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BRIDGE CONSTRUCTION AT NEWCASTLE, N.B.

DESCRIPTION OF THE FOUNDATION WORK OF THE MIRAMICHI RIVER HIGHWAY BRIDGE — BUILT ON TWO ABUTMENTS AND FIVE PIERS OVER 1400 FOOT CHANNEL—OPEN CAISSON DREDGING METHOD USED

By C. A. WENTWORTH

An interesting piece of bridge foundation work is being built for a highway bridge across the Miramichi River at Newcastle, N.B. Newcastle is situated about thirty miles from the mouth of the river and is a growing town of 3,000 inhabitants. Across the river is the town of Nelson, and six miles below, on the Nelson side, is Chatham, whose population is slightly larger than that of Newcastle.

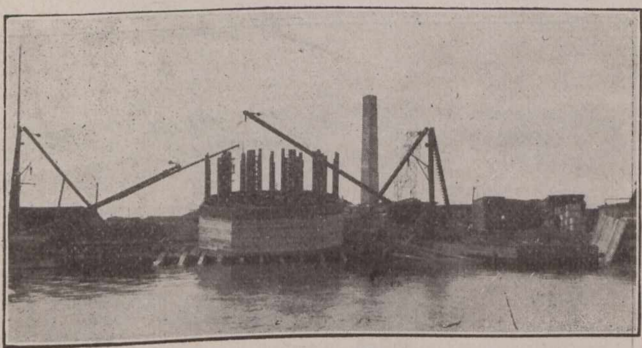

Fig. 1.—Pivot Pier Caisson Ready for Launching.

The river varies from three miles wide near the mouth to about one-half mile wide at Newcastle. The nearest highway bridge to the mouth of the river is at Indiantown, over forty miles from the mouth and about fifteen mines from Newcastle.

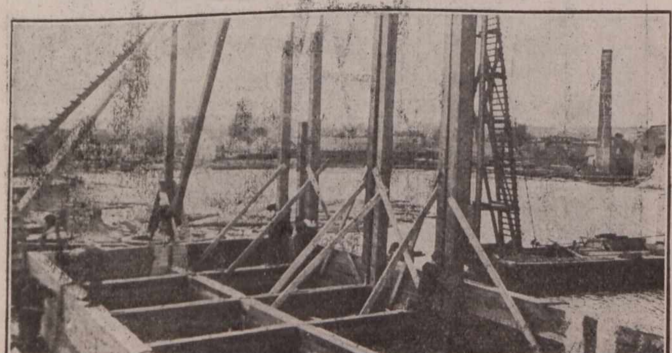

Fig. 2.—Lower Course and Binder Posts of Caisson No. 2.

Four to five months in the winter the river can be used as a highway, as the ice is usually 30 in. to 36 in. thick; and for a slightly longer time in the summer ferry boats cross the river at both Newcastle and Chatham, but for a month or more in the fall and spring there is no way of crossing. The important lumber and manufacturing interests all along the river made the construction of a bridge a necessity to accommodate the important interests of the people in this section of New Brunswick.

After careful examination by diamond drill borings, the location was decided upon opposite Newcastle and about one mile downstream from the confluence of the southwest branch with the northwest branch of the Miramichi River.

Fig. 3.—Launching Ways.

The water in this river is from thirty to forty-five feet or more in depth, and there is a tidal variation at Newcastle of about six feet, with a maximum of ten feet. The current varies with the tide from three miles per hour upstream on the flood tide to nearly six miles per hour downstream on the ebb tides.

The river bottom consists of fine sand and mud, twenty to thirty feet deep overlying harder strata of sand and clay, and sand and gravel, carrying artesian water. This bottom produced unusual foundation difficulties to contend with, there being no ledge rock on which to rest the piers, except at the Nelson abutment.

The design finally adopted for the bridge calls for four spans of 278 feet, and a draw span with an opening of 115 feet on either side of the draw. The approaches are each about 700 feet long and are composed of rock-filled slope walls with an earth core, the rock fill protecting the earth from erosion by the waves and ice.

There are two abutments and five piers, each founded on piles, and built of concrete from the bottom to a point seven feet below mean tide. From this point to high tide level they are composed of cut granite masonry backed with concrete, and above high tide level of freestone backed with concrete.

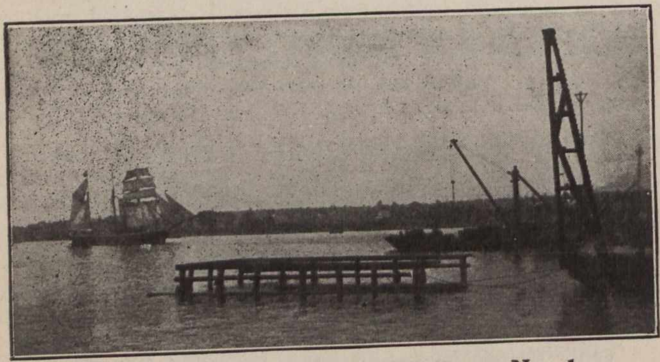

Fig. 4.—Guide Frame for Caisson No. 1.

The abutments presented no unusual features. They were both built in open cofferdams, which were made by driving wooden sheet piling around a built-up framework of 12-in. by 12-in. yellow pine timbers, which formed the braces and wales of the cofferdam. As soon as the sheet piling was completed the cofferdams were pumped out and excavation made to ledge at a depth of twenty-eight feet at the Nelson abutment, and to a hard clay and sand strata at a depth of sixteen feet in the Newcastle abutment. The piles for the latter abutment were then driven with a drop hammer; using an extension lead pile driver; and the concrete of both abutments was placed in dry space.

The five piers presented the most interesting and difficult work. They vary from 56 feet to 69 feet in height and are being built in water from 35 to 48 feet deep.

The plan of construction adopted for these piers was the "Open Caisson Dredging Method." Caissons were framed up of yellow pine timber, twenty-six feet wide (except the pivot pier caisson) and of the height required for each pier. The two largest caissons were 63 feet 6 inches high. The pivot pier caisson was octagonal in shape, 42 feet across and 59 feet 6 inches high. The pivot pier caisson ready for launching is shown in Fig. 1.

All of the caissons were framed up on shore to a height of twelve feet around the first set of binder posts, which in the largest caissons were 31 feet high. The outside walls of this portion were built solid of 12-in. by 12-in. timbers and braced by one longitudinal and four lateral sets of timbers framed into the sides and bolted solidly at the intersections and to the binder posts. The bracing timber was placed in vertical rows so that the caissons were divided into ten pockets, four of which served later for dredging and six of them for loading with sand for sinking. The lower courses and part of the posts of one of the rectangular caissons is shown in Fig. 2.

The launchingways, illustrated in Fig. 3, were built of heavy timbers 30 feet long, laid horizontally and resting at their centre on a 12-in. by 12-in. rocker timber 54 feet long.

The caissons were built on these timbers in a level position and, when ready for launching, the caisson and supporting timbers were tilted on the rocker timber. This brought them in line with another set of timbers leading on the same slope into the water, and the caissons were launched by sliding on these timbers. No cradle or falsework was used and no difficulty was experienced with this method of launching. (Two hours were sufficient to tip and launch the caissons and thirty minutes after launching a caisson the launchingways were ready to start construction of the succeeding caisson).

Pontoons were secured in four of the pockets of each caisson before launching to float it in a level position when launched and hold it at an elevation in the water convenient for working. All of the caissons were lauched sideways as the water was only about six feet deep at high tide where the launchingways were constructed.

After launching, the caissons were tied up at a dock where building up continued until the caissons drew 23 feet of water, the total depth available, and then towed to their final site. They were then built up in place to their finished height, the caissons in every case drawing enough water to rest on bottom before being completed.

The strong current in both directions required special means of holding the caissons in place, the pressure against them being over 50,000 lbs. on the ebb tide at times. A guide frame composed of thirty-two piles, sixteen of which were batter piles, bolted to the other sixteen

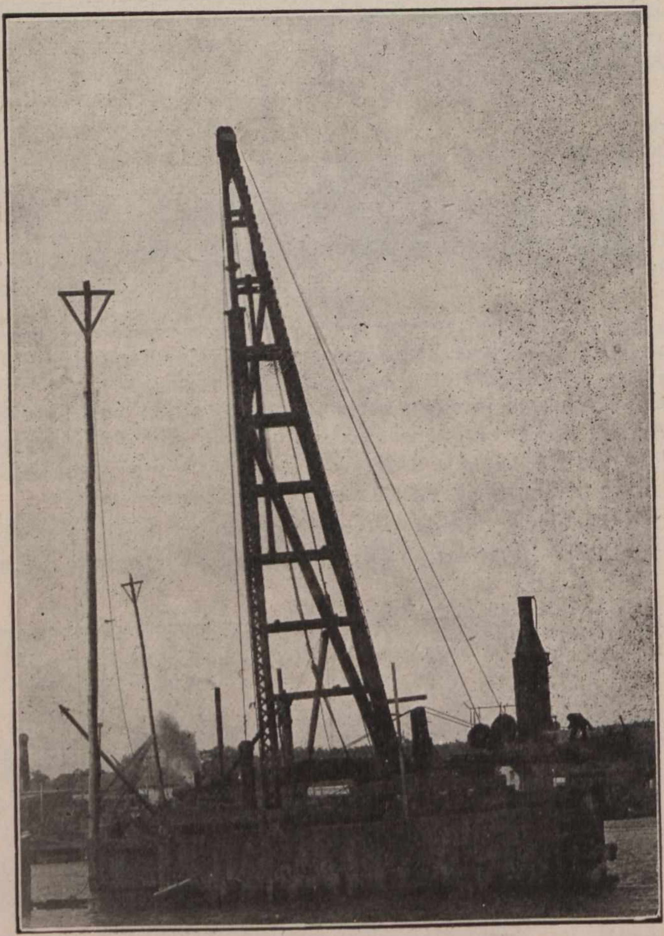

Fig. 5.—Pile Driver.

vertical piles, was driven to from three sides of a rectangle the upstream side being left open, as shown in Fig. 4. These piles were capped and braced in position. Chinese anchors, made by filling timber cribs 16 feet square with 40 tons of rock, were previously constructed and sunk about 400 feet upstream and downstream from the caissons. Each caisson was secured to four of these anchors by means of 1¼-in. galvanized iron cables with double wire rope blocks and tackles so as to adjust it in position and hold it against the current.

The caissons were sunk through the mud and sand by dredging in four of the pockets with a clamshell bucket. False bottoms were placed in the other six pockets, sixteen feet above the cutting edge, and these pockets were weighted with sand while the dredging was going on. For one hundred years the Miramichi River has been a lumbering centre and many of the logs have become waterlogged and sunk. Many of these, sometimes twenty feet deep in the mud, were encountered in sinking the caissons, and were either taken out by the clamshell bucket or had to be cut off by a diver. High-power jets were also used by a diver under the cutting edge of one caisson to sink it through a strata of clay. In addition to the sand pocket method of weighting, pig iron was also used. All of the caissons have now been sunk and the maximum variation of any caisson is 15 ins. from the actual to the located centre line.

The hard strata of sand, clay and gravel on which the caissons rest might be sufficient support for the piers, but it was considered advisable not to rely on this, but to use a pile support. The heads of the piles had to be driven to a depth of over 60 feet below the top of the caissons in some cases. A sixty-five-foot extension lead pile driver was built and provided with a steel tube which worked in these leads. The piles were placed in this tube and driven by a 5,100-pound drop hammer working through the water. The piles were cut to length and driven until their heads were at the cut-off grade with a few exceptions. These were cut off by a diver. The pile driver was mounted on a turntable, the leads and engine turning on conical rollers on a circular track secured to a bed frame. A 2½-in. steel king bolt fastened the sills to the turntable. With this driver it was possible to reach every part of a caisson, while the weight of the driver, tube and hammer, amounting to over 25 tons, was supported along the centre line of the caisson. This pile driver is shown in Fig. 5. When the piles were driven in one caisson the pile driver was rolled on a scow and floated to the succeeding caisson.

After completing the pile driving, 12 feet of concrete was placed, entirely filling the bottom of the caissons. This concrete was put in with a bottom dump bucket working through the water. When the concrete had set the caissons were pumped out and the pier shafts constructed in dry space. Rail grillages were set vertically in the under-water concrete by a diver while the concrete was being placed and after pumping out, additional rails are connected to these by splice bars to reinforce the pier shafts. A view of the work four months after starting is shown in Fig. 6. The work was begun the latter part of May, 1913, and will be completed early in the coming winter.

The Hon. John Morrissy is Chief Commissioner of Public Works; A. R. Wetmore is Provincial Engineer, and A. R. Sprenger is Resident Engineer. The Foundation Company, Limited, are the contractors, and C. A. Wentworth is superintendent.

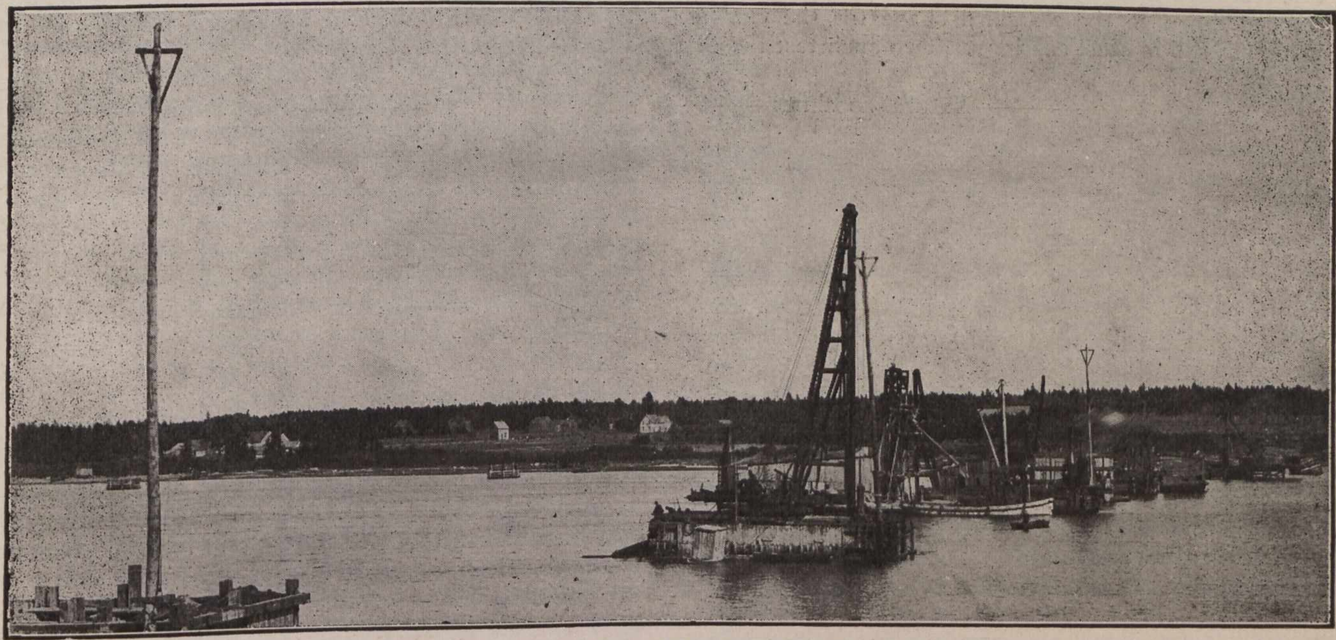

Fig. 6.—General View Four Months After Beginning Work.

The new harbor at Emden, Germany, which has taken three years to build, was opened recently with a good deal of ceremony. The sea sluice of the Emden harbor is the largest in the world; it is 260 meters long, 40 wide and 13 deep. Sixteen torpedo boats can pass through simultaneously within 15 minutes.

The Governor of New York, after consultation with the commissioner of highways, the attorney-general and the commissioner of efficiency and economy, has decided that hereafter asphalt shall be bought on open specifications and not under separate specifications for natural and oil asphalts, as was proposed by the consulting board of highway engineers. Full details have not yet been prepared, but it has been announced by the Governor that "it has been decided to have the specifications so drawn that every suitable asphalt known can be used, but to insert the conditions that every contractor must guarantee the road he builds for at least three, and possibly five years. This will do away with the asphalt scandal. This provision will give every asphalt dealer in the world who has an asphalt which he will guarantee for five years an equal chance with every other asphalt man for the business of New York State."

EFFECT OF HEAT TREATMENT ON THE STRENGTH AND DUCTILITY OF ELECTRIC FURNACE STEELS.

An article written by T. R. Loudon, B.A.Sc., and descriptive of a Canadian electric steel furnace, appeared in October 23rd issue of *The Canadian Engineer*, and the general layout of the plant of the Moffat-Irving Steel Works, Limited, was included.

Since the appearance of the above article Mr. Loudon has conducted some experiments on the tensile strength of various carbon steels made in this furnace. The main idea followed out was to determine the strength of the steel as used in an ordinary steel casting, and then by heat treatment, to refine the grain size and note the effect on the strength and ductility.

The test bars were cast in rectangular form, and were then turned down to the standard shape for the tensile test of metal used in steel castings. Two such test pieces were made from each heat. One of these test bars was then placed in an annealing furnace and the grain size heat refined, care being taken to reach the desirable temperature for the various carbon contents.

