge approximately 3,000 sec.-ft. When the water rises to the limit assumed there will be 9 ft. depth in the sluices and the discharge of each will then approximate 4,500 sec.-ft. The discharges may be less than above given, but they are assumed for the purposes of a demonstration; accuracy is not now in question.

One of the sluice-gates is to be of most careful construction, and fitted in all its parts for hand control and operation, and five of them are supposed to be operated automatically by siphon, all gates being of a type falling down stream from the reservoir. These latter have the siphon throats and their air-entrance breaks adjusted in level so that the gates will fall in succession, upon increments of, say, about 3 in. in reservoir levels, beginning with the first gate falling when that level reaches 7 in. above the crest when raised, and the last or sixth gate falling when the water level of the reservoir is about 3 in. below the maximum safe limit named above. Now, when the water level in the reservoir rises until it is nearing 7 in. above the crests of the gates—at which level the first gate is arranged to fall—the operator would begin to lower the hand-operated gate at a rate that preserves the level of the reservoir water until that gate be fully depressed.

Whenever the first automatic gate goes down, the hand-operated gate should at once be raised, and the same gradual movement of the hand-operated gate be resumed between the falling of the first and second, etc., and succeeding automatic gates, if such care be necessary. It is, then, practicable to make the discharge from a reservoir by the use of these gates, or indeed of any of the "bear-trap" family, as gradual and regular as by any other device, even if that device be a fixed weir, but the controlled sluiceways have the material advantage over the fixed weir of allowing the storage of 7 ft. (in this case) depth of water over the entire surface of the reservoir, which cannot be done by a fixed weir of same length of crest with as little waste and as little fluctuation in water level in the reservoir, and the sluices moreover, serve admirably for drift chutes.

In some very large reservoirs now in existence, or under construction, this additional storage of 7 ft. in the reservoir might run to a hundred thousand acre-feet or even much more, a matter of very great importance in our arid region, where water is so precious for irrigation and domestic use.

EXPLOSIVE PRODUCTION.

The United States Bureau of Mines has compiled some figures on the production of explosives in the United States in 1912. It appears that there were manufactured, 230,233,-369 lbs. of black powder; 24,630,270 lbs. of permissible explosives; and 234,460,492 lbs. of high explosives, such as dynamite, nitroglycerine, etc. Of the high explosives, 89,-703,081 lbs. were consumed in mining other than coal and 4,668,399 lbs. of permissible explosives in the same industry.

ELECTRIFICATION OF STEAM RAILWAYS.

IN *The Canadian Engineer* for July 9th, 1914, appeared a discussion of the steam railway electrification problem, by Mr. J. A. Shaw, of the Canadian Pacific Railway Company. The following, extracted from a paper read by Prof. D. D. Ewing before the Indiana Engineering Society, will be found of particular interest, as the statements advanced by both authorities leave little to be desired in the matter of general information respecting the systems that have received practical recognition. Prof. Ewing states that power companies are interested in electrification because they have electrical energy for sale. The railway companies can build and operate their own power plants, but in many cases they find it cheaper to buy energy than to generate it, the low ratio of average demand to maximum demand making a railway load alone rather unprofitable for a power station.

As far as the power station and transmission lines are concerned, nearly all systems of electric traction are similar, consisting generally of three-phase power generation and high voltage and three-phase transmission. It is in the motive power equipment and the distribution systems that the differences come. Four systems are finding practical application to-day.

Direct-Current System.—In this system direct-current series motors are used on the locomotives or motor cars and voltages ranging from 600 to 2,400 volts are used on the trolley or third rail. The trolley or third rail and its feeders receive direct-current energy from substations located at intervals along the right-of-way. In the substations, transformers and rotary converters change the high-voltage three-phase currents of the transmission system to direct current at the proper trolley voltage. This is the well-known system used on street railways, modified to meet the demands of steam line traffic, and up to the present time has found wider application in this country than all of the other systems put together. Of interest in connection with this system is the recent announcement that the Chicago, Milwaukee and Puget Sound Railway has decided to use it in its electrification over the Rocky Mountains.