The specimen bars were then tested in a Riehlé machine in the ordinary manner with the following results:

It is quite noticeable that in every case the tensile ultimate strength has been raised by heat refining the grain. The elastic limit, however, has been lowered but, as would be expected, the elongation results show a very great increase in ductility. The metal examined under the microscope shows evidence of being very sound, and, as intimated in the former article, the wearing qualities of this electric furnace steel are greater than mere physical tests would indicate.

		Natural specimen			Heat refined		
Heat.	Carbon.	Elastic limit.	Ultimate strength.	Per cent. Elongation in 2 ins.	Elastic limit.	Ultimate strength.	Per cent. Elongation in 2 ins.
167	.23	53,300	68,950	12.5	52,200	72,100	26.25
168	.18	47,500	63,900	15	46,300	66,850	25
171	.31	56,000	82,800	12.5	53,000	84,500	22.5
175	.12	49,200	53,700	17.5	47,050	57,450	35
178	.23	52,500	68,750	13.75	53,600	70,500	27.5
181	.35	53,300	84,600	10	53,950	88,400	20
184	.21	59,450	80,050	15	59,200	81,500	22.5
187	.29	49,950	74,850	15	50,500	76,650	30

ELEVATORS: THEIR USES AND ABUSES.*

By B. C. Van Emon.

An elevator may be termed an ingenious mechanical device, invented and designed by man to overcome nature's imperative law, the law of gravitation.

The overcoming of gravitation by the use of an elevator is by no means modern, for, many ages ago, history has shown that man had equipped a clumsy handpower contrivance, whereby, with the use of considerable human energy, a greater weight was overcome by a lesser energy; but modern equipment, invention and devices place the elevator in a mechanical class entirely by itself. The towering buildings of modern construction, these massive structures of many stories, are rendered possible, practical and economically advantageous, only through the installation of the modern elevator, which, by its convenience in carrying passengers and freight to a higher or lower elevation and its accommodations for a practically unlimited number of passengers, increases property a hundredfold in its initial value.

Like most modern inventions, which many centuries ago were in crude construction, the completion and almost perfection of the elevator has been an achievement left for the present century. Thus, again, like the perfection of all other wonders which now seem to us so commonplace, the practical completion of the elevator has been a matter of slow evolution.

The combined mechanical genius of many elevator engineers has given to the public various types of elevator construction, of which a list is herewith presented:

Elevators may be divided into the following classes: Handpower elevators; belt or power-driven elevators; steam elevators; hydraulic elevators; pneumatic elevators; electric elevators; each of these being divided into classes by governing conditions.

Handpower Elevator.—This is the oldest elevator known, patented in the year 1846. When used for handling freight in buildings the machinery is generally located overhead and consists of a long wooden drum, with a large gear wheel attached to the end; this wheel engages with a smaller pinion driven by a large "bull" wheel, or wheel upon which a rope is placed, leading from the lower floor through the several floors of the building over this "bull" wheel; this rope is spliced and is made continuous. By pulling this rope the countershaft is made to revolve and drives the small pinion; this engages the large gear wheel which turns the drum upon which the rope is attached to the car, and in this manner lifts the freight. The sizes of these hand-power elevators, under this condition, vary, according to the work to be done, and are built for capacities of 4,000-pound or 5,000-pound loads at a very slow speed.

The next type of hand-power elevator commonly used is for sidewalk elevators, this type dating from 1858. The gearing or hoisting mechanism is generally built on an iron frame, and consists of gear wheels, ratchets and brakes. These frames are sometimes built of wood, with

*Read before the Technical Society of the Pacific Coast, July 18, 1913.

the gearing mounted as upon the iron frames, and are used for raising and lowering merchandise from basement to sidewalk level.

Double Belt Worm-Gear Elevator.—Another type of elevator commonly used for handling freight, is driven with belts from the main line shaft in the building to pulleys on the worm shaft of the belt elevator. These are double belted, one belt traveling in one direction, the other, a cross belt, traveling in the opposite direction; and by the use of a pull rope placed conveniently in the well hole, by means of a mechanical device, these belts are shifted on and off the tight pulley on the worm shaft, giving the operator control of the direction of the elevator. When the rope is pulled to the neutral position, the belts are both off of the tight pulley and run on the loose ones. This same movement sets the brake on the tight pulleys and holds the car when fully loaded. The worm gear mechanism is enclosed in a cast-iron casing and filled with oil, and on the worm wheel shaft is placed a winding drum of sufficient size to accommodate the hoisting cables, these cables being carried up through the hatchway over a sheave on top of the elevator shaft, and down to the car. On the opposite side of the drum are ropes passing upward through the building over another set of sheaves, that are attached to a counterweight, balancing the car and part of the load, this arrangement giving the best results. These worm-gear machines were built in sizes as high as 6,000-pound loads and were considered very large elevators in the early elevator days. However, even with the great advancement made in the elevator industry, a belt elevator is rarely built to exceed a capacity of 6,000 pounds even at the present day.

Later, the belt elevator was operated by an electric motor with a single belt running to the drive pulley, or tight pulley on the worm shaft. This electric motor was started and stopped by an electric switch which reversed the current in the motor, and gave it the direction required, thus eliminating one belt and giving a direct drive from the motor power to the elevator, and when the elevator was not in operation no power was being consumed. This was practically the next step in the elevator advancement.

Steam-Driven Elevator.—About the period these belt-driven elevators were first used, there was also a steam-driven elevator, operated by steam direct to an engine, of the reversing type, somewhat like the "Brotherhood engine" used on steamboats to control the rudder. These steam-driven elevators were operated by a pull rope with a pilot valve on the engine almost in the same manner in which the steamboat operated its controlling mechanism with the rudders. The first of these engines were direct-geared to a drum, with suitable rope connections over sheaves overhead to the car and counterweights. Latterly, these steam engines were geared to worm-geared machines.

Hydraulic Elevator.—This elevator was developed about this time, and consists of a large cylinder with a piston and a piston rod running through a stuffing box properly packed, and on the end of the piston rod are fastened several wire ropes wound around a very small drum, securely fastened to a shaft, upon which is keyed a very large drum. This was what was termed, at that time, a "pull-back machine," and was run generally from the city water pressure or city hydrants. This was controlled by hydraulic valves for admitting water into the cylinder, and also discharging it into sewers. These elevators were quite commonly used about 1880 and 1890, at which time the electric elevator came into general use.

Plunger or Hydraulic Ram Elevator.—About 1882, the first plunger or hydraulic ram elevator, as it is termed, came into use. This plunger elevator consists of a piece of steel or iron pipe, which is turned true and smooth on the outside and operated through a stuffing box, which is securely fastened to the top of a piece of pipe of a larger diameter in which the smaller is enclosed. By admitting water on the top end of the larger pipe, in which the smaller pipe is placed, the water pressure will cause the smaller pipe to pass through the stuffing box and propel the car in either direction when the control valve is opened, thus allowing the water to escape into the sewer. Plunger or ram elevators are set into the ground, a hole being bored of sufficient size and depth according to the travel and height of the building in which the elevator is to be operated.

At the present time, plunger elevators are built for almost any travel up to 300 or 400 ft., and the water pressure applied is in ratio to the height of the building; in some instances, the water pressure required being 700 pounds per sq. in., varying, of course, according to the size of the ram and the conditions under which it operates. The writer will not enter into technicalities to the extent of figuring out accurately just what the strains are, and what the tension on the ram would be, under certain conditions, but it is a well-known fact that in tall buildings where the ram or plunger elevators are used, when the ram or plunger is a certain distance out of the stuffing box it comes under a pull instead of a push, and, in many cases, and almost universally in high buildings, it is necessary for the manufacturer to put a couple of wire ropes inside of the ram or plunger pipe the full distance, these being securely fastened at both ends very taut to hold the compression of the ram, so that when the stress or pull is put on the car after reaching a certain height it will not separate or pull apart at the joints, these joints being necessary in the plunger to keep it water-tight, and also assist in overcoming the strain which is placed on the pipe. This, it will be readily understood, becomes a strain or pull on the plunger after it has reached a certain distance from the ground or level at which the stuffing box is placed, caused by the increasing counterweight, this being necessary to overcome weight of the car and plunger, the same being generally made of steel pipe of a thickness sufficient to withstand the water pressure admitted in the larger pipe, around which the water is encased, which presses against the smaller or finished turned plunger which travels up and down the well hole. The plunger elevator is now being very successfully operated in tall buildings; the only drawback being the immense weight which constitutes the elevator equipment, also the time element necessary in starting, stopping and reversing this enormous weight in a given time. The stress upon the ram or plunger pipe, casing, control valves and other parts, is very great, as the water pressure is very high. An elevator equipment in a building of 300 ft. travel consists of the ram or plunger, the car with its counterweights, necessary to properly balance the car, and plunger which must be very heavy; and it seems to the writer that the time element is very necessary in starting, stopping, and reversing this elevator; whereas an electric elevator made very light can be started, stopped and reversed much quicker, and, unquestionably, can run at any speed desired.

Admitting the plunger elevator for tall buildings to be very expensive, it being necessary to bore a hole in the ground equal to, if not a little more than, the total height of the travel of the car, it is a fact that the turning of the steel plunger or ram, the fitting together of the same, with the outside casing necessary to contain the high water pressure, the stuffing box at the top of the outside casing, with all its pumping apparatus and controlling apparatus, the necessary variable counterweights and all their accessories, must entail more expense than any direct electric elevator. Conceding that the starting and stopping of the Hydraulic elevator are much easier and more gradual, the actual running conditions of both are the same, and, so far as safety is concerned, the electric elevator is conceded by experts to be safer than the plunger type. In high buildings the electric elevator requires less for repairs, is less expensive to operate and costs less for installation.

The efficiency of the plunger elevator depends entirely upon its construction, and to make it efficient it is necessary to properly counterweight the same, so that as the plunger leaves the ground floor, and it comes out of its stuffing box, it pushes the car up; the counterweight in coming down must be so constructed that it will increase in weight equal to the same amount of the weight of the plunger coming out of the stuffing box. For example, suppose one foot of plunger should weigh 25 lb., every foot of counterweight that passes over the overhead sheave must weigh an equal amount, and it is readily understood that in tall buildings when the elevator reaches a certain point in its travel it becomes a pull upon the ram by the amount of counterweight that has passed over the sheave, and that the remaining part of the ram from this point in the shaft down to the stuffing box is holding back to this point over the counterweight, so that as the elevator ascends beyond this given point there becomes a strain upon the ram instead of a push. As before stated, to insure safety there must extend the whole length of the ram, and on the inside, a wire rope drawn very taut to make sure that the ram will not separate at one of the joints and allow the elevator car with its load to go crashing through the roof, which actually occurred with fatal results in an eastern city some years ago.

In the use of safety devices for the car it is necessary to have them so arranged that they will operate in either direction, because the safety devices must work in the reverse direction after the ram is placed under a strain by being out of the casing a certain required distance.

There is also another type of plunger elevator where the plunger is not placed in the ground, but is at one side of the well hole. This type is worked under somewhat the same conditions heretofore mentioned. In this type of plunger elevator, the weight of the plunger must equal the car plus the load. This plunger is held up by the pressure of the water, and when the load is lifted, the pressure of the water is released from the cylinder under this plunger, thus allowing the water to escape, and the excessive weight of the plunger over the weight of the car through its multiplication of ropes and sheaves will lift the car. When the car descends, it is necessary to produce a pressure in the cylinder great enough to lift this ram or plunger and allow the car to descend. Ordinarily, this type of elevator was a multiplication of "two to one" or "three to one" in the rope connections, and all of the work is accomplished through wire ropes connected to the car, over sheaves, placed overhead in the hatch. This type of elevator has the reverse features of the plunger elevator when the plunger elevator is a certain distance out of the ground, that is, the safety devices on this elevator operate in the opposite direction to those on an ordinary electric elevator, for if the cylinder which holds the water should break or a pipe should give way, allowing the water to discharge freely from the cylinder, the plunger would drop very rapidly, and the elevator would attain excessive speed in going up, and might result in an accident. These safety devices must operate in case the ropes should break, and prevent the car from falling, and they must be operative in both directions.

This type of elevator is very successfully operated at high speeds, can be started and stopped very quickly, and comes nearer the action of a direct electric elevator for high buildings than any other hydraulic elevator.

Horizontal Multiple-Sheave Elevator.—This type is generally placed in the basement of a building on the floor and consists of a large cylinder with a piston, a connecting rod and a set of multiple sheaves travellng on a crosshead mounted on a track. On the other end of the cylinder is also placed a set of sheaves, equal to the number which travel with the piston and connecting rod, and as the water is admitted into the cylinder between the head and the plunger it moves the plunger out, thus pushing the plunger and sheaves upon the ropes passing around these sheaves—the other end of these ropes being attached to the cylinder—and thus lifts the car. In this type of elevator, the car is counterweighted to within a point wherein the weight of the car will overcome the water in the cylinder, and when the valve is open to lower the car the weight of the car must be sufficient to push the water out of the cylinder into the tank where it is again pumped under pressure. This latter is the most universal type of hydraulic elevator used for passenger service in high-class buildings, as the starting and stopping of this elevator is very gradual and accomplished without shock or jar, and it may be handled successfully at very high speeds.

Direct-Connected Electric Elevators.—There are several types of direct-connected electric elevators, one consisting of the worm gear with drums attached and ropes fastened to the winding drums; another, the direct-connected worm-gear elevators with traction sheaves around which the rope is passed several times and run over an idler sheave, where one end of the rope is fastened to a counterweight, and the other end to the car. This worm-gear traction elevator is now coming into general use.

Another type of traction elevator is the "one to one" type, with the traction sheave securely fastened to the rotating shaft of the armature and the idler sheave directly over or underneath same, depending upon the position and condition under which the elevator is to operate. The ropes pass around these sheaves the same as in the worm-gear traction type of elevator. This type of elevator is capable of an unlimited speed, while the worm-gear traction drive elevator is somewhat limited in speed.

Again referring to the worm-gear elevators with their winding drums and ropes securely fastened thereto, it should be said that they are generally made in two types, one of a single worm and worm wheel, and the other, a double worm and two worm wheels.

The double-worm machines consist essentially of two worms in an oil-tight casing, one of which is made right hand, the other left hand. The two worm wheels in which these worms engage are made right and left hand to fit, and they are so arranged that, in most cases, the two worm wheels constitute a gear wheel, as well as a worm wheel, being meshed together, thus constituting a three-point connection between the right-hand worm and the left-hand worm and the two worm wheels which are gear wheels, thus giving the double-worm elevator its superior working qualities and strength over the single worm, because it has double the amount of contact or wearing surface between the worm and the wheel, thus allowing the use of a much larger motor and doing much heavier duty than can be done with a single worm, since there is a limit to the amount of work that a worm will do under a given load and speed. This double-worm elevator, or tandem worn-gear elevator (as it is commonly known), is only used for high-duty purposes, that is, where it is high speed with ordinary heavy loads for passenger service.

In some instances these worms are cut a double pitch, these being two worms of the right hand and two worms of the left hand, thus giving what is termed four points of contact for driving the worm wheel upon which is fastened the winding drum, around which the cables are wound. These worms are always made of a very high grade of steel, and the worm wheel also is made of the best grade of phosphor bronze, thus giving the best metals known for heavy friction at high speeds. These worms are operated, in some cases, up as high as 1,400 rev. per min. and are giving excellent service at that speed. They are all enclosed in an oil bath with a special oil for the purpose, and when doing very heavy duty become quite warm at times.

With all of the worm-gear elevators it is generally conceded that, if properly constructed, the efficiency is about 50 per cent., and in instances less than that; so that in placing the electric motor for an elevator of a given duty, it is necessary to put on a motor having a capacity not less than 50 per cent. greater than the theoretical work to be performed, and in many cases as much as 75 per cent. greater capacity. It is also necessary to have a motor which will do at least 50 per cent. excess duty for a few moments in starting the load and getting under headway in a given time. It is now the rule for manufacturers of motors for elevator purposes, to build them for what is termed "intermittent duty," so that they will stand an excessive over-load for a few moments and also operate at their normal horse-power and carry the load for the time required. These motors are now built especially for this purpose with large extra shafts, extra strong windings, and other features necessary to meet the severe conditions under which an elevator motor is to operate.

Controlling devices for these motors are also built by manufacturers who make a specialty of that class of work, and who have made an exhaustive study of the duties required for controlling apparatus. The advance made in the last few years in such apparatus is very marked, as the elevator controllers at the present time are much more durable than in former years, are simpler, more efficient, less liable to breakage and are somewhat cheaper, owing to the large number now being built.

There has also been developed within the past few years the full magnet control for alternating-current elevators. These controllers are built in all sizes.

The difficulty in the past has been that the laminations for the working parts of the solenoids or the magnets required to operate the switches have made too much noise, and in operation would heat, and the constant expansion and contraction of the laminated parts loosened them and broke them down completely. But these A.C. solenoids and magnets are now so constructed that they do not heat and the noise is at a minimum, thus giving excellent service in operating the switches. No doubt in time there will be a marked improvement in the A.C. controlling mechanism for elevators. They are also well developed for the full automatic control elevators such as are used in apartment houses, and their cost is but very little more than for the D.C. apparatus to do the same duty.

During the past few years the A.C. motor for freight purposes has made marked progress and is giving good service without interruption.

Within the last year or so an A.C. motor has been introduced for elevator purposes which can be thrown directly across the line using a reversible switch. These motors are very simple. They have an enormous starting torque, from two to three times their normal running torque with about the same overload of current necessary to produce this torque. This makes the A.C. motor very valuable for small freight elevators. These motors are now built so that they run very quietly and are very flexible in starting.

In the larger motors, for heavy freight duty and also for passenger service, what is termed the "slip ring armature resistance type motor" is used, operating with practically the same device that operates a direct-current motor, and the resistance in the armature is cut out in several steps by a control magnet, operating cut-out contacts, for cutting out or short-circuiting the armature resistance as the motor comes up to speed, thus giving it from two to three times its starting torque and holding the same until the armature resistance is completely cut out. This development in the A.C. motor has been very beneficial to the elevator manufacturer, since prevailing current supply is now alternating, and it is only a question of time when the direct current will become obsolete.

The first electric motors for power came into use in 1886 and 1887. These electric motors were operated from the old constant-current arc-light machines, viz., 9.6 amperes of constant current where the voltage varied according to the load placed upon the electric motor. These motors were controlled by shifting the brushes on the commutator, and were, at that time, the only known electric power which gave commercial satisfaction. A great many of these motors were built in San Francisco from 1886 to 1890. The old constant-current motors were built up to 15 h.p. and as high as 20 h.p., this latter being considered a large motor. They were belted to countershafts for driving pumps for pumping water into a tank on the roof, or in a steel compression tank under air pressure, where the water under pressure was used to operate the elevator, it being discharged from the elevator into a surge tank and then repumped under the pressure required to operate the elevator.

About 1890 appeared the constant potential motor which is now in use, that is where the voltage is kept constant and the amperes vary according to the work to be done, and wherein the motor does not require a governor to operate the brushes to control the speed, but where the brushes of the motor are fixed, the speed depending upon the adjustable relations. These motors were much cheaper than the old constant-current motor and gave better results. About this time all of the controlling devices necessary to start and stop the electric motor which operated the pump were also perfected. Some of the apparatus is in use at the present time, giving fairly good service.

In 1891, the writer patented a direct connected electric elevator. This was a tandem-geared, or double-worm machine with a right- and left-hand worm and a right- and left-hand worm wheel. This worm wheel consisted of two gear wheels spirally cut on about the angle and pitch of the worm, and the worm wheel was hobbed out of the centre sufficiently to make a proper contact between the worm and the worm wheel. These worm wheels were made of common cast iron accurately machined, and the right- and left-hand worms were made of phosphor bronze securely keyed to the worm shaft. Upon the end of the worm shaft an electric motor was installed, designed and built by the writer. Also all of the controlling mechanism was operated mechanically by reversing switches with springs, lever and dash pot which cut out the armature resistance as the motor came up to speed. This elevator was sold to the Keil estate and placed in their building at 770 Mission Street, occupied by Hulse-Bradford Company. The elevator did good service up to the time of the great fire of 1906.

About this time the writer patented a larger elevator of this same type, the motor and control however being of a different type from the above. This elevator was placed in the Old Cliff House about 1892 and did good service until it was destroyed by fire. This installation was first operated from 110-volt circuit of direct current, and was later changed or rewound for a 220-volt circuit. When the electric railway was built to the Cliff House, it was changed to 500 volts.

The single-worm elevator was then developed by the writer, who later patented several devices for controlling elevators, and after much study and experience these devices were brought up to satisfactory efficiency.

Since 1900 the development in electrically controlled elevators has been very marked, and the writer predicts that the advancement in the next thirteen years will be equally as great.

About 1898 or 1900, the eastern manufacturers realized the importance of the demand for electric motors and electric controllers for elevator purposes, and they made a study in detail of elevator equipment, viz., the making of motors especially for this purpose, also a controlling apparatus made for controlling freight and passenger elevators electrically driven. The constant usage of these motors and controllers has exposed their weaker points, and they have now reached a point of efficiency where they are commercially a great success, also being economical and practical in their operation.

Within the last few years, in the electric motor especially, there has developed what we term the "interpole motor," which has eliminated the commutator trouble originally had with reversible motors under heavy duty with varying loads.

The writer wishes to state a few facts regarding the care, maintenance and abuses of elevators. We are aware of the many advantages to be gained by good elevator service in buildings equipped with the modern elevators of the present day.

Good Service.—It is not enough that the owners get from the manufacturers a first-class machine; they must do their part, employing good, reliable, intelligent men, who are capable of understanding the importance of keeping all parts well cleaned and properly oiled, and who understand making adjustments when required, thus in many instances lessening the liability of accidents and reducing the up-keep of the machinery very materially; and the writer would ask the consideration of owners and the public for the elevator manufacturer. who is the man who is blamed for all the mishaps, accidents and unsatisfactory results, while as a matter of fact these conditions in many instances are caused by lack of care and attention on the part of the owner or, more often, the tenant. Then again, many troubles can be traced to the architects or engineers, who, when planning the buildings, fail to make the proper allowance of space for elevators; also, conditions are many times disadvantageous, such as poor light, etc.; and many other conditions obtain, all detrimental to a successful installation of what is conceded to be a most complicated mechanical contrivance.

In many instances, the owners of buildings consider their responsibility ended with the payment of the manufacturer's bill, forgetting that only by eternal viligance and care can any machinery give good service; elevators are certainly no exception to this rule.

An elevator doing heavy duty in a building is a very essential part of the building, and when the elevator is out of commission the expenses of the building are just as great, without any results. Owners should realize that elevators should be taken care of by men experienced in elevator mechanism.

The writer will give the following illustration to make his meaning plain. Not long ago he was called to a rooming house to figure on putting in a new commutator on a motor which had been running for several years. The motor and controlling devices were placed under a stairway leading from a back entrance into a basement; part of the elevator machinery being in one room, a partition under the stairway brought part of it in another room. The controlling devices were so close to the wall as to render it absolutely impossible to reach one side at all. In this room were four barrels full of inflammable matter, one of which was placed directly against part of the controller. It would have been easy for a spark from the controller to have dropped into this barrel. Undoubtedly this would have set fire to it, thus endangering the whole building. Around the machinery, the oil was ½ in. thick. Old rags, boards and shavings covered the floor. This elevator was in the care of a Japanese, who could neither speak nor understand English, consequently it was impossible to make him comprehend that the elevator must be kept clean. Doubtless these conditions exist in many other cases in this city.

The writer suggests that, when owners and architects of buildings decide upon the elevator equipment required to meet the conditions under which the building is being built, it would facilitate matters to employ an elevator expert, who as an expert should be qualified to give them information valuable to insure good results, inasmuch as it is very material that the elevator manufacturer should understand the details, viz., how many entrances there are to the car, how the overhead supports should be constructed, what room and provisions are to be made for the semi-automatic gates, whether or not a freight elevator is required, and also the conditions required for fire hoods and fire doors, and much other necessary information. All of this is required to make a successful installation, and conduces to the owner's benefit, insures satisfactory results to the lesee of the building, and last, but not least, is of great assistance to the elevator manufacturer in helping him to thoroughly understand just what is required.

You will understand that the elevator contractor, in bidding upon the installation of an elevator, in most instances only receives a few of the actual conditions under which the elevator must give service, such as the load, speed, travel and size of car, etc. This is only a part of the information he should have. In order to bid intelligently, he should know every gate, fire door, and many other conditions with which he should be thoroughly in touch in order to insure a good installation.

The writer knows of several instances where the architect has designed a concrete well-hole, or a brick well-hole, without any recesses on the inside for gates; these shafts, being constructed for fireproof purposes, must necessarily have a roller drop fire door on the outside, this door completely covering the entrance. The gates must be put outside in the room beyond this roller door and the contractor is obliged to drill through the walls to put connections through, so as automatically to trip the the gate when the car leaves the floor. Gates installed this way are invariably unsatisfactory. The writer suggests that when architects or engineers require bids for elevators it would be advisable to have a complete drawing made of gates, doors, automatic locks, safety devices and other things necessary, so that it may be determined how they should go into the elevator installation, these drawings accompanying the specifications of the material to be used. Then the bidder has full knowledge of what is required and is able to bid intelligently, while without this knowledge the elevator contractor is compelled to use his own judgment, and in many instances it is at variance with the ideas of the architect and owner and often leads to confusion and dissatisfaction to all parties concerned. Hence, the writer's reason for suggesting the services of a competent elevator engineer to make the lay-outs and specifications for the bidder.

A good, efficient elevator installation is of vital importance to all concerned in the elevator equipment of a building, and in order to obtain this the architect and contractor must work together to this end and for their mutual advantage, the architect giving the contractor all necessary data, etc., and the contractor, upon the other hand, assisting the architect by giving him the benefit of the knowledge of actual experience.

SASKATOON'S WATER AND DISTRIBUTION SYSTEM.

OWING to the expenditure of much money and effort on the Saskatoon water supply and distribution system, a deficit of $23,802.01, shown last year, has been converted into a considerable profit. This has been effected by rigid economy and extensive repairs and reconstruction. Some of the improvements carried out at the pumping house during the year were the removal of 3 return tubular boilers and of the brick chimney; the remodelling of the old boiler room and the division of the same into two; the utilizing of the space previously occupied by the boilers for the generator room; the rearrangement of the entire steam piping and the erection of two new feed water lines, one from the injector to the boilers, and the other from the feed pump to the boilers; the transference of a 500 k.w. reciprocating unit from the power house, and its erection in the pumping plant, together with the exciter, the condenser, and the air pump; the complete rearrangement of the steam and exhaust steam piping, and the placing of the same beneath the floor in the steam pump room. Other changes in the building itself are the raising of the roof 5 feet and the making of it fireproof; the placing of a new concrete floor in the pump well; and the removal of two 100-h.p. domestic pumps and one 50-h.p. booster pump from the steam pump room to permanent positions in the new pump room, and the connection of the delivery pipes made to the city mains.

This rearrangement of the pumping plant has been undertaken, with the result that the city can now pump its entire water supply with electrically driven centrifugal pumps. The present capacity of the pumps is 4,000,000 gallons per day with a nominal pressure of 60 pounds in the mains. In case of fire the pressure can be instantly raised by means of a booster pump to 100 pounds. The capacity of the pumps is sufficient to meet present demands, the average daily consumption being about 1,800,000 gallons. Provision has been made so that additional pumps can be added without enlarging the building, which would provide a daily supply of 12,000,000 gallons, sufficient for a city of 180,000 population, on the present basis.

The filtration plant has caused the least concern on the part of this year's council, having given almost complete satisfaction.

Further improvement is arranged for, in order to eliminate complaints made last winter with reference to the delivery of water to householders who are not supplied from the city mains. Small vertical boilers will be installed at several standpipe stations for heating the water and thawing out the delivery tanks. This will effect a saving of $20 a month for the city on each standpipe.

The economic effect of the works carried out at the pumping plant is shown by the following figures: in May the output was 59,119,060 gallons and the operating cost was $6,079.10, or 10.28 cents per 1,000 gallons; in October the output was 51,556,000 gallons and the operating cost was $3,686.79, or 7.15 cents per 1,000 gallons; showing a decrease of 30.4 per cent.

The waterworks department proposes, however, by carrying out further improvements to acquire still greater gain for the city, and anticipates a surplus in 1914 of $10,000. This will be chiefly effected by the reduction in the cost of fuel, which will result from the doing away with the stand-by at the pumping station in case of breakdown—e.g., the keeping up of steam on one of the boilers, which is prepared at any time to propel a reciprocating engine, drive a generator, and run horizontal steam pumps,— and the substitution of a separate stand-by and the installation of a duplicate main from the power house to the pumping station. This, alone, it is expected will decrease by $14,000 a year the waterworks expenditure.

That sawdust and other mill waste can be profitably manufactured into briquettes for fuel is evident from the fact that a large lumber company in British Columbia is erecting a $50,000 plant, which will have a daily output of about 30 tons of such briquettes. They will sell for about five dollars a ton at the mill.

The quantity of coal required to produce a ton of coke is much less than was required formerly. The average gain in 1912 compared with ten years ago is probably at least 160 pounds. It is doubtful if in the earlier years the actual yield of coal in coke exceeded 60 per cent., whereas in 1912 it was 67 per cent., according to the United States Geological Survey. This gain is largely due to the increase in the production of by-product coke, in which the yield of coke from a ton of coal is very much higher than in making beehive coke. In Illinois, Indiana, Massachusetts, Michigan, New Jersey, New York and Wisconsin, where coke is made exclusively in by-product plants, the yield varies from 69.6 per cent. in Wisconsin to 81.8 per cent. in Indiana, whereas in the States where beehive practice prevails the yield in 1912 varied from 50 per cent. in Georgia to 66.5 per cent. in Pennsylvania.

PROTRACTING RAILWAY TRAVERSES BY THE METHOD OF CO-ORDINATES.

By J. A. Macdonald, Ottawa, Ont.

IT has been repeatedly shown by various writers, that when the distance measured on a sphere is a portion of a rhumb line, whether direct or oblique, or when it coincides with a parallel of latitude, when it crosses a meridian obliquely, and forms equal angles with them, all the corresponding amounts of latitude and departure, and the distance itself, may be accurately represented by the three sides of a right-angled triangle. As the length of lines to which we apply latitudes and departures are, when compared with the vast length of a great circle of the earth, extremely small, the error arising from considering the distances measured, and the difference of latitude and departure corresponding thereto as three sides of a right-angled triangle, is trifling.

Station.	Def. Angle.	Bearing.	Distance.	Lat. N.	Lat. S.	Dep. E.	Dep. W.	Total Lat.	Total Dep.	Offsets.
0	31° 40′	N. 25° 30′ E.	1910	1724	....	822	....	0	0	
1	73° 20′	N. 47° 50′ W.	910	612	....	....	674	1724	822	
2	61° 15′	N. 13° 25′ E.	1420	1381	....	329	....	2336	148	
3	47° 00′	N. 60° 25′ E.	2000	987	....	1739	....	3717	477	
4	21° 10′	N. 39° 15′ E.	1500	1161	....	949	....	4704	2216	
5	40° 00′	N. 0° 45′ W.	1420	1419	....	....	18.6	5865	3165	
6	43° 30′	N. 42° 45′ E.	1205	875	....	818	....	7284	3146	
						4657	692.6	8159	3964	
						692.6 subt.				
Totals				8159		3964				

A Knowledge of Plane Trigonometry Required.

A Knowledge of Plane Trigonometry Required.—Such surveys as are conducted under the rules of plane trigonometry may be all classed as having for their object either to obtain an accurate plan of a limited portion of country with a view to the calculation of its area, or its suitability for a railroad, by obtaining representations of the varying features of the surface, such as the extent of mountains, woods, lakes, rivers, roads, towns, villages, coast lines, or any other details of country through which it may be required to run a railroad.

An acquaintance with the higher branches of mathematics is necessary for those who are entrusted with surveys of any kind, railway and otherwise, though a wonderful degree of perfection is frequently obtained by practice and with only a limited knowledge of the rules of plane trigonometry. It is for the assistance of the labors of those so equipped that the following notes may be applied in practice, assuming that the reader is acquainted with the use of the transit or the surveyor's compass, and the chain.

Mapping of a Railway Line.—The method of plotting the survey of a line of road, or mapping by traverse, is a *modified application of protraction by co-ordinates*, for in a road survey the lines generally lie on one side of the meridian, though not necessarily so. Table I. contains an extract from a survey, by the writer, of a line of road in the North-West provinces, made in the year 1906, and will serve to illustrate the application to this method. The second column refers to the angles of deflection taken with the transit; the third, to the true bearings, either astronomical or magnetic, as calculated from the deflection angles, registered on the limb of the transit, and so on.

Fig. I. (sketch-plan) contains a few of the first stations protracted on a definite scale. The stations are plotted in the following manner: Draw any line (Fig. I.) to represent the meridian, and assume any point upon the line for the first station of the survey; mark a point upon the meridian, "O." The position of this meridian on the plan, and of this first station, will depend upon the general direction of the line to be surveyed.

The first station being marked "O," or 0 + 00, where the transit was first set up, and the bearings having been taken from the back-sight of a connecting line, N. 57° 10′ E., the instrument is then put in the meridian

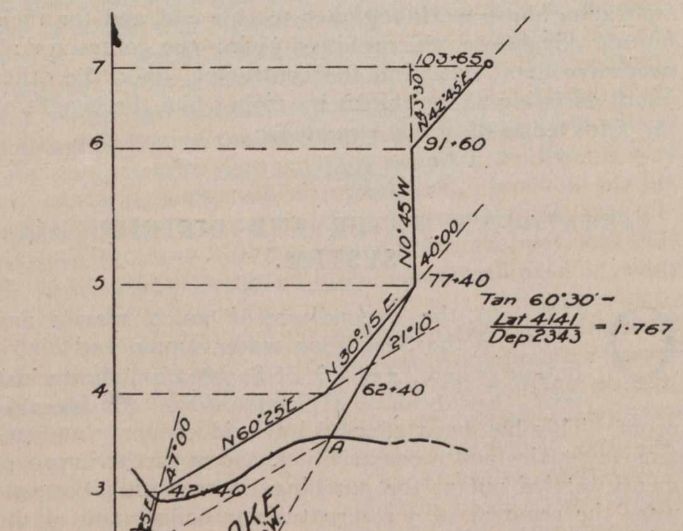

Fig. 1.

by turning 57° 10′ back to zero, with a suitable scale. Mark a point N. from Station 0, 1,724 ft., being the first entry, and opposite to the number 1 in the plotting column, Total Latitude, of the table, and number the point 1′. From 1′ on a line perpendicular to the meridian mark a point 822 ft., being the first entry, and also opposite to the number 1 in the plotting column, Total Departures (10th column), and this point will be Station 1 (19 + 10). Again, from Station o in a direction N. 2,342 ft. mark a point and number it 2′, and from 2′ on a line perpendicular to the meridian set up the point E. of the meridian 148 ft., which will be Station 2 (28 + 20). Proceed in a similar manner for the remaining stations, taking all the values successively from the plotting columns, under the head of Total Latitude and Total Departures (9th and 10th cols.), and laying them off as above from Station o. Draw lines connecting the stations o, 1, 2, 3, etc., which will represent the measured or station lines of the survey, from which distant objects are filled in by intersection, and near ones by offsets in the usual way.