Single-Phase System.—Either series or modified repulsion type, single-phase motors are used on the locomotives or motor cars. The trolley receives its single-phase current supply from transformers, located at intervals along the line, which transform the high voltage of the transmission system to a value suitable for the trolley. Trolley voltages range from 3,300 to 25,000 volts, 11,000 volts being common in this country. A balanced three-phase load is approximately secured by dividing the trolley line into sections and feeding the different sections from different phases. Transformers on the locomotives or motor cars step the trolley voltage down to a value suitable for the motors. The motors are rather complicated and have high maintenance charges. On account of the high trolley voltages used, the first cost and line losses of the distribution system are low. The most prominent example of this system, in this country, is that of the New York, New Haven and Hartford Railway.

Three-Phase System.—In this system three-phase induction motors are used on the locomotives, and two trolley wires are required, the track forming the third leg of the three-phase circuit. Trolley voltages up to 11,000 volts have been used. Transformers on the locomotives step the trolley voltage down to a value suitable for the motors.

The two trolley wires required complicate the overhead work, but the motors are simple and rugged. The system is readily adapted itself to regenerative control of trains on down grades. The motor is inherently a constant speed motor, and will carry its load up grade approximately as fast as it will carry it down grade or on the level. With some modifications in the design of the motor, its speed can be varied in steps without seriously affecting its efficiency.

The Great Northern Cascade Tunnel electrification is the only example of this system in this country, although locomotives having an aggregate rating of about 200,000 h.p. are in use in Europe.

Split-Phase System.—The locomotives are equipped with polyphase motors and single-phase current is supplied from the trolley. A phase converter on the locomotive converts the single-phase energy to the polyphase energy required by the motors. The distribution system is the same as with the single-phase system, and the motive power equipment is the same as with the three-phase system, with the exception of the phase converter. In a measure the good points of both systems are combined. The system is a new one, and is possibly the most spectacular development in electric traction made during the year just passed.

Advantages and Disadvantages of Electric Traction.—The following are a few of the more important advantages and disadvantages of electric traction for railway trains. Briefly, the advantages are:—

The safety of operation is increased because signals are not obscured by smoke and steam, and the locomotive-driver can give his entire attention to driving, and his seat can be located so that he can see both sides of the track at all times.

Regenerative control is possible with all systems of electric traction. With regenerative control the air-brakes are used only in stopping or in case of emergency. Car wheels and brake shoes are not heated by long-continued applications of the brakes on down grades, and the number of wrecks due to cracked wheels is lessened. The energy that would otherwise be used up in heating the brake shoes and wheels is pumped back into the line and helps pull some other train up hill. While regenerative control is possible with all systems, it has not been used on all systems in the past on account of the resulting complication in the control apparatus and motor windings of series type motors.

The dispatcher can stop a train at any time by ordering the power supply shut off from the section in which the train is running, and the control mechanism may be readily arranged so that the brakes are applied automatically if the power is shut off from the trolley.

In mountain grade work, higher speeds may be maintained over the grades than is possible with steam locomotives. Going upgrade, the speed of the steam locomotive is limited because its power output is limited by the boiler capacity. The electric locomotive is not limited in this way, and for short intervals it can carry large overloads.

Powerful motors can be mounted on comparatively light locomotives. While the weight of a locomotive fixes the drawbar pull at starting, its horsepower capacity fixes the pull when running at a given speed. This means that electrically operated trains can be accelerated at much higher rates than steam trains and can be operated at higher speeds over grades.

Electric locomotives require inspection once in from 1,200 to 2,500 miles of operation. To keep steam locomotives in similar condition they must be inspected and cleaned at the end of every run. On those roads which are operating electric locomotives, the daily mileage of the locomotives is from 25 to 50 per cent. greater than the steam locomotives which they replaced, and their reliability is indicated by the fact that the delays chargeable to motive power are less than 50 per cent. as compared with steam motive power.

Experience has shown that the fuel cost with electric operation is from 40 to 75 per cent. of that with steam operation. There are no standby losses. Prof. Goss has estimated that one-fifth of the coal burned under locomotive boilers is burned while the locomotives are standing on sidings, or in starting fires.

The first cost of electrification is high as compared with the first cost of steam motive power. The cost of steam motive power for the average steam road is about $2,000 per mile of single track, while the cost of electric motive power runs from $7,000 to $12,000 per mile of single track. The cost of terminal electrifications may be even higher.

Power-house accident might put a whole railway system out of commission. The dependence of the electric locomotive on the power-house tends to make it inflexible in some respects.

Steam locomotives have passed through the development stages and are practically a standard product. They have developed to their present perfection through a period covering nearly a century. They are reliable and remarkably efficient, considering the conditions under which they operate, and their characteristics and limitations are well understood by a majority of the operating men. On the other hand, electric traction as applied to railway trains is scarcely two decades old. Progress in the electric arts has been so rapid during the past quarter of a century that apparatus which to-day represents best modern practice is likely to be on the scrap-heap tomorrow, not because it is worn out, but because it is obsolete.

Long-continued overloads overheat and burn out the electrical equipment. Such overloads are common in railway service and do not seriously injure a steam locomotive. If the overload on a steam locomotive is too great, it simply stops work, and no serious injury results.

As the rails are used as part of the main power circuit, the signal circuits for electric block signals and for interlocking plants are more complicated and expensive to maintain.

While no trainmen within the motor cars or locomotives have been killed or seriously injured, there have been a few fatalities among the men employed outside.

The losses, in a poorly-designed transmission and distribution may amount to as much as the power actually used to operate the trains.

In general it may be said that no one system of electric traction is best adapted to all classes of service. The direct current system seems best adapated to terminal work where a large number of trains are operated, and where, on account of the large number of stops per mile, rapid accelerations are necessary. On account of the denseness of the traffic the substations may economically be placed close together, and, as the distances are short, transmission losses are low. As far as fulfilling the general requirements of railway service is concerned, the series direct-current motor is the best motor available. But its use is limited because it cannot be operated at high voltages; low voltages on the trolley mean high line losses. Likewise, the alternating-current systems, with their high trolley voltages and low line losses, and motors which lack the powerful starting torque of the direct-current series motor, seem best adapted to long trunk-line service where the stops are few and the accelerating period is short as compared with the total time of the run.

Coast to Coast

Winnipeg, Man.—Excellent progress is reported upon the work of erection of the new Parliament buildings and court house at Winnipeg.

Brantford, Ont.—It is claimed that the C.P.R. will transform into an electrically operated road the new L.E. and N. Railway being constructed between Brantford and Lake Erie.

Owen Sound, Ont.—On August 1, plans for Owen Sound's drydock were filed with the Ottawa department of public works. The structure, which will be 775 feet long, will be the largest drydock on the Great Lakes.

Medicine Hat, Alta.—Several carloads of building materials have been delivered to the site of the Saskatchewan Bridge and Iron Company's factory; and the work of construction has started on the laying of brick and the erecting of the iron work.

Ottawa, Ont.—It is announced that the contract for the construction of the Morrisburg and Ottawa Electric Railway has been let; but further details concerning the contract will still be published. It is expected that the work on the line will commence very soon.

Revelstoke, B.C.—The automobile road which is being constructed to the summit in the Revelstoke national park is reaching completion. The work is starting at the upper end of the completed portion of the road, and 10 miles will be completed this summer at an estimated cost of $27,000.

Ottawa, Ont.—A flow of water of the highest quality was struck recently at Ottawa, while excavation was proceeding for the furnace room of the new horticultural building in the city's exhibition grounds; and it is believed that by the opening of the exhibition, a supply can be piped to all parts of the grounds.

Toronto, Ont.—The new registry office which is to be constructed in Toronto, is estimated to cost $400,000, and to be completed in 18 months. It is planned to be a 2-story structure with a basement, which is to contain a bindery in addition to regular equipment; and it will be as nearly fireproof as possible.

West Vancouver, B.C.—The urgency of providing a water supply to West Vancouver is receiving the attention of the ratepayers and council of the municipality; and a report is to be made by the municipal engineer in the near future.

Quebec, Que.—About two weeks ago was commenced the work of setting in position the four shoes, upon which will rest the superstructure of the Quebec bridge, and which have been made by the St. Lawrence Bridge Company. Three cars were required to ship each shoe, and each has a weight of 404 tons and took 2 months to manufacture.