By the use of a parallel ruler (a pair of set-squares answers quite as well) all the points of a series may be defined at once. When the scale is laid along the meridian all the points, 1′, 2′, 3′, 4′, 5′ 6′, etc., may be pricked oft at once from the figures opposite to these numbers in the 9th column of the table. For the Departures (next column) it will be necessary to draw a line, precisely perpendicular to the meridian at Station o, then with the parallel ruler draw lines parallel to the first one through the latitude points, 1′, 2′, 3′, etc. Now, place the scale on those several perpendiculars and measure the departures (column 10) opposite to their numbers, and make a fine point. These points are then connected by lines joining each, and represent the distances between stations. It will be seen that the column distance is not used in plotting. This column is only used to obtain the latitudes and departures of the several courses.

In protracting each piece of work it will be found advantageous to fix the extreme points first before filling in the intermediates. Great facility is also afforded thus for reducing, enlarging, or transferring maps of single lines of road where the bearing of the line is considerable. The differences of latitudes and departures in the columns entered against the several stations serve to determine the relative geographical position of those stations with reference to the first, or any other station in the series.

Obtaining a True Bearing.—The lake shown in the plan was first crossed at its narrow part, involving several sharp curves. It was thought that the lake might be boldly crossed in as nearly as possible a direct line at Station 5, 77 + 40. It was decided to back-run a line, directly across the lake to Station 1, 19 + 10, to strike this station as nearly as possible.

The latitude and departure from 19 + 10 (Station 1) to 77 + 40 (Station 5) is found as in Table II.:—

	Lat.	Dep.
Station (1)	o	o
" (2)	+ 612	— 674
" (3)	+ 1933	— 345
" (4)	+ 2980	+ 1394
" (5)	+ 4141	+ 2343

The latitude is 4,141 and the departure 2,343. Dividing the one by the other we get the tangent. Then orienting the transit at 270 degrees, due west, and turning the angle, 60° 30′ we run the line, S. 29° 30 W., back across the lake. If everything is right, should strike the hub at 19 + 40 (Station 1).

Triangulating.—It will be necessary to triangulate across the lake. Though rather wide for a "sight," this may readily be done. The transit-man, on approaching the bank of the lake, drives a hub, and, having taken his back-sight, sets his instrument in the same direction forward, and signals to his flagman, on the opposite bank of the lake, who, on getting the line, drives his hub there, at B.

The transit-man must now choose a point somewhere on the edge of the lake to the west, unobstructed by trees, if possible. Such a point can usually be secured without much cutting on a lake. A flagman must be there to get a point, and, on reading the angle on this point, C, moves his transit there and sets up. Taking a back-sight with transit set at zero, the first triangulation point, A, he reads the angle to B, and then proceeds to measure the distance, C B, for a base. He has secured two angles, A and C, and the base, C B, and calculates the distance, A B, before proceeding further. The calculation of this triangle is shown on the plan, as well as the triangle, shown dotted, and the lettering of the three angles, A, B and C. Taking the log. of sin. C, 86° 10′, the cos. of A, 31° 50′,

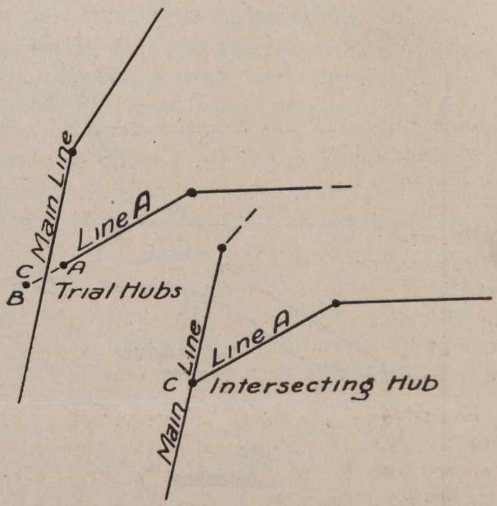

Fig. 2.—Showing Method of Intersecting.

and the log. of a', 1,200 ft., we get the distance A B. Then taking a back-sight from B to A, the line is projected forward to the hub at Station 19 + 10.

In all these operations we have used no protractor nor angle-measure. We depend entirely on our sines and cosines, or latitudes and departures. It may be mentioned that this method is used in all important new lines of railway. Engineers prefer plotting by deflecture angles, as it involves no mathematics, and it is quick and simple, but open to many errors.

Intersecting.—In running a railway line it is usually necessary to run several lines through some portions of the country in order to get a line that is satisfactory to the surveyor. These several lines are tied to the main or first line in almost every case. We come to a lake, perhaps, and are undecided (if the lake is a large one) which bank of the lake to run or line along. If the country is wooded, as a good deal of country is in Canada still, the better side will not be known until we run a line on both. When the farther end of the lake is reached we tie one line to the other. In many cases we shall have to intersect, particularly if we are running through thick woods. In a clear, level country we can easily see the hub of the main line, and bear on it. Intersecting is rather bothersome, but the refinement of every action required to make a true intersection has its merits.

Fig. 2 shows a line, A, intersecting on the main line, the first operation and the completion. On reaching the line already run, i.e., the "main line," the flagman, after ranging the line, just arrived at, sets for a point about a foot *from* the line, at A. Here, at A, he drives a temporary hub and drives a nail in the point. Immediately on the far side of the line, and also about a foot from it, he drives another temporary hub, B. The transit-man now comes along and sets up on the nearest hub of the main line or line to be crossed or tied to, as need be. Getting a back-sight, he looks ahead to get a hub exactly in line, and also precisely in line with the two temporary hubs, A and B. The picketman approximates the position of this hub and drives it, at C. With a straightedge or piece of the chain stretched across the nail-points of the two temporary hubs, he marks a line on the centre hub, C, in range, of course, with line A. Now, the picket signals the transit-man for a point on this pencil-line on the centre or permanent hub, C, and when he gets that point he drives the nail. This nail in hub C is then precisely in line with the position of line A, and also in line with the position of the main line. It is exactly at the intersection of the two lines. If the transit is now set up

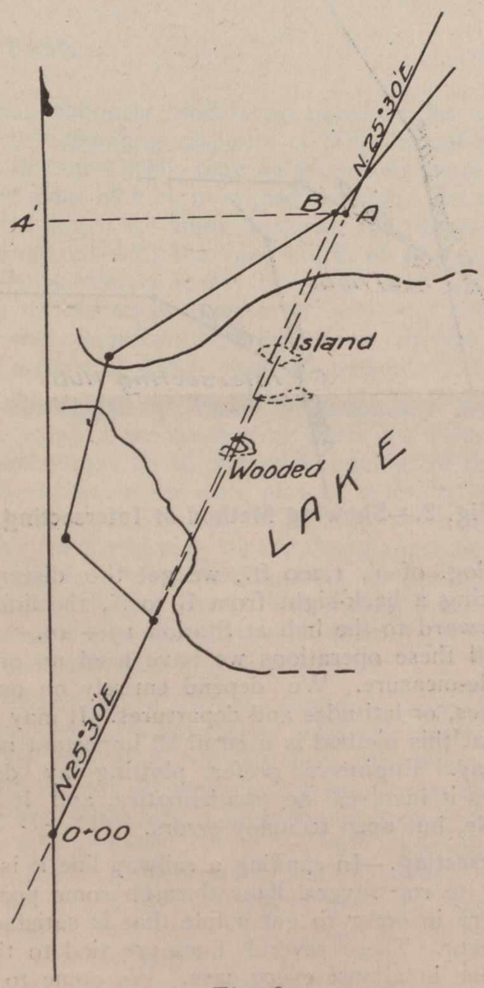

Fig. 3.

on the intersecting hub, C (the hubs A and B being pulled up) and the bearing of the line "A" taken, then orienting the transit on the main line, and noting the deflection angle, he gets the bearing of the line he has just struck —the main line in this case. If he ran that line himself, he will know its bearing and can make comparison. The lines may not close in bearings—may possibly be ten, twenty or forty minutes out, and will not connect or tie on the plot, but that is another story.

When One Cannot Sight Across the Lake.—Frequently it is impossible to sight across the lake on account of its being too wide, or on account of islands covered with bush intervening. This is a peculiar case, but in some surveys may arise frequently. For example, there were islands in this lake, already referred to, on the line of sight of our first bearing, N. 25° 30′ E., and we could not sight across, as shown in Fig. 3. In such cases we proceed in the same way around the lake by a traverse to B (Fig. 3), which is the same point as Station 4′ (62 + 40), (Fig. 1). On reaching the point B (Fig. 3), that is, Station 62 + 40, which has a bearing of N. 60° 25′ E., we judge we are approximately near the line, if produced from the first bearing across the lake. We then get our latitude and departures to determine our exact position.

By looking over the table, we find in column 9 that this point has a latitude of 4,704, and a departure of 2,216, which gives a tangent of 25° 12′. In other words, the bearing of B (Fig. 3), or Station 62 + 40 (Fig. 1), from 0 + 00 (starting point) is N. 25° 12′ E.; that is, B (Fig. 3) bears N. 25° 12′ E. from 0 + 00. But the bearing we want is N. 25° 30′ E. Looking up our table of latitudes, the latitude of B is 4,704. This sum multiplied by the natural tangent of 25° 30′, which is 4,770, gives the desired departure, viz., 2,243, which is the departure of point, A. We have already ascertained the departure of point B, and the difference between A and B is 27 ft. In order to get on the line we must increase our departure 27 ft. We now set the transit up at B (Fig. 3), or Station 62 + 40 (Fig. 1), and measure exactly 27 ft. due east, when we are in the direct line of our first bearing. A hub is driven here, of course. We now set up at A, take our bearing, N. 25° 30 E., when we proceed in a direct line, at A (Fig. 1). From the starting point, 0 + 00, to A, is easily calculated, being, as we know, the latitude and departure, and the angle 25° 30′.

Lat. 4,704 ÷ nat. cos. 25° 30 = radius, equals distance from starting point, 0 + 00 to A = 5,214. It is by this method, or a modification of it, we locate the line on the projected preliminary plan. No up-to-date surveyor projects a railway location by deflection angles with the aid of a protractor. On first-class roads the protractor is barred. All bearings of both preliminary and location are projected upon the map or plan by the method of co-ordinates, latitudes and departures; sines, cosines and tangents.

Canal statistics for the season, which is now practically closed, exceed all previous records. Up to the present time 46,428,283 tons of freight have passed through the canals, an increase of 4,845,171 tons. Of this, the Soo canal is credited with an increase of 3,384,713 tons, the Welland 729,-713 tons, and the St. Lawrence canals 851,569 tons.

It is announced that the first Canadian Roads Congress, a national convention arising out of the needs of all the provinces for better highway facilities, is planned to be held in Montreal during the coming winter. The federal and provincial governments are co-operating with the Automobile Club of Canada, as well as the local and foreign road associations, boards of trade, municipal and county councils and societies in general, to make the congress of great value to the good roads movement.

Another Alaskan railroad to open the natural resources of the territory is proposed in a bill Chairman Houston, of the Territories Committee, has favorably reported to the House. The road, to be built by the Government and either leased or Government operated, would run from the southern coast at Cordova or Seward or their vicinity to the upper Yukon River, and would not be more than 722 miles long.

CANADA'S PROJECTS OF WATERWAY IMPROVEMENT.

The Hon. J. D. Hazen, Minister of Marine and Fisheries, addressed the tenth annual convention of the National Rivers and Harbor Congress, held recently at Washington, D.C., on the great projects of waterway improvement under contract or in contemplation in the Dominion of Canada.

It was pointed out by Mr. Hazen that Montreal, the chief port of Canada, affords the best example of modern harbor works and equipment and has special advantages over any port on the North American continent from its inland situation in regard to discharging of cargo and affording communication by water via the Great Lakes to a point 1900 miles farther inland at the head of Lake Superior. Mr. Hazen referred briefly to the great growth in trade at Montreal which has made necessary the deepening of the channel in the St. Lawrence River at a cost up to the present of $16,000,000; and which will be greatly augmented by the work now in progress.

Mr. Hazen pointed out also improvements under way or to be undertaken at other ports: at Quebec harbor, the lock and dam on the St. Charles River to cost $3,000,000; at St. John, improvements to cost millions, one contract alone amounting to $7,500,000; at Halifax, the reconstruction of deep-water terminals to cost over $8,200,000; the new breakwater 5,500 feet in length under construction at the twin ports of Fort William and Port Arthur; the many new drydocks, etc., at numerous smaller intervening ports, and at Vancouver and Victoria the government wharf and breakwater respectively, totalling a general cost of $5,500,000.

In connection with Canada's canal question, Mr. Hazen said: "Canada and the United States jointly operate one of the largest systems of Inland waterways in the world, a most valuable heritage for purposes of transportation. This whole system of canals on both sides of the line is free of tolls, and open to the vessels of both countries. The Canadian canal system represents a capital cost of $104,000,000. If to this, however, is added the capital cost of harbors, the dredging of channels, lighthouses, buoys, etc., it will be found that Canada has contributed upwards of $365,000,000 all told for the establishment of means of transportation by water."

He mentioned that the whole scheme for the Trent Canal is now being carried out; that the new Welland Canal is already under construction, and is to aggregate a cost in the neighborhood of fifty million dollars; and that the construction of the Georgian Bay Canal is one of the schemes contemplated for the near future.

Mr. Hazen closed his address by remarking that the Canadian Government has entered actively upon "the project of affording facilities at all our great national ports which will enable them to compete on at least even terms with any other ports on this continent."

German capitalists headed by Capt. Von Der Osten, of Berlin, have secured from the provincial government a concession of forty square miles near Sussex, N.B., and will prospect for salt, gypsum ore, potassium and petroleum. The project is capitalized at three million dollars, and in particular the promoters expect to develop a big industry in potassium, which is known to exist in large quantities, and for which the United States offers an almost unlimited market.

THE CORROSION OF WATER MAINS.*

By William Ransom, A.M.I.C.E.

THE subject of the corrosion of iron mains is one of great importance to waterworks engineers, who naturally desire to obtain as long a life as possible for their water mains, and also are anxious to use such materials as will not impart any impurity or deleterious property to the water in the course of its distribution. The need for investigation and conference on the subject can be realized and its practical importance better understood when the recent case of a town in South Africa is mentioned, where a new steel water main has become so pitted with rust that it has become necessary to partly replace it with a cast-iron main. It was found that the damage was due to the sulphuric acid in the soil resulting from the oxidation of pyrites in the soil. Other portions of the main have been protected by covering with two thicknesses of bituminized Hessian cloth, and afterwards coated with a bituminous composition.

The writer had his special attention drawn to this subject in connection with some investigations he made with regard to a town water supply which not only corroded the mains but deposited a brown percipitant upon exposure, and caused an objectionable discoloration to domestic utensils, etc., while at times an unpleasant smell was noticed when the water was drawn from the mains.

We are all familiar with the ordinary formation of rust, but there are many factors at work to complicate the corrosion of water mains, and in this short paper the writer can only hope to refer to one or two phases of the subject in which he has been especially interested.

Dry oxygen has no effect upon iron at normal temperature, but if the iron be heated oxidation takes place and a black scale or oxide forms on the surface, which, when the metal is heated to white heat, is represented by the formula Fe_3O_4. This is the scale which, being non-adherent, is brushed off the hot plates after they have passed through the rolling mills.

It is when moisture is present together with carbonic dioxide that oxygen is able to act most readily upon iron at the ordinary temperature and a brown hydrate of ferric oxide if formed. Water, which contains free CO_2, and is therefore a weak acid solution, will very quickly corrode the iron mains through which it is being distributed. The rust that is formed is not a protective coat, for it is hygroscopic, and fresh water is brought into contact with the iron to continue the process of oxidation. The chemical action produces a certain amount of heat, which also helps in the work of oxidation. The various impurities in the water and the different qualities of iron modify or complicate the corrosive effect on the mains and the discoloration caused to the water. The ordinary action of corrosion is prevented by giving the iron a protective coat of some bitumastic material, but there is great difficulty in ensuring perfect protection, for pinholes, etc., may soon form centres for the formation of rust.

There have been many investigators who have made a special study of the formation of rust. Wehner, of Munich, in 1907 summarized the various forms of rust under three headings: Firstly, coarse blotches or blisters of rust which are formed on the interior of water mains and on the exterior of pipes laid in damp or salt soil. Pro-

*A paper read at the meeting of the Institution of Civil Engineers, held at Birmingham on Nov. 20, 1913.

fessor James Campbell Brown likens this rust to the limpets which are found on a rocky sea coast, and found that they grow by addition of concentric layers. This incrustation will keep on extending, and in large mains may form a layer 1 in. to 1½ in. in thickness. If this be removed or the surface disturbed the incrustation will go on reforming. Secondly, a fine and more or less brightly tinted mud of a yellowish tinge, which is found deposited in the interior of pipes. Thirdly, graphitic destruction of iron, which is effected by weak acids, and causes the iron to assume a spongy nature. There is no outward indication of rust, and Wehner has found that this form of rust can take place, leaving a protective coating apparently undamaged. This fact emphasizes the necessity of care in selecting suitable materials for the manufacture of water mains.