Brantford, Ont.—The hydro-electric branch line between Brant substation and Port Dover is to be commenced immediately. A new aluminum steel-covered cable has been completed by the commission between Brant substation and Dundas; and further protection is to be given to the city by the construction of a fourth series of cables from Niagara Falls to Dundas, according to a recent announcement made by the commission.

Fredericton, N.B.—Repairs are in progress on the roadbed of the Canada Eastern division of the I.C.R. New ties are being laid between Fredericton and Loggieville, and new sleepers are to be placed along the same portion of the line this month, as well as about 40 miles of 85-pound rails on different section of the same length of line. On the portion between Blackville and Derby Junction, 85-pound rails have already been installed.

Victoria, B.C.—Further delay in the progress of arrangements for the construction of the Johnson Street bridge structure has arisen owing to the request of the British Columbia Electric Railway Company to have modifications made in the plans for the bridge in order to widen it to 47 feet and to provide for the passage over the bridge of freight cars; and to have the bridge made stronger beneath so that heavy cars may be conveyed across it with safety.

Indian Bay, Man.—A recent inspection of the Falcon River diversion works at Indian Bay made under the auspices of the Greater Winnipeg Water District Commission shows that very rapid progress is being made. A distance of 1,500 yards has been built in the four weeks since the commencement of operations; while still more rapid work will now be done, since three engines, instead of two as previously will now be used for the hauling of sand and gravel.

Moose Jaw, Sask.—It is now expected that the necessary financial arrangements for the city's programme of sewer, watermain, sidewalk, and paving construction will soon be completed. And since no injunction has been served on the city by the Bitulithic and Contracting Company of Winnipeg to restrain the National Paving and Construction Company of Regina from proceeding with the paving for which it was awarded a contract in June, it is likely that the entire programme of works will be set in operation at once.

Victoria, B.C.—The contractors, Sir John Jackson, Limited, have erected another dolphin off Macaulay Point to replace their fifth dolphin which was carried away recently when a tug with a scow became entangled with the piles. It is expected that some time will elapse before this fifth breakwater dolphin, which marked the extreme end of the seawall, can be again placed in position. In the meantime the newly erected temporary dolphin will facilitate the dumping of rubble on the final 750-foot section of the breakwater.

Red Deer, Alta.—An announcement has been made which states that the Alberta Central Railway, a subsidiary line of the C.P.R. system, which extends for 60 miles from Red Deer to the Rocky Mountain House, will be taken over by the latter railway company at the conclusion of the present month, when a service will be placed in operation. All construction work on the line has been completed and all that at present delays the opening of the new branch is the lack of the consent of the board of railway commissioners, who have not yet made an inspection.

Barton Township, Wentworth County, Ont.—Some of the improvement work at present being carried out in Barton township includes concrete sidewalk construction approximating $16,000 and being undertaken by Chas. Brayley; while a staff of engineers is engaged upon plans for a comprehensive sewer and water scheme for the township, which, in the event of favorable consideration by both the township and city of Hamilton councils, will be constructed at a cost of $500,000. These plans, if possible, are to be completed and ready for submitting the first week of August.

Montreal, Que.—News comes from Montreal that the commission which was appointed to study the problem of the lowering of the water levels in the St. Lawrence River expects to hand in its report in time for action to be taken at the coming session of Parliament. The commission began its investigations last summer, and it is at present making examinations at Cap Rouge. It has been said that a system of weirs will be the possible recommendation to prevent the water from becoming shallower, these having been found satisfactory in other rivers.

Winnipeg, Man.—At the next session of the Greater Winnipeg Water District board, a deputation of Winnipeg business men will urge that still greater efforts be made to secure for Winnipeg a better supply of water considerably in advance of the contemplated time. It is believed that, with greater speed, the work can be completed within 3 years, rather than within 5 years' time. Business men of the city state that the water supply from the wells, though comparatively pure, is very hard and thus detrimental to the equipment of their establishments, causing them annually an enormous expenditure for the replacing of machinery.