The production of rust, especially in water service pipes, is often much accelerated by electric action. If there be two metals an electric disturbance is produced, and if the metals be conductors one will become electro-positive and the other electro-negative. If the water be slightly acid current is able to circulate, and the chemical action previously referred to at once comes into operation, and the electro-positive metal is attacked. Galvanized pipes are preserved from ordinary corrosion, but if the protective coating of zinc be cracked or has been imperfectly applied, electro-action will be set up, destroying the zinc, and exposing the iron to the ordinary action of the water. Hydrogen will at the same time be liberated, and impart an unpleasant smell to the water.

Waters which become discolored during the process of distribution and choke the mains with a brown deposit are chiefly those in which the presence of free CO_2 is able to intensify the ordinary action of rusting.

The chemical action can be briefly explained as follows: The water containig the free CO_2 forms a weak acid solution, and, attacking the iron pipes, produces ferrous carbonate or bi-carbonate, liberating hydrogen in the process, thus:

$$H_2O + CO_2 + Fe = FeCO_2 + 2H.$$

If the ferrous carbonate absorbs oxygen from the water or the air it oxidizes, and a brown hydrate is produced, while CO_2 is liberated which is ready to attack fresh iron. It will, therefore, be seen what an important bearing even a very small proportion of free CO_2 present in the watci has upon the life of the main and the color of the water.

Ferrous carbonate is insoluble in water, and would quickly completely choke the mains but for the fact that it is dissolved in water which contains CO_2, while by the absorption of more CO_2 it becomes a bi-carbonate which is soluble in water, and is passed on to the consumer to be drawn off at the tap. If this bi-carbonate has not been able to absorb oxygen whilst in the mains the water when drawn from the tap will be clear and free from turbidity until, by combining with oxygen from the air after the water has been standing sufficiently long, the water will gradually become turbid, and then precipitate the brown hydrate. If the bi-carbonate has been able to absorb oxygen in the mains the water is drawn off in a turbid condition, and will gradually become clear, leaving the brown hydrate precipitate. If the water has been pumped and air sucked in, the above action is very much intensified, and if the water be allowed to remain stagnant in the mains serious deposit will occur. The mains would quickly become choked unless they are frequently flushed, while the water will be very much discolored.

We have seen how that hydrogen is liberated in the process of chemical action, and imparts an unpleasant smell to the water. This is naturally increased if the water remains stagnant in the mains to allow time for the hydrogen to accumulate, and the remedy is to liberate the hydrogen by frequent flushing of the mains and the avoidance of dead ends.

Where a public water supply is of such a nature as to produce the results above described, the problem is how to prevent the action of the free carbonic acid upon the mains, so as to fit the water for domestic and laundry use. We see in nature where water containing CO_2 has dissolved iron from the minerals with which it has come in contact during its passage through the soil, how upon exposure the ferrous bi-carbonate is deposited in the brown form so familiar to us in the watercourses and streams of iron districts. Household utensils and domestic sanitary appliances are soon stained by the use of such waters, while it is quite impossible to use the same for laundry purposes. Cisterns and pipes will become choked with the brown deposit, and from the consumer's point of view the question becomes of very great importance, especially as it is found to be more difficult to deal with waters which have such action than with those which bring iron with them in solution from their source.

The removal of the free CO_2 appears to be the only certain way of preventing the action of such waters upon the iron mains, and the passing on of ferrous bi-carbonate to the consumer, which, by absorption of oxygen, causes turbidity and the brown deposit.

Oeston, of Munich, mentions a peculiar case, where, in 1908, at Berlin, a water had been treated for the removal of iron. The carbonic acid gas, however, had not been eliminated, and upon examination of the water drawn from the cast-iron mains of the Berlin Zoological Gardens it was found, owing to the corrosion of the mains by the Co_2, that the percentage of iron had again risen, and the work of removing the iron from the water at its source was wasted. He also found that the greater the pressure in the mains the greater was the action of the carbonic acid gas upon iron.

In connection with the ground water supply of Frankfurt-am-Main, where the free Co_2 existed to the extent of 3 parts per 10,000, Scheelhaase describes an apparatus for the removal of the Co_2. The water passes through a special marble aerator, and is allowed to fall in the form of spray over the marble, which absorbs a large proportion of the CO_2, but the hardness of the water is increased by the formation of a bi-carbonate. The destructive action of the water upon the mains has ceased, and the cost of the process is given at about one-tenth of a penny per 1,000 gallons treated.

The writer does not propose to deal in this paper with the deposits of calcium carbonate caused by hard water, and the well-known processes of softening such waters; but it is well to bear in mind that such hard waters give a protective coat to the mains against the ordinary action of corrosion.

Dr. Hartwig Klut, of Munich, made a special study in 1907 of carbonic acid gas in relation to water supplies, and he found that when oxygen is present with CO_2 the latter acts upon the lead service pipes, and there is the danger of lead poisoning.

The Massachusetts Board of Health have made experiments with similar results. The removal of free CO_2 is therefore necessary in some cases to prevent the danger of lead poisoning where the water passes through lead service pipes.

At Dessau, in Anhalt, where the water is very soft and contains so much CO_2 that lead was dissolved from the service pipes, the excess CO_2 has been removed by the addition of powdered carbonate of lime.

Many waters are contaminated with iron at the source of supply, and this iron not only imparts an unpleasant taste, but is a cause of deposit in the mains rather than a cause of corrosion. Such waters, if rendered slightly acid by vegetable matters, such as peat, deposit a ferruginous slime in the mains, caused by the growth of an organism known as Crenothrix, which is able to thrive under such favoring conditions. The dead organisms impart a bad taste to the water. The remedy is to remove the organic feeding matter by filtration and the iron by aeration. If the acid be neutralized, the iron organisms are not able to develop.

In North Germany, at Konigsberg, 90 per cent. of the iron in solution is removed by aeration. The water is delivered in a fine spray over coke filters, and ferric oxide is deposited in the coke.

The organism causing the black slime has been specially examined by Migula, of Carlsruhe, and has been given the name of Chlamydothrix. He says that the germs come with the water, and attach themselves to the inner surface of the mains. From minute specks of jelly the organisms develop into threads, while iron oxide is deposited by the organisms in the process of growth.

Professor James Campbell Brown says that waters which deposit black slime invariably contain an appreciable quantity of iron in solution in combination with organic matter of an acid character. He thinks that the slime organisms live on the carbon compounds which are found in a soluble organic compound of iron, and iron oxide is deposited throughout their growth.

The flocculent matter which is thus deposited by such iron organisms must not be confused with the corrosion of the mains caused by chemical action and subsequent deposit of the iron dissolved from the mains.

COST OF CONCRETE ROAD.

In the following itemized table the compiler, Mr. B. P. Lampert, county engineer, Emery, Ia., gives the cost of building a concrete road at Fort Dodge, Ia. Points to be taken into consideration when studying the data are: (1) Average haul, 2½ miles; (2) sand not screened and not charged; (3) engineer's time included, also 1/5 cost of plant used.

Total amount laid, 9,472 square yards. Approximately 3,100 cubic yards of grading (cut and fill).

Labor on Concrete.

Based on average organization and average rate of 500 square yards daily.

No. of men.	Job.	Cost per day.	Cost per sq. yd.
2	Finishing and removing forms	$ 8.00	$0.0160
2	Striking off concrete	5.50	0.0110
1	Fireman on mixer	3.50	0.0070
1	Engineer on mixer	4.00	0.0080
2	Side forms and joints	6.00	0.0120
1	Cement	3.00	0.0060
2	Wheeling and shoveling sand	5.50	0.0110
3	Wheeling stone	8.25	0.0165
6	Shoveling stone	16.50	0.0330
1	Extra, fixing subgrade	2.75	0.0055
1	Water boy	1.00	0.0020
1	Hose boy	1.00	0.0020
23		$65.00	$0.1300

*Not included in calculating cost.

Material and Handling Same.

Job.		Total cost.	Cost per cu. yd.	Cost per sq. yd.
Grading: wheel scraper and wagon work	$ 497.25			
Loading wagons	60.00			
		$ 557.25	....	$0.0588
Surfacing	......	307.50	....	0.0325
Baker joints and felt	......	536.40	....	0.0566
Sand, 874 cu. yds. taken from pit:				
Stripping pit	60.00*	.....	....	.....
Loading	129.50	.....	....	.....
Hauling	243.00			
		372.50	$0.426	.0393
Crushed stone, 560.74 cu. yds.	560.74	.....	....	.....
Freight	285.09	.....	....	.....
Loading	141.45	.....	....	.....
Hauling	341.00			
		1,328.28	2.37	.1405
Gravel, 885 cu. yds.	595.04	.....	....	.....
Freight	493.02	.....	....	.....
Loading	123.50	.....	....	.....
Hauling	493.00			
		1,614.56	1.89	.1705
Cement, 2,413 bbls. at $1.56 on cars	3,764.28	.....	....	.....
Hauling	217.17	3,981.45	....	.4203
Total	......	$8,697.94	....	$0.9183

General Charges.

Freight on mixer, both ways	$184.94		
Engineer	49.70		
		$ 234.64	$ .0247
Miscellaneous teaming		71.43	.0075
Oil, coal, gas, repairs		60.55	.0064
Misc. labor, unloading mixer, laying pipe, building culvert, lost time, etc.		176.69	.0187
Engineering and foreman		125.00	.0132
One-fifth of cost of plant		105.00	.0111
		773.31	.0816
Totals, all expenses		$10,750.72	$1.13

A steel dipper dredge of 5 yards' capacity is being completed by the M. Beatty and Sons, Limited, Welland, for the C. S. Boone Dredging and Construction Company, of Toronto, for use in harbor improvement work. The dredge has a hull of 100 feet in length with 40-foot beam, and 10 feet in depth. It is similar to those now being used by the Canadian Dredging Company, Midland; the Dominion Dredging Company, Quebec, and others. It has been used on a wide variety of work, and has established good records for capacity, and low cost of maintenance.

SEMI-STEEL CASTINGS.

IN a paper read recently, by Mr. R. H. Probert, to the Ohio Society of Engineers it was stated that one of the principal points in making semi-steel is to have the metal hot. To get the best results and to insure a thorough mixing of the iron and steel when tapping, the metal is run into the tapping ladle, which is tilted enough to run the metal into a shank or bull ladle. The latter also is tilted to allow pouring the metal into the hand or crane ladles. When melting for castings weighing from 2,000 to 8,000 lbs. each, the crane ladle is of sufficient capacity to hold the entire amount of metal required, and into this ladle is placed 5 lbs. of 80 per cent. ferro-manganese to each ton of iron. This method of tapping permits the steel and iron to mix thoroughly in the ladles before pouring the metal into the molds.

In mixing metal for high-grade castings that are :e-quired to stand up under high pressure and high speeds, the pig iron is charged on the bed and the steel scrap on top of this charge of pig iron. Charges amounting to 2,500 lbs. each in a 40-in. cupola are as follows:

Coke	1,000 lbs.
Pig iron	1,000 "
Gray iron scrap	500 "
Steel scrap	500 "
Pig iron	500 "
Coke	250 "

The coke bed must be large enough so that the first iron will come hot. Having tapped the metal white hot, it must be poured into the molds as nearly as possible at that heat. The hotter the iron the greater should be the care taken in venting the molds, as the more resistance and refractory the mold, the more care and skill is required in feeding the hot metal into the mold.

The steel used is boiler-plate scrap from ¼ to 7/16 in. thick, either square or rectangular pieces, from 6 to 18 in. long. The steel scrap is not charged directly on top of the coke bed, but, as previously stated, about 150 lbs. of coke are charged on top of steel scrap before charging the next layer of pig iron.

Careful attention is given to the charging of the cupola throughout the various heats including the firing of the coke bed before the first charge of pig iron is placed in the cupola. By doing so, dull metal is avoided during the whole of the heats for the day's melt.

The range of analysis of the boiler-plate scrap, which consists of shell, firebox and flange steel, is as follows:

	Per cent.	
Sulphur	0.022	0.038
Phosphorus	0.015	0.020
Carbon	0.12	0.18
Manganese	0.34	0.45

In 25 minutes after the blast is turned on the metal is ready to be tapped and drawn off.

Recently several semi-steel flywheels about 9 ft. 6 in. in diameter, each weighing 7,500 lbs., were successfully cast without difficulty or loss. They were for special service, to run at a peripheral speed of 12,000 ft. per min. The castings proved to be clean, solid, without flaws, the metal was tough, but not hard, and the turnings curled from the tool like pine shavings. The steel scrap amounted to 25 per cent. of the charge. The transverse tests on a ¾-in. square bar with 12-in. supports averaged 1,625 lbs.

The analysis averaged:

	Per cent.
Silicon	1.41
Manganese	0.36
Phosphorus	0.462
Sulphur	0.122
Combined carbon	0.95
Graphitic carbon	2.46

The analysis of the pig iron charged with the gray iron and steel scrap averaged:

	Per cent.
Silicon	1.65 to 2.75
Sulphur	0.035 to 0.054
Phosphorus	0.322 to 0.754
Manganese	0.55 to 0.85

Small and medium-sized castings that are cored and of peculiar shape, weighing from 400 to 500 lbs. each, that are required to stand up under constant high duty, are made as previously stated, showing the same analysis in the pig iron and in the finished castings.

Gas-engine cylinders each weighing about 1,650 lbs. for 50-h.p. engines, were successfully made from semi-steel. The metals charged were No. 2 foundry pig iron, gray iron scrap and the steel scrap amounted to 30 per cent. of the charge. The transverse tests on ¾-in. square bars, with points of support 12 in. apart, averaged 1,755 lbs. The deflection amounted to 0.22 in. The cylinders were solid, clean and tough. They were easily machined and the bore showed excellent, smooth finish. The fractures on the test bars were fine and close grained and took a very fine finish when machined, draw-filed and polished.

The cylinders were poured on end, the molds were skin-dried and were provided with ample pouring basins, down gates or leaders and large risers. The shrinkage was about 3/32 in. to the foot, but on castings poured in a horizontal position the shrinkage is about 7/64 in. per foot.

In making the molds the best results are obtained by working the sand as dry as possible, not sponging the patterns around their ends and sides, as the water will dampen the edges of the molds and will result in making the castings hard on their outside edges—too hard to machine profitably.

Provide the molds with a pouring basin and well, and do not depend on one large down gate or leader. When making medium and small work, use a strainer gate, which is a pouring basin on the top surface of the cope, with sufficient down runners of small diameter to a gate below in the surface of the drag. These runners will prevent the lighter metal and other impurities from running down into the body of the mold, resulting in clean, solid castings. Large molds should be skin-dried, and all molds for semi-steel castings provided with ample pouring basins, down runners, gates, risers, etc.

The flasks should be strongly made, as the mold strain is entirely within itself and on heavy castings the flasks must be well braced and banded around cope and drag to counteract the great strains on the mold.

Semi-steel can be used in such castings as cylinders, pistons and plungers for steam, gas, ammonia and hydraulic work, engine and machine beds, flange couplings, bearing boxes, large flanges, brackets, pedestals, pinions and gear segments, forming dies for sheet metal, electric motor castings, etc.

It takes no more coke or labor to melt semi-steel than it does to melt gray iron—1 lb. coke to 7 and 7½ lbs. of iron.

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CONTENTS OF THIS ISSUE.

THE POLLUTION OF INTERNATIONAL WATERWAYS.

When the International Joint Commission meets next month it is quite likely that it will draft recommendations to the Canadian and United States Governments that will accentuate considerably the attitude of both countries with respect to the water pollution along about 2,000 miles of boundary line. Both countries have numerous cities that are deeply concerned in the investigation, and whether or not this winter will see legislation enacted to curtail the use of lakes and especially of rivers as general receptacles for all manner of refuse and waste, the report, in itself, will fill a most important mission, by revealing the present dangers that beset these riparian communities. The report will cover five waterways, viz., Niagara River; Detroit River and connecting waterways from Lake Huron to Lake Erie; St. Mary's River; St. Lawrence River from Lake Ontario to a point where it departs from the boundary; and a portion of the St. John River.

The Niagara River situation is the most acute. All the sewage from Buffalo, Tonawanda, North Tonawanda and Niagara Falls, N.Y., is discharged in raw state directly into the river, and the sewage of Lackawanna is discharged untreated into Smoke's Creek, whose outlet is 1½ miles above the head of the river. The population of the territory thus draining directly into the Niagara River from the New York State side, and above the Falls, is estimated at 615,000. All of these cities, together with numerous villages near the river bank, and the city of Lockport, with a population of about 20,000, take their water supplies directly from the river.

The Detroit River, and its connecting waterways, furnish a problem possibly greater than the Niagara conditions. The other points of investigation are likewise important to the people of both countries.

The International Joint Commission was assigned its task on August 1st, 1912, by the two Governments. The questions referred to it are as follows:—

1. To what extent and by what causes and in what localities have the boundary waters between the United States and Canada been polluted so as to be injurious to the public health and unfit for domestic or other uses?

2. In what way or manner, whether by the construction and operation of suitable drainage canals or plants at convenient points or otherwise, is it possible and advisable to remedy or prevent the pollution of these waters, and by what means or arrangement can the proper construction or operation of remedial or preventive works, or a system or method of rendering these waters sanitary and suitable for domestic and other uses, be best secured and maintained in order to insure the adequate protection and development of all interests involved on both sides of the boundary, and to fulfil the obligations undertaken in Article IV. of the waterways treaty of January 11, 1909, between the United States and Great Britain, in which it is agreed that the waters therein defined as boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other?

The questions were considered at the October 1912, meeting of the Commission at Ottawa, and upon later advice as to the scope of the investigation, various meetings were held during the winter for the working out of all details. It was decided that the investigation should include a bacteriological examination of samples of water taken, including the bacteria count and the qualitative and quantitative estimation of B. Coli, according to standard methods, and such chemical examination as might be deemed necessary. Dr. Allan J. McLaughlin, of the U.S. Public Health Service; Dr. J. W. S. McCullough, chief health officer of Ontario, and Dr. John Amyot, professor of hygiene, University of Toronto, have been actively engaged in these bacteriological examinations during the past summer and have very recently submitted their report.

Mr. Frank S. Streeter, representing the United States, and Mr. Henry A. Powell, representing Canada, constituted a committee which, pending the above report, looked after the gathering of such testimony from parties interested as might seem desirable in forwarding the investigation.

The Commission's findings will, as stated, be published shortly. It is generally understood that while they are not alarming they will disclose conditions that will necessarily be remedied to conform to the health conditions stipulated in Article IV., above referred to, of the waterways treaty.

THE CORROSION OF WATER MAINS.

The subject of pipe corrosion is one which necessarily interests engineers and manufacturers in their efforts to obtain durability and long life in water mains. The paper by Mr. Hale, read before the American Public Health Association, and published in December 4th issue of *The Canadian Engineer*, and the article by Mr. William Ransom appearing in this issue, contain a great deal of valuable information concerning corrosion from various causes.

There is no difficulty in realizing the need for sound investigation and conference on the subject, as every waterworks engineer is naturally desirous to use materials that will be durable, and that will not impart any impurity to the water, nor furnish it with any deleterious property in its course of distribution.

Mr. Ransom refers to a particular instance where a new water main had been laid down and which, after a brief duration of service, became so pitted with rust that it was found necessary to remove a portion of the distributing system and replace it, the damage being caused by the presence of free sulphuric acid in the soil, due to the oxidation of iron pyrites. He also calls attention to the fact that corrosion by electrolytic action is often much more serious than is commonly thought to be the case.

Mr. Hale refers to numerous sources of corrosion to be found in both raw and treated waters, the action being more pronounced when the metal is clean and free from incrustation, which forms a protective coating, depending upon the nature of the water, delaying the corrosion and reducing the resulting percentage of iron in the distribution service.

A third writer on the subject, Mr. E. K. Rideal, in a paper to the Society of Engineers (England) strongly supports the electrolytic theory of corrosion. He expresses his belief that the theory is perfectly tenable when due attention is paid to considerations such as alterations in the solution pressures on crystal surfaces, and the phenomenon of passivity shown by iron.

According to Mr. Rideal, corrosion is due either to internally generated electric currents or to those from external sources. The theory is applicable to the problems of rusting in reinforced concrete, water-pipes and structural iron-work, as well as to the action of stray currents from street railway circuits, damp electric-light leads and telephone cables. In the light of that theory both the plating of iron with metals, or covering the surfaces with paints and varnishes, are to be regarded as means to an end, namely, to prevent the formation of local "corrosion cells." The effect of pitting in steel pipes is to be attributed to inclusions of slag and oxides of iron. Metallic coatings must be perfectly uniform in character, otherwise rusting may be augmented instead of retarded by such processes, while paints should be applied to clean surfaces and should possess certain definite characteristics, such as high specific electrical resistance, a pigmentary vehicle that does not readily liberate water during the process of aerial autoxidation and is not permeable to water vapor when thus oxidized, and pigmentary particles not widely separated from iron in their electrochemical potential.

LETTERS TO THE EDITOR.

Re "Stresses in Circular Pipes."

Sir,—With reference to Mr. Hogg's article on "Stresses in Circular Pipes," which appeared in your issue of November 13th, while I cannot offer any detailed discussion upon it, one or two points may be noted. Mr. Hogg has applied the ordinary formulæ for the arch rib to determine the bending moments in a thin circular pipe due to the hydrostatic pressures exerted by the water, which it contains when just full, and supported on a horizontal knife edge below the pipe. The effect of putting the water under pressure, as in the case of a conduit conveying water to a turbine seems to have been considered only as producing a circumferential tension in the ring. The influence of this tension in determining the changes in the vertical and horizontal diameters of the ring does not appear to be touched upon, and while Mr. Hogg may have satisfied himself that an effect of this nature is insignificant as compared with the deformations which he has calculated, it does not appear in the analysis. If the pressure is very great in the pipe, then the deformations due to the weight of water in the pipe are, as Mr. Hogg says, insignificant; while if the pipe merely contains water which is not under pressure, those deformations are the only ones to be considered. Not having investigated such effects numerically, as Mr. Hogg has probably done, I cannot venture a suggestion as to their relative importance in determining Δx and Δy, and it would be interesting to have the deformations worked out for a pipe, say 6 or 8 ft. in diameter, under different heads of up to, say, 200 feet. If Mr. Hogg has such data perhaps he will publish it.

There are some misprints to be noted. On page 696 in the first equation for M_D the integral should not contain the term $(1 - \text{Cos}\ \phi)$. The subsequent expression found by substitution for Sin $\phi\ dp$ is, however, correct. On page 689, the expression for dp in the right hand column evaluates to $\frac{-r\,(\frac{1}{2} + k)}{H + (1 + k)}$, and not as stated. On page 697

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in Fig. 3 there are too many x's and the text is not readily connected with the figure. I have not checked the analysis in detail, but as it follows along conventional lines there is little likelihood of error arising. The chief interest of the investigation, to my opinion, would be in the presentation of comparative figures along the lines which I have suggested, but I do not think there is a great field for discussion.

Engineers are well aware of the existence of pressures due to earth loads, of the differences between a supporting saddle and a theoretical knife edge below the pipe, and of the necessity of modifying theoretical deductions based on assumptions which are necessarily so much at variance with the actual conditions. But such modifications are matters of judgment or even arbitrary opinion, rather than the result of any clear line of reasoning. For such reasons I regard the earlier part of Mr. Hogg's article as possessing interest which would be increased considerably if some actual examples were given to illustrate the points which I have noted.

E. BROWN,
Professor of Applied Mechanics and Hydraulics.

McGill University, Montreal, December 1st, 1913.

Sir,—While the discussion of "Stresses in Circular Pipes" by Mr. T. H. Hogg, in your issue of November 13th, forms a valuable contribution to the literature of the subject, there are still many important problems connected with this and allied fields to which the attention of skilled investigators might be directed with profit.

In the case of the particular type of structure considered by Mr. Hogg, namely, the large conduit subjected to low internal water pressure, it would be of interest to know at what head the consideration of bending moment in the shell becomes necessary for pipes of various diameters. Some valuable work might also be done in investigating the effect of the relatively shallow earth fill existing along such pipe lines on the total stresses in the pipe. The large variation between the lateral pressure at the crown of the pipe and at its base and the uplifting effect of the earth pressure on the the lower half of the pipe place the problem outside the case considered by Professor Talbot and quoted by Mr. Hogg—that of a uniformly distributed lateral pressure acting on the vertical diameter of the pipe. In this connection it is interesting to note that since each half of the pipe lying on one side of the vertical diameter is in effect an arch, the imposition of a load of the character of the earth pressure would require, for coincidence of the curve of the shell with the line of pressures, a pipe cross-section of flattened oblate form similar to that found desirable for the resistance of low internal water pressure. Another consideration of importance to the constructor of such pipes is the proper width of the saddle or bed of concrete upon which the conduit is to rest. In the recent discussion of the "Theory of Loads on Pipes in Ditches," by A Marston and A. O. Anderson, (Bulletin No. 31, Engineering Experiment Station, Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa), it has been shown that a pipe resting upon a shaped earth bed derives practically its entire support from the lowest 90 degrees of the surface. Whether a concrete bed of the same relative width would be suited to large pipes subjected to internal pressure might well be given some thought, and having arrived at the most desirable width of bed, equations for maximum moments corresponding to this condition would be found of especial value to the designer.

A promising field of enquiry related very closely to the one in which Mr. Hogg has done useful work, is that of the design of pipe culverts subjected to the pressure of earth embankments. Research pertaining to this problem does not concern the calculation of the stresses in the shell so much as the fixing of the loads applied to it. At the present time great divergence of opinion exists as to the amount of earth filling which a culvert should be figured to carry. Some engineers assume that the entire weight of earth above the structure is supported by it while others consider less than half that amount as sufficient. The effect upon the culvert of live-loads moving along the embankment is a source of probably greater disagreement. Assuredly valuable work might be done in reducing these uncertainties of loading, for, by so doing it would be possible to design culverts by a little more rational process than mere guesswork.

It is to be hoped that Mr. Hogg and other investigators of the problems relating to stresses in pipes, sewers, tubes, culverts and tunnel linings will carry their researches still further. Certainly there is no more promising field for practical mathematical research.

C. R. YOUNG.

University of Toronto, December 18th, 1913.

Sir,—Professor Brown, in his discussion of the article on "Stresses in Circular Pipes," states that the effect of putting the water under pressure seems to have been considered in the analysis, only as producing a circumferential tension in the ring, and that the influence of this tension in determining the changes in the vertical and horizontal diameters of the ring does not appear to be dealt with. The writer must apologize for having given in the discussion only the analysis of the particular case when the conduit is filled with water to the crown. The general case for water to any head above the top of the pipe has been analyzed, but the integrations are much more laborious and long drawn out. The results are exactly the same, however, as the results obtained for the particular case and given in the paper, with the exception of the amount of the tension, which of course varies with the head; the additional amount being represented by $H\gamma r$, I infer from Professor Brown's letter that he believes the deformations may be affected by the water pressures when the head is above the crown of the pipe. This is not the case, as noted on page 698 of the article, and as proved by the analysis of the general case.

It is true that, as the head increases the tension in the shell will increase, and this in turn will cause an increase in the length of the circumference. Within the elastic limit, however, this movement will be comparatively small. In any case, the values given in the article for the deformations are for the deformations due to the eccentric loading. If a person were interested in obtaining the exact amount of the shortening and lengthening of the diameter, the increase due to the stretching of the shell would have to be added or subtracted from these deformations. These figures, however, are of no practical use, since within the limits of allowable stress of the material, the stretching of the shell is exceedingly small. They might perhaps be of service in the use of concrete or concrete lined steel pipes in determining whether a coating of plaster would crack.

The writer desires to point out that the conditions of loading in a horizontal circular pipe under water pressure is very similar to the case of an eccentrically loaded column. In the case of a column, it is the eccentric load which causes deformation in the sense of a departure from the vertical axis. The axial load on a column has no effect on the deformation in this sense, but simply shortens the column by compressing the material.

The writer regrets that the analysis of the general case of water pressure above the top of the pipe cannot be given here; space will not permit.

The misprints noted by Professor Brown are errors which have slipped in, in the hurry of preparation. Also Fig. 3 was traced by an assistant and the x's have been misplaced. A little thought, however, will clear this up when following the analysis.

The writer would like to draw attention to a fact which has been overlooked in a number of the other discussions presented, the formulæ derived, allow of the ready fixing of the stresses in such conduits, even although it may not seem desirable for construction reasons to use the hydrostatic chord in preference to the circular shape. As noted in the article, these stresses have previously been overlooked.

In answer to Mr. Young, in the writer's opinion the correct formulæ as obtained in the discussion should always be used in computing the stresses of this particular type of structure. There is little difficulty in the use of the equations for practical design and it will always be safer to compute the bending moment due to the water pressure, and include sufficient material to care for these additional stresses. As regards the point at which it becomes desirable to use the hydrostatic chord in place of the circular shape the cost of materials and local conditions will have a large bearing. It is unlikely, however, that there would be any economy in the use of the hydrostatic chord, for pipes less than 8 feet in diameter under a head of more than 50 feet. Under such conditions it would be more economical to use the circular shape, as the saving in material in the use of the chord would be more than counterbalanced by the constructional difficulties introduced by the irregularity of the shape.

It is quite true, as pointed out by Mr. Young, that the oblate form is desirable from the point of view of earth pressure. This is easily seen if we assume fluid pressure outside; in which case we get the hydrostatic arch as the most desirable form to resist the pressure.

T. H. HOGG.

Toronto, Dec. 20th, 1913.

Re "Flat Slabs."

Sir,—Mr. Elmont states that the matter regarding moments is a question of test loading. The writer will submit that Dr. Eddy pointed out that his (Mr. Elmont's) mathematics did not apply to the flat slab as built by Turner, because his theory assumed a uniform distribution of reinforcement; and, accordingly, the mathematics which he has merely copied from Grashof, does not apply to this particular construction. It is difficult, indeed, to discuss the subject of mechanics with one who, while familiar with Clapeyron's theorem, assumes that it is inapplicable to the flat plate.

Mr. Elmont's attention has been called to the fact that, under bending, energy is stored radially and circumferentially. Ordinary familiarity with the construction would impress anyone with the fact that circumferential deformation does not affect the vertical geometry of the slab; whereas, the radial deformations alone determine deflection. Hence, there is less deflection with the storage of energy partly in a circumferential direction, than where it is stored in a radial direction; and this effect on the total work of deformation is most marked, and effects the magnitude of the moments to be resisted.

This subject will be discussed very fully and completely in a long paper, about completed, for discussion in one of the large engineering societies; and it will be sufficient for the present, to state that this theory of work, properly developed, is the simplest solution of all the problems the writer has met in reinforced concrete construction; and it shows the absurd degree of error which those engineers have fallen into, who assume that the old reliable law of conservation of energy does not apply, and that corollaries derived therefrom do not apply to such a device as a reinforced concrete floor slab.

C. A. P. TURNER.

Minneapolis, Minn., December 2nd, 1913.

Sir,—The writer desires to reply that he neither stated that "the matter regarding moments is a question of test loading" nor that Clapeyron's theorem could not be applied to flat slabs.

As regards Grashof's theory on flat plates and slabs, which Mr. Turner now deems inapplicable to the Eddy-Turner flat slab design, the writer would say that he fails to see that their design is so defective that it is not even governed by that theory, which is simply built up from the fundamental equations of external stress and strain, as Dr. Eddy also has expressed it in his and Mr. Turner's joint opus entitled "Flat Plate Theory." It is strange that Mr. Turner has only recently discovered the usefulness of the theory of work, while other structural engineers have employed it for years as the general basis for calculation of statically indeterminate structures. By further study Mr. Turner will find that also Grashof's formulæ can be derived from it.

The conclusion the writer drew from the results arrived at in his paper on "Bending Moments in Flat Slabs" was merely that a certain type of flat slab, which includes Messrs. Eddy-Turner's, could be improved by arranging reinforcement as described in the paper.

V. J. ELMONT.

Montreal, December 9th, 1913.

At the annual meeting of the directors of the American Highway Association, the announcement was made that Atlanta had been selected by the executive committee and that the convention would be held there from October 19th, to October 26th, 1914. The selection of Atlanta was due to the fact that the committee considered the south entitled to the annual congress in 1914 as the east was recognized at the 1912 meeting, the north-west at the 1913 meeting and the far west will receive the 1915 meeting. The unique experiment by Georgia in working the entire state convict force on the roads will afford an interesting study to the delegates, while the stimulation afforded by the great good roads assemblage will probably hasten the establishment of state highway departments throughout the southern states.

The Dominion Iron and Steel Company, of Sydney, N.S., are preparing to install a new furnace in their rolling mill department with a view of developing an output of soft steel in addition to the other products at present manufactured. It was at first intended to establish a number of extra soaking-pits in the blooming mill division, but it was finally decided to adopt the furnace for the soft steel production. New tables are also shortly to be put in the rolling mill to replace those which have been in use for a long period.

CONVENTION OF THE AMERICAN ROAD BUILDERS' ASSOCIATION.

THE tenth annual meeting of the American Road Builders' Association was held in Philadelphia, December 9th to 12th inclusive. It is stated that the attendance exceeded in good measure any of the previous sessions. The registration of members and delegates approximated 1,100.

The convention was officially opened on Tuesday afternoon, December 9th, by Governor Tener, of Pennsylvania, who delivered an address on the good roads movement, in which he passed very commendatory remarks respecting the efforts of the various organizations and the receptive mood of the popular mind in the interests of road improvement.

Col. E. A. Stevens, Commissioner of the Department of Public Roads of New Jersey, read a paper on "Highway Officials, Their Duties and Powers," which dealt with the subject in considerable detail. It was followed by a discussion opened by Mr. A. N. Johnson, State Highway Engineer, Illinois, who explained fully the methods of road administration adopted by his and other States, emphasizing the dependency of success upon the "pay-as-you-go" system. Mr. A. R. Hirst, who occupies a similar position in Wisconsin, described the new road laws and the fundamentals of road making and maintenence with which he had to do. He enumerated the ways in which Wisconsin roads were financed to be as follows:

(1) A municipality, the county and the State may bear equal shares of the expense.