Brandon, Man.—The city of Brandon is making every endeavor to hasten the completion of the construction of the G.T.P. Railway line into Brandon. To this end, a new matter which is to be brought before the Board of Railway Commissioners is with regard to a double subsidy which the railway company will receive in case the construction exceeds $15,000 per mile. A single subsidy of $32,000 per mile was provided in case that the construction work cost $15,000 or under; but if it exceeds $15,000 per mile, provision has now been made for a double subsidy, amounting to $64,000 per mile. Another new phase is that the company will be given an additional grant of 35 per cent. of the cost of the bridge, which will be required to be constructed to admit of the entry of the line into the city.

London, Ont.—The form of construction which will comprise the major portion of the work on the London breakwater provides for a 3-foot by 2-foot concrete base toe line and a 26-foot natural slope front of embankment, faced with reinforced concrete 11 inches thick at base and 7 inches thick on top of slope, where provision is made for a substantial concrete cap and a 5-foot sidewalk with guard tubular iron railing. Short lengths of vertical retaining walls will be necessary at the Oxford and Blackfriars bridge ends of the breakwater. The proposition is to provide for a top area of embankment, giving provision for a driveway, and utilizing existing conditions without disturbing trees or making excessive filling necessary in fixing face line of embankment. The estimated expenditure, as authorized, is $25,000.

London, Ont.—A report made following a recent inspection of the work being done on the London and Port Stanley Railway, shows that the new steel has been laid from St. Thomas to Port Stanley; and that new rails are being laid north of St. Thomas, this work on the whole line from London to the lake being practically completed. No statement of cost has yet been given on the roadbed, the 23 miles of steel rails, the 70,000 ties and the ballasting. A number of new sidings are to be constructed; and at present, the foundations of a new freight shed are being laid, which building it is expected to have completed by fall. The officials of the railway say that the road will be in operation within a few months, though so far no rolling stock has been purchased. However, they plan to lose no time in expending the $750,000 which has been expropriated for the electrification of the line.

Edmonton, Alta.—In addition to an offer of cheap power which has just been made to the city of Edmonton by New York and San Francisco engineers, it is understood that a second proposition is to be made by a syndicate, for which Sir John Jackson, of Montreal and London, Eng., is engineer. The site for the water power plant is just 50 miles from the city on the Saskatchewan River, above the Rocky Rapids. For two years or more, the company has been investigating and studying the location, and many plans have been prepared, showing where 3 immense storage dams can be built, capable of holding several hundred million cubic feet of water each. The scheme contemplates the development of 40,000 horsepower, while investigation has shown that further power can be secured when the load increases. The approximate expenditure, which the company estimates will be spent in harnessing the Saskatchewan River, is $6,000,000.

St. John, N.B.—Four hundred men, 5 tugboats, 3 dredges, 2 locomotives and trams and 4 reclamation plants are engaged upon the scheme of reclamation and development which is in progress on the western side of the St. John Harbor, where berths are being constructed to accommodate some of the large ocean steamships of the C.P.R. Company this coming winter, and where the contract is held by the Maritime Dredging and Construction Company, sublet to Cape and Company and to Mr. D. C. Clark. Three hundred workmen, 1 powerful suction dredge, 3 high-power elevator dredges, an ocean tug, 5 locomotives and ballast trains, 2 steam shovels, and other accessories, are being constantly employed by the Norton Griffiths Company in pushing forward the harbor and industrial development at East St. John. The firm has almost completed an immense breakwater of stone; has reclaimed over 12 acres of land for a ship repair plant; has excavated about one-third of the site for a dry dock; and has made considerable progress in dredging berths inside the breakwater for ocean commerce and in widening and deepening the entrance channel. Next spring the company will begin the construction of concrete and steel cylinder quays for ocean berths, and a pier at the entrance to the dry dock. The contract, which expires in 1917, covers the supplying of 23 steamship berths and involves an expenditure of over $30,000,000. It is expected that this particular point will be utilized by the G.T.P.R. Company.