(2) The county may assume two-thirds.

(3) A private citizen may guarantee one-sixth of the total expenditure.

"Division of Expanse, Responsibility and Authority Between Nation, State, County and Town" constituted a paper read by Mr. S. P. Hooker, Superintendent of Highways of New Hampshire, in which were explained the various methods that have been proposed for federal aid toward road construction. In this connection, he emphasized the fact that the question of federal aid should be given very careful consideration, and that any accepted arrangement for the extension of same, should be most wisely handled.

Mr. Nelson P. Lewis, Chief Engineer of the Board of Estimate and Apportionment of New York City, opened the discussion and emphasized Mr. Hooker's cautionary remarks concerning the neglect of careful consideration and planning as evidenced by previous cases where federal aid has been extended. Mr. Harold Parker, ex-chairman Massachusetts Highway Commission, also spoke, urging the appointment of a committee with international scope to investigate the matter, this committee to have three members, an engineer, a lawyer and a business man.

Mr. J. de Pulligny, director of the French Mission of Engineers to the United States, gave a brief description of the methods under which the important public roads of France were constructed, and paralleled with it the lack of organization which is in evidence in America. He remarked that the admixture of engineering ability and financial backing required organization to ensure success in road building. He stated that the French unit of assessment is the square mile, that towns do their own maintenance, and that 90% of the present French system are township roads, upon which is spent 80% of the road funds. The old national roads we hear so much about constitute less than 6% of the present system.

The session on Wednesday morning opened with a paper by E. L. Cranford, road contractor, Brooklyn, N.Y., who dwelt upon the relation of the contractor, the engineer and the inspector to each other. In his address, he showed the frequent lack of harmony, and explained numerous methods of redress, expressing a clear conception of the functions of each official. Prof. A. H. Blanchard, of Columbia University, opened the discussion in a very appreciable manner, corroborating the general opinions expressed by Mr. Cranfield toward methods of making the relation and conditions more harmonious. Mr. H. W. Durham, Chief Engineer of the Bureau of Highways, Borough of Manhattan, N.Y.; Mr. F. E. Ellis, Manager of the Essex Trap Rock and Construction Co., Peabody, Mass.; Mr. Geo. S. Webster, Chief of the Bureau of Surveys, Philadelphia, and others continued the discussion, bringing out numerous suggestions worthy of due consideration for the improvement of conditions by intelligent co-operation.

A paper entitled "The Determination of the Amount of Re-alignment, grading and Drainage to be Done in Connection With Road Work" was read by Mr. S. D. Foster, Chief Engineer of State Highways, Pennsylvania. Among those who presented discussions were J. A. Johnson, Massachusetts Highway Commission; Mr. R. A. Meeker, Department of Public Roads, New Jersey, and Mr. J. H. MacDonald, Highway Commissioner, Connecticut. Another important paper was that by Mr. L. R. Grabill, Suburban Road Superintendent, Washington, D.C., who dwelt upon the factors covering the proper selection of road and street pavements.

Col. W. D. Sohier, Chairman, Massachusetts Highway Commission, in discussing Mr. Grabill's paper, emphasized the need of accurate traffic investigation and careful forecasting in future road improvement. He urged the adoption of an expense unit with traffic as a basis, suggesting the cost of maintenance per ton per mile over a unit width. He stated that the traffic in Massachusetts had doubled in two years' time, and that computation should be made with respect to the maximum traffic which will be encountered during the lifetime of the road.

Mr. W. A. MacLean, of the Ontario Public Roads and Highway Commission, gave a short address, outlining the work which the commission purposes doing in Ontario, and commenting upon the observations which have already been made through investigations. He suggested the method followed in England to secure stability of road foundation should be closely studied, and that roads in this country, after grading, be allowed a period of about three years of traffic in order to obtain natural settlement before road metal and surfacing be applied.

Papers giving details of construction of various types of roads and pavements were read at Thursday's session. Mr. Lynn White, Chief Engineer of the South Park Commissioners, Chicago, read a paper entitled "Bituminous Macadam and Bituminous Concrete." Other papers were "Earth Roads," by E. A. Kingsley, State Highway Engineer of Arkansas; "Sand-Clay Roads," by E. J. Watson, Commissioner, Department of Agriculture, Commerce and Industries, South Carolina; "Gravel Roads," by G. W. Cooley, State Engineer of Minnesota; "Concrete Roads," by E. F. Rogers, State Highway Commissioner of Michigan; "Birch Roads," by J. M. McCleary, Engineer, Cleveland, O.; "Wood and Asphalt Block," by H. H. Schmidt, Chief Engineer of the Bureau of Highways of Brooklyn, N.Y.; "Waterbound Macadam," by J. W. Hunter, Deputy State Highway Commissioner of

Pennsylvania; "Sheet Asphalt," by George H. Norton, Deputy Engineer Commissioner, Buffalo, N.Y.; "Granite Rock," by R. H. Gillespie, Chief Engineer of Highways, Borough of The Bronx, New York City.

Another paper which brought forth much open discussion was read by Mr. H. C. Hill, Meriden, Conn., who spoke concerning unit price and lump sum contracts and percentage work.

Thursday afternoon was taken up by an automobile trip over the different types of recently constructed roads and pavements including the inspection of the Philadelphia Service Test Roadway, which is built of twenty-six separate sections, with each section constructed of a different road material.

Prevost Hubbard, Institute of Industrial Research, Washington, D.C., read a paper on Friday morning entitled "The Testing of Materials for Road and Street Construction." Another important paper was "Sub-Organization for Securing Efficient Maintenance," by Mr. J. M. Carlisle, State Highway Commissioner, New York. These two papers, together with their discussion, constituted the entire session. In the afternoon Mr. A. W. Dean, Chief Engineer, Massachusetts Highway Commission, who spoke on "General Methods of Repairs and Renewals," and Mr. W. H. Connell, Bureau of Highways and Street Cleaning, Philadelphia, on "Bituminous Surface Treatment and Dust Prevention," presented very instructive papers, which called forth a good deal of discussion. These were followed by reports of committees, etc.

A synopsis of each of the papers read will appear in *The Canadian Engineer* at an early date.

CONCRETE ROAD CONSTRUCTION.*

By A. N. Johnson,

State Highway Engineer, Illinois; Springfield, Ill.

OWING to the nature of a concrete pavement there are involved in its construction certain principles quite different from those entering into the design of most other pavements. The fact that a concrete pavement consists of large slabs of rigid material, having a coefficient of expansion due to temperature changes very nearly that of steel, demands provisions for such changes.

As a concrete pavement possesses far less resiliency than most other street pavements, the stresses from traffic loads are greatly increased. This is particularly true of the blows delivered to the surface of the pavement by heavy horse-drawn traffic. Moreover, as all the surface is liable to receive such stresses, it is necessary that every portion of it shall be equally well constructed. It is, therefore, of first importance in the construction of a concrete road to have the greatest possible uniformity in the composition of the concrete. It is not only necessary that each batch of concrete shall have the requisite amount of cement and properly proportioned aggregate, but that every portion of each batch shall be so deposited in the road as to be as nearly uniform as possible.

Again, owing to the brittle character of the concrete, it is evident that depressions in the foundation causing a settlement of the pavement will be manifested by cracks, while such depressions occurring in a pavement of more resilient character, as for instance in most all forms of macadam construction, may not cause any serious break in the surface. Therefore, the utmost care should be taken to provide proper drainage for the foundation soil, perhaps even more care than in many other forms of construction.

Joints.—A concrete pavement is to be regarded as constantly moving. As the temperature increases, the pavement lengthens and with a fall in temperature it shortens. It is evident that provision for these variations must be made in the design of the pavement. Likewise it has also been shown by recent investigation that the absorption of moisture induces an increase in the bulk of the concrete, while the loss of moisture produces a shrinkage from which it will be readily appreciated that climatic changes introduce very complex conditions.

To prevent formation of cracks in a concrete road, in a haphazard way, joints must be arbitrarily placed in the pavement at the time of construction. As every joint in the pavement is a source of weakness, which the traffic will detect and which will afford an opportunity for moisture to penetrate the foundation, it is highly desirable to make as few joints as possible.

If the coefficient of friction of the concrete with the soil is assumed as unity, a slab of concrete 25 ft. long may be pulled over the foundation without exceeding 20 or 25 lb. tensile stress. Therefore, if expansion joints were placed every 50 ft., the centre of the slab, as the slab contracts, would develop a stress in the concrete within allowable limits.

If a crack, due to shrinkage that occurred in the pavement, remained compressive, that is, if it did not subsequently become filled with grit that would prevent the crack from closing as the pavement tended to swell, either from a higher temperature or absorption of moisture, there would be no great necessity for providing beforehand for expansion joints. This is based on the fact that concrete as it sets is observed to shrink an amount about equal to its expansion due to a change in temperature of 70° Fahrenheit, and the small shrinkage cracks which occur offer sufficient room for subsequent expansion of the pavement due to any expected rise of temperature.

But the joints will not remain free of grit, with the result that compressive stresses of over 1,000 lb. per sq. in. may be developed which are sufficient to buckle the comparatively thin slab of a concrete road. It is therefore important that expansion joints be provided and, moreover, that they be constantly maintained so as to be always compressible, which requires that they shall be filled with a plastic material, either a suitable coal tar or asphaltic pitch.

Various devices for the construction of expansion joints have been tried. In some cases ordinary wood paving blocks have been laid, on the theory that the shrinkage of the wood blocks in dry hot weather would provide sufficient room for the expansion of the concrete and that in cold weather, usually wet weather, as the concrete contracts the wood blocks will swell and the joint will remain filled. Steel plates, cut to the shape of the crown of the road, have been manufactured, with which each edge of the joint is lined, the space between the plates being filled with pitch.

It should be observed that there is very likely to be some unevenness at the joints, due either to faulty construction or subsequent wear, so that it is desirable, if traffic is to be inconvenienced the least possible, to place

*Paper presented before the Permanent International Association of Road Congresses, London, 1913.

the joints at other than 90° with the centre line of the pavement. An angle of 60° with the centre line of the road has been successfully used and found to add much to the comfort of traffic.

Materials.—Attention has been called to the fact that every portion of a concrete road should be of a high-grade concrete and also uniform. Many failures of concrete roads, due to raveling under traffic, may be explained by a lean mixture or a lack of uniformity. If a successful concrete pavement is to be laid, a concrete rich in cement must be used. It is evident that the strength of the pavement to resist the action of traffic depends upon the strength of the matrix or mortar in the concrete, assuming a proper aggregate has been employed. Also, if each particle of the aggregate is to be held in place, it is necessary that there shall be a sufficient amount of matrix entirely to surround each piece. To accomplish this purpose, it is first necessary that the mortar be rich in cement and second that the concrete be rich in mortar. probably quite as many failures have been due to a lack of mortar in the concrete as to a lack of cement in the mortar. If every particle of aggregate is to be surrounded by mortar, there must be mortar in excess of the voids in the coarser aggregate. Therefore, if failures have occurred with mixtures providing but 50% of mortar, as would be the case, for example, in a 1:2½:5 or 1:2:4 mixture, no great advantage would be gained by merely increasing the amount of cement and leaving a deficiency of mortar, for example, substituting for the above mixtures a 1:1½:3. A mixture that increases this proportion of mortar should generally be used; a 1:2:3½ mixture may be recommended.

Each batch of concrete must be thoroughly mixed and, as it is deposited in the road, great care should be exercised that the mortar does not flow to the edge of the pile and leave a core of aggregate with insufficient mortar. This is quite likely to happen and must be remedied by workmen who should be provided with rakes or shovels to distribute any such nests of aggregate. A little care and watchfulness will entirely obviate any difficulty from this source.

The nature of the aggregate will determine the wearing qualities of a concrete road. It is therefore important that only hard, sound materials be used for this purpose. In general, limestones and similar soft rocks are not to be recommended, while quartzitic or flint gravels afford widely dispersed sources of excellent materials.

Drainage.—It has been observed on some concrete roads that longitudinal cracks had occurred which are thought to have been due to the seepage of water under the outer edges of the concrete slab, thereby softening the foundation and causing a movement of the concrete slab by frost action. To prevent this, it is recommended that a shallow trench about the width of a shovel be constructed under each edge of the pavement, this trench forming a blind drain to be filled even with the subgrade with some coarse material and that lateral blind drains be placed from 40 to 50 ft. apart across the shoulders of the road, these cross drains extending from the longitudinal drains to the gutters or side ditches thereby preventing any seepage of surface water under the edge of the pavement in the foundation.

Two-Course Construction.—Many concrete pavements have been constructed in two courses, using a leaner mixture for the lower course and a richer mixture for the wearing surface. Evidently, this is an economical arrangement and would be recommended were it not for the unsatisfactory results obtained due to the fact that at the junction of the two classes of concrete there is developed a horizontal plane of weakness which would be caused by even a comparatively short delay in applying the top course. Under exposure to the hot sun, whereby the surface of the pavement becomes of a higher temperature than the lower portion, there is a tendency for the pavement to become slightly convex on the upper or wearing surface. If there is a horizontal plane of weakness near the convex surface, the upper layer of the pavement may become separated from the lower layer. And this has actually occurred. Soon after this takes place, the surface cracks under traffic and rapidly deteriorates. Therefore, unless some method can be found by which the top layer of rich mixture can be deposited simultaneously with the leaner mixture of the lower course, it is recommended that the whole pavement be made of uniform quality throughout equal to that desired for the wearing surface.

Curing the Concrete.—A most important part of the construction of concrete roads, and one that has been very often neglected, is a proper protection for the concrete while setting so that there will be no lack of moisture at this time. As soon as the concrete is a few hours old it should be covered with canvas which is kept moist. This canvas is to be replaced by a layer of earth which should be kept well wet for a period of ten days to two weeks.

Crown.—A concrete road requires perhaps less crown than any other form of paving surface, scarcely more than the eye would demand for appearance sake. One-eighth to one-quarter inch per foot will be found sufficient.

For convenience in construction, the roadbed may be made practically level and, it is evident, should be constructed with considerable care so that it does not become necessary to fill depressions in the roadbed with expensive concrete. The crown may be given by making the roadway slightly thicker at the middle than at the sides.

Thickness.—A thickness of 6 to 8 in. for the concrete seems sufficient for all ordinary conditions. On roads 20 to 24 ft. in width, and average of 7 in. may be used with 8 in. at the centre and 6 in. at the sides.

A form of construction that may prove desirable, where the greatest economy must be exercised, would be to provide a comparatively narrow strip of concrete at the centre with a good macadam construction for the shoulders. This would answer for those roads where the traffic at a given time of day is nearly all in one direction. Under these conditions a strip of concrete 10 to 12 ft. wide at the centre would take practically all the wear while the narrow strip of macadam at either side, 3 or 4 ft. in width, would suffice for the occasional passing of vehicles.

This character of construction is particularly applicable to a vast mileage of highways in America where such an enormous percentage is merely earth roads and where at present the maximum length of roads at the lowest cost possible is of the utmost importance.

Finish.—A concrete road should be left slightly rough as would be effected by a wood float. The templet which is used to give the shape to the surface of the road can be so devised and handled as practically to give the desired finish to the surface with the possible exception of here and there a slight imperfection which should be remedied by men with hand floats working from a lightly constructed bridge thrown across the road. It is highly desirable, however, that as little as possible be left to the hand finishers as there is inevitably a tendency on their part to work slight depressions in the surface of the concrete which can scarcely be detected until the concrete has set and it is too late to afford a remedy.

Conduct of Construction.—The actual work of construction consists mainly of two parts: First, the preparation of the roadbed and hauling of materials thereon in such quantities as may be needed ready for the mixed. Second, placing the concrete and trimming the road sides.

The mixer used should be of a type especially adapted for this work, one which will move under its own power along the road as the work progresses and provide convenient means for handling the material onto the road.

Attention is called to the fact that the success of the road primarily falls upon the second portion of the work, which, however, involves but 9% of the total cost. It is suggested, therefore, that the public department having in charge a considerable mileage of this construction could well carry it on under two divisions, allowing the first part of the work to be done by contract while the actual placing of the concrete should be done by day labor under the immediate supervision of the officials of the department, in this way securing with the least trouble and expense assurance of proper construction in every particular. The organization for placing the concrete is compact, easily controlled by one man and, moreover, this portion of the work moves along rapidly and uniformly, so that its cost from time to time should vary but little and can be estimated with precision.

Costs.—The difficulty of presenting cost data that would be of any very general application is fully appreciated. The following table is offered together with such general information as to conditions as may prove of some interest if not of actual value.

Estimate of Cost of 1 Square Yard of Concrete Road, 7 Inches Thick.

No profits or overhead charges included.

Labor .... 25c. per hour
Team and driver .... 45c. per hour

	—Length of haul—			
	½ mi.	1 mi.	2 mi.	3 mi.
Superintendent, watchman and miscellaneous labor	0.055	0.055	0.055	0.055
Shaping roadbed and trimming shoulders	0.083	0.083	0.083	0.083
Loading and hauling materials	0.116	0.153	0.218	0.296
Mixing and placing	0.109	0.109	0.109	0.109
Cost of sand and gravel at $1.50 per cu. yd., f.o.b. destination	0.379	0.379	0.379	0.379
Cost of cement at $1.20 bbl.	0.364	0.364	0.364	0.364
Expansion joints spaced 50 ft.	0.025	0.025	0.025	0.025
Coal, oil and miscellaneous supplies for mixer	0.007	0.007	0.007	0.007
Forms and other lumber	0.005	0.005	0.005	0.005
Total	1.143	1.180	1.245	1.323

For a thickness of 6 in. a similar analysis gives total costs per sq. yd. for the various hauls as follows: ½mi., $1.003; 1 mi., $1.035; 2 mi., $1.091; 3 mi., $1.158.

In adopting concrete for a road surface, it should be borne in mind that if a hard rigid form of pavement is undesirable for the traffic to be accommodated, it will not prove satisfactory. For example, with a large amount of light, horse-drawn traffic some more resilient form of pavement would be found better adapted, but where a large amount of motor and heavy horse-drawn traffic is to be provided for, concrete pavements are proving satisfactory. There are experimental data at hand which seem to indicate a concrete pavement to be one of the most durable forms of construction that have been employed, and, under many conditions, the most economical.

The wide distribution of materials suitable for concrete makes this form of construction of the widest application and, in fact, in many areas where there is nothing but gravel deposits, poor for ordinary road purposes, a concrete road becomes the most economical and durable pavement possible. Moreover, it does not require exceptional skill on the part of the workmen, but may be successfully laid, under careful supervision, with any reasonably good labor.

CANADIAN CANAL TRAFFIC IN 1913.

In a report recently issued by the Department of Railways and Canals, Ottawa, it is shown that the total tonnage to pass through Canadian canals for the past navigation season was 51,319,426. Last year with the ending of the navigation season the figures showed that 46,952,605 tons went through Canadian canals, the figures for the 1913 season, therefore, making an increase over last year's figures of 4,366,821 tons.

It will be noticed that there has been a falling off in the tonnage handled by the Ottawa Canal. The decrease for this year over last is 26,912. However, the principal freight to pass through that waterway is sand and building material and therefore the decrease is attributed to the lesser demand by contractors. This is also the case where other waterways show a decrease as their traffic depends upon the demand made for sand and similar material.

The figures also show that the Rideau Canal has accommodated more traffic during the past season than the previous or any other year in its history, the increase this year amounting to 11,090 tons.

The figures for the season ending November 30th, 1913, with the increase or decrease over last year's are as follows:—

Canal.	Traffic, in tons.	Increase or decrease.
Sault Ste. Marie	42,022,609	2,920,815
Welland	3,545,984	726,973
St. Lawrence	4,275,863	823,400
Chambly	555,602	62,813*
Ottawa	365,438	26,912*
Rideau	171,223	11,090
St. Peter's	65,108	1,699*
Murray	180,576	11,605
Trent	55,728	21,384*
St. Andrew's	81,295	14,254*
Total	51,319,426	4,366,821

*Decrease.

"Vol III. of the Annual Tables of Constants and Numerical Data, Chemical, Physical and Technological," published by the International Commission of the Seventh and Eighth International Congresses of Applied Chemistry, is now in press and will be issued early in 1914. A descriptive circular with references to reviews of previous volumes may be secured on application to the University of Chicago Press, the American distributers.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

CONTENTS.

BOOK REVIEWS.

Design of Plate Girders.—By Lewis E. Moore, B.S., C.E. A. M. Am. Soc. C.E., Mem. Western Soc. of Engineers; Associate Professor of Structural Engineering, Massachusetts, Institute of Technology. Published by McGraw-Hill Book Company, Inc., New York. 283 pages; 85 illustrations; 3 folding charts; 42 tables; cloth; size, 6 x 9 inches. Price, $3.00.

This book is the outcome of six years' experience in teaching the subject of Bridge Design and of practical railroad work and designing in a bridge company. The author has also had experience on the Massachusetts Railroad Commission.

His practical experience has led him to thoroughly appreciate the difficulties encountered by young designers, with the result that the work is exceptionally complete and will be found very useful to structural engineers.

The arrangement of the subject matter is logical, and the space devoted to the various parts of the subject bears a better proportion to their relative importance than is to be found in most books of this nature. The explanations of the formulæ used are very full and clear, and numerous examples of the results of faulty design give the reader an appreciation of girder design from a practical viewpoint such as is seldom obtained from a text-book.

A contribution on deflection by Prof. W. H. Lawrence, of the Massachusetts Institute of Technology, will be found at the end of the chapter on the Theory of Plate Girders. There is also incorporated in the book a very useful chapter by John C. Moses, of the Boston Bridge Works, on Shop Practice. In this chapter the reader is introduced to considerations which are of the utmost importance, and which are, in a great many cases, either unknown to the designer or lost sight of in the mass of purely theoretical knowledge which he uses in his design. A design of this kind produces either of two results. Firstly, if the engineering department of the bridge company awarded the contract is abnormally busy or undermanned, the design will be executed, as nearly as possible, in accordance with the plans supplied, and the cost of fabrication will be excessive. Secondly, the bridge company may, as is usually the case, redesign the structure (without weakening it) to conform to economical shop practice. In this event the new design must be checked by the original designer, and the cost of the design is more than it would otherwise have been.

In the last chapter is embodied a set of the general specifications of the New York, New Haven and Hartford Railroad, dated 1912. Most bridge designs in Canada are, however, governed by the specifications of the different railway boards.

The book also contains a useful set of tables.

Conservation of Water.—By Walter McCulloh, C.E. Published by Yale University Press, 135 Elm Street, New Haven, Conn.; 225 Fifth Avenue, New York City. 106 pages; 40 plates; cloth, 7 x 10 inches. Price, $2.00 net, postage 15 cents extra.

This volume constitutes the first of the series of memorial lectures delivered under the Chester S. Lyman Lectureship Fund, before the Senior Class of the Sheffield Scientific School, of Yale University, and is made up of five chapters with the following captions: Introductory, Basic Data Essential to a Comprehensive Study of Water Storage, Water Power, Water Storage for Water Supplies, Sanitation and Irrigation, and the Water Resources of New York State. The lectures cover the field of the use and storage of water in a broad and general manner. The book is not a text-book in any sense of the word, but affords a readable commentary on the salient features of water conservation. It is unfortunate that as no doubt the size of the book has been curtailed by the necessity of covering the work in five lectures, space should be given to descriptions of the power plants at Niagara, since these developments have all been described many times, both in the engineering periodicals and in recent text-books. The volume is very handsomely printed, the numerous illustrations give it a most pleasing appearance; and, altogether, it will form a desirable addition to the library of the hydraulic engineer or the student interested in conservation.

The Railways of Great Britain.—By Lord Monkswell, D.L. Published by Smith, Elder & Company, 15 Waterloo Place, London, S.W. 296 pages; 25 illustrations; cloth. Price, $1.50.

The table of contents, which extends through five chapters, covers almost every item of railway equipment, expenditure, working, financing, traffic, hotels, water communication, labor union problems, and, indeed, all the varied activities and details of management involved in the maintenance and working of a large, modern railway. The main headings include the East Coast, the Railways of Central England, the West Coast and the railways of the South and East. The author, Lord Monkswell, is the third Baron with that title, but the family name is Collier. He is a barrister by profession, who has made railroad operation a study, and has written very fully on "French Railways." His book on British practice, while not being technical in the narrow sense, yet contains a great deal of technical information. It is a general and comprehensive survey of the whole railway situation as it exists in the British Isles at the present time.

The author deals very frankly with the matter of railway competition. In many cases, he shows that where there is an assurance of very considerable traffic between two points, served by two or more lines, it is almost impossible to bring about any competition in the ordinary sense of the term The tendeny is to enter into an agreement whereby each line binds itself not to give more than such and such facilities to the public. In cases of this kind, the only remedy for the public lies in the Government imposing definite conditions in the interest of the people. Even then, tacit understandings are reached between the companies, and these understandings not only tend to suppress competition still further, but actually hinder the introduction of improvements. Notwithstanding all this, it is true that the railways of Great Britain are ahead of their continental rivals in the matter of public conveniences.

Pursuing this matter, under a different heading, Lord Monkswell says that if there are two things, above all others, which the public would thoroughly appreciate, they are decreased third class fares and increased speed. In 1888, when the race from London to Edinburgh took place, and in 1895, when the race to Aberdeen was on, some very remarkable locomotive performances were shown. The Caledonian Railway, working the passenger traffic from Carlisle to Edinburgh, were able to haul a train, on time all the way, with perfect ease. This was done with a "single" driver engine weighing 42 tons, of which 17 tons were on the driving wheels, and these had a diameter of 84 inches. The grate area was only 17 square feet, or about the size of an ordinary dining-room table. The engine, No. 123, was timed to run 100¾ miles in 112 minutes and surmount the "Beattock bank," a grade of 1 in 80 for ten miles and 1 in 75 for six miles. The daily performance of this engine, well within the booked time, produced a profound impression at that period, and all the more so, when it was apparent that her uphill work was better than her downhill performance. The designs of engines used on the Caledonian proved what can be done in the way of speed, but the timing of trains at the present day has not been kept up to the high level of promise inaugurated in the West Coast race to Scotland. At that time, however, the entire railways of Great Britain felt the impetus, and the speed of trains was accelerated all over the Kingdom, until, as our author shows, the paralyzing effect of "agreements" deadened and restricted the otherwise natural growth of improvement.

It has been held that high speed on long non-stop runs is expensive, and with this subject Lord Monkswell deals very fully. The average British railway manager believes that high speed is a good thing, but believes also that it is costly, and does not pay. How far the danger of misplaced switches or misread signals, enters into this view, Lord Monkswell does not say. The author, however, believes that accelerated service can be made to pay. High speeds cost more than slow speeds, but the corresponding advantages gained by selling the better article, i.e., rapid transportation, might easily put the balance on the right side of the ledger. As a concrete example he takes the 6.05 a.m. ex-Euston for Manchester, and shows in detail what effect altering its time of arrival from 9.35 to 9.05 a.m. would mean and what the cost of gaining this 30 minutes would be. Step by step he proceeds, and takes the difference in cost, if more powerful engines replaced those now in use, with increased outlay for up-keep, more fuel, more supplies, and even higher wages for driver and fireman. All the many etceteras are taken note of, and set down as money items required in gaining the half hour, daily on this train. On the assumption that the engines ran 40,000 miles between "shoppings," the increased cost would be 2½d. a mile. Adding to this, the extra expense in road maintenance, and that due to increased wear and tear of train, he says that even taking the most unfavorable view possible, that 5½d. a mile would be the limit of extra expense, and that the average, when other trains are considered, would probably be considerably less. In face of this, if the increased speed attracted six more third class passengers to travel, the railway would actually be making a profit.

Lord Monkswell does not leave the matter here, but offers several very pertinent suggestions as to how time could be saved on the run from London to Edinburgh. He does not merely say it can be done, but shows how. He cites instances of locomotive performance on the Nord, in France. He gives his own country credit for pre-eminence in long non-stop runs, and shows the saving that has been effected by the use of the Ramsbottom "pick-up" water-troughs. He advocates a serious trial of increased speed as a revenue producer.

In the matter of railway carriage design, the old stage-coach, modified to suit railway service, was long the model. The advent of Pullman cars showed what could be done when that model had been entirely abandoned. The Pullman car is not popular in Great Britain, as English travellers prefer the compartment system, and their desires must be met; but certain it is that, unpopular as the Pullman car itself is, yet its advent produced a very marked change in the whole spirit of British railway carriage design. The increased dead weight per passenger, which gradually came as a result of increased comfort for patrons is at the bottom of the heavier engine design, which naturally went hand-in-hand with the desire for comfort and speed.

Railway signals are dealt with when the London and South-Western is under review. The author believes that the British system of signals is the simplest and most complete now employed. He says: "Ordinary visual signals leave little to be desired in broad daylight; they are slightly less perfect at night, when color and not shape has to be depended on." This is, perhaps, a fairly accurate statement of the average man's opinion. We can only say that experts are here and there beginning to modify their views, and feel that "position" for day and "color" at night is not an ideal arrangement. The author may have this in mind, for in a footnote he remarks: "Possibly something may be done by means of flashlight signals to differentiate signals at night." The Great Western, he tells us, has experimented with cab signals, both audible and visual, which give a driver the correct indication of the position of any sgnal he is approaching. The L. and S.W. are successfully experimenting with a system of wireless train control which involves the automatic stop.

The whole of the goods traffic on all the railways is gone over in detail, and to those who know only our long, unbroken trains of bulk freight, such as ore and coal, the demands of British traffic will be a revelation. The whole of the goods traffic seems to us more like a magnified express business than legitimate freight handling. The small car has its uses over there, and its economies, and the heavy, high capacity box cars used in Canada would well-nigh be useless in Great Britain.

As science advances and inventions multiply the possible rivals of the locomotive are mentioned in this book. Electricity has now an established place of its own, and the tram-car has secured a field for its own activities which is no longer debatable. The possibilities of the turban principle are still remote as applied to the locomotive, while the Diesel engine, using crude oil fuel, may some day be applied to railway work.

The book as a whole contains a mass of most useful information, and, though we have touched on the locomotive side of it for the benefit of interested readers, yet we have only given a sample of its interest and its scope. The book can be read with profit and pleasure by the financier, the lawyer, the business man and the technical student, and, indeed, by any intelligent man to whom the many phases of the railroad problem appeals. The facts presented are not complicated by tables and masses of statistics, but the whole story is written in easy, flowing, connected style, which gives to the many and diverse topics treated an interest and a value which is unique in semi-technical literature.

A Pocket-Book of Useful Formulæ.—By Sir Guildford L. Molesworth, K.C.I.E., Past-President of the Institution of Civil Engineers, M. I. Mech. E., Fellow of the University of Calcutta; and Henry Bridges Molesworth, M. Inst. C.E. With an Electrical Supplement by Walter H. Molesworth, M. I. E. E., M. I. Mech. E. Published by E. & F. N. Spon, Limited, 57 Haymarket, London, and Spon & Chamberlain, New York. Twenty-seventh edition, revised and enlarged; 800 illustrations; viii. + 938 pages; oblong 32mo.; leather; gilt edges. Price, $2.00.

Molesworth's Pocket-Book of Engineering Formulæ needs no more than a mention to engineers. Fifty years have elapsed since the first edition was published containing 220 pages. In this, the twenty-seventh edition, there are 944 pages. The pocket-book has been thoroughly revised, and contains a valuable addition in an Aviation Section. The Electrical Section has been carefully revised, and its symbols brought in accord with the International Standard Notation. This little volume well deserves its name of "A Pocket-Book of Useful Formulæ and Memoranda for Civil, Mechanical and Electrical Engineers."

The Railway Goods Station.—By Fred. W. West. Published by E. & F. N. Spon, London, and by Spon & Chamberlain, New York. 192 pages; fully illustrated; cloth; 4½ x 7½ inches. Price, $1.50.

This volume, written as a guide to the control and operation of the railway goods station, supplies a good deal of much-needed information, and a number of suggestions on the main principles upon which the regulation and organization of a goods station are based. The author does not attempt to publish an exhaustive treatise on the subject, but the general information concerning the station itself, staff organization, office routine, and discipline, the checking of goods, etc., should be found instructive. Of course, there is the fact that the book deals specifically with English practice, and a good deal of it, therefore, would be found somewhat impracticable by Canadian station men.

Highway Engineering.—By Arthur H. Blanchard, C.E., A.M., Professor of Highway Engineering, Columbia University, New York, and Henry B. Drowne, C.E., Instructor in Highway Engineering, Columbia University, New York. Publishers, John Wiley & Sons, New York. 762 pages; 240 illustrations; 40 tables; 5 plates; cloth; 6 x 9 inches. Price, $4.50.

The subject-matter of this volume, according to the author's preface, is based largely on the courses of instruction given by them at Columbia University and upon their practice as highway engineers. It is designed not only as a text for students, but also as a reference for engineers.

The order of arrangement is good, the treatment of the various phases of the subject is clear and concise, the text is well supplied with tables, diagrams and half-tones, and the volume is a model of the printers' art. Of many of the illustrations it must be said that the authors have given considerable advertising to a number of those who furnished cuts of machinery, a thing which, in a treatise of this nature at least, is open to criticism.

Chapters X. to XV. inclusive are devoted to bituminous materials. The authors deal at some length with the nomenclature, sources of supply, properties, physical and chemical tests, and also, in the light of more recent investigations and practice, with the employment of the material in the various types of construction and maintenance. To this extent a contribution has been made to the literature in highway engineering.

Of the remaining chapters it must be said that the subject-matter has, in most cases, been fully covered by former writers, and that this part of the book is largely a work of compilation. The volume will, however, find a place both with the student and with the engineer.

PUBLICATIONS RECEIVED.

Canadian Society of Civil Engineers.—Bulletin No. 9, dealing with elections, Society affairs, accessions to the Library, etc.

Ohio State Board of Health.—Monthly bulletin for November, containing articles on subjects of interest in the field of public health.

Department of Customs, Canada.—Report for year ending March 31st, 1913, comprising tables of imports, exports and navigation, compiled from official returns, 656 pages.

The Red Iron Ores of East Tennessee.—Bulletin No. 10, of the State Geological Survey. Compiled by E. F. Burchard, geologist. A book of 170 pages, well illustrated by figures and maps and carefully indexed.

Production of Copper, Gold, Lead, Nickel, Silver, Zinc and other Metals in Canada during 1912.—A report of 86 pages by C. T. Cartwright, B.S., Assistant Mining Engineer, Mines Branch, Department of Mines.

Central Railway and Engineering Club of Canada.—Official report of the October, 1913, meeting. The 48-page pamphlet