Moose Jaw, Sask.—Recently, what was thought might prove to be a serious break occurred at the infiltration gallery at the headworks of the Moose Jaw water system at Caron, Sask. The break occurred while the water department was engaged at cleaning out one-half of the Rosedale reservoir, which has not been cleaned since put into commission in December, 1912. The break is a large one and only a few feet west of the pumping station, so that it does not allow of the water being brought in through the infiltration gallery. A large flume has had to be built out to the side of the natural reservoir and a steam pump installed. In this way the water now being used in the city is being pumped twice. In the first place, it is pumped from the reservoirs into the flume by the steam pump, and afterwards from the well into the pressure main to the reservoir. The cleaning of the reservoir has proven, apart from this, to be a difficult task, no provision having been made for the like at the time of its construction. One-half of the big reservoir, which has a capacity of 1,000,000 gallons, was left full, while the other half was emptied and Moose Jaw supplied with water direct from the pressure main from Caron. During the 18 months that the reservoir has been in use, there has been deposited in the bottom of it almost 4 feet of silt. This has been pumped into a surface reservoir which had to be constructed on a street north of the reservoir. The work has been in charge of Commissioner Mackie of Moose Jaw; and no further serious trouble is anticipated by him from the break at the headworks, provided none is caused by the steam pump before the break has been repaired.

PERSONAL.

J. B. NICHOLSON, B.A. Sc., is engineer for the Township of Barton, Ontario.

H. E. M. KENSIT, has tendered his resignation as city commissioner for the city of Prince Albert, Sask.

W. V. HUNT, electrical engineer in the employ of the British Columbia Electric Railway Company for the past several years, has resigned to engage in private practice in Vancouver, B.C.

OBITUARY.

The death has been reported from Porcupine, Ont., of Mr. B. C. Wolfram, manager of the West Dome mine.

It is reported that Mr. Louis Margolin, formerly with Clarke and Lyfrod, forest engineers, of Vancouver, met death recently in the Sierras, Nevada, by drowning. Mr. Margolin, who was 34 years of age, was a well-known timber estimator in British Columbia.

NEW CANADIAN MEMBERS A.W.W.A.

Among recent additions to the membership of the American Water Works Association are noted the following names:—

James Barr, M. E., Department of Water Works, city of Toronto.

R. C. Harris, Commissioner of Works, city of Toronto.

Robt. B. Owens, B.A., B.E., Governmet Buildings, Edmonton.

Joseph Race, City Bacteriologist and Chemist, Ottawa.

R. A. Ross, Consulting Engineer, Montreal.

Jas. T. Wickham, City Engineer's Office, Eastern Division, Montreal.

JOINT ROAD CONGRESS IN 1915.

The matter of holding a joint convention or congress in which the American Highway Association and the American Road Builders' Association are the chief factors, is under consideration in connection with the Panama Pacific Exposition in 1915. The meeting will probably be held at Oakland or San Francisco.

COMING MEETINGS.

WESTERN CANADA IRRIGATION ASSOCIATION.—Eighth Annual Meeting to be held at Penticton, B.C., on August 17, 18 and 19. Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

AMERICAN PEAT SOCIETY.—Eight Annual Meeting will be held in Duluth, Minn., on August 20th, 21st and 22nd, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.

CANADIAN FORESTRY ASSOCIATION.—Annual Convention to be held in Halifax, N.S., September 1st to 4th, 1914. Secretary, James Lawler, Journal Building, Ottawa.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Seventh Annual Meeting to be held at Quebec, September 21st and 22nd, 1914. Hon. Secretary, Alcide Chausse, 5 Beaver Hall Square, Montreal.

CONVENTION OF THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—To be held in Boston, Mass., on October 6th, 7th, 8th and 9th, 1914. C. C. Brown, Indianapolis, Ind., Secretary.

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9th to 13th, 1914. I. S. Pennybacker, Executive Secretary, and Chas. P. Light, Business Manager, Colorado Building, Washington, D.C.

AMERICAN ROAD BUILDERS' ASSOCIATION.—11th Annual Convention; 5th American Good Roads Congress, and 6th Annual Exhibition of Machinery and Materials. International Amphitheatre, Chicago, Ill., December 14th to 18th, 1914. Secretary, E. L. Powers, 150 Nassau St., New York, N.Y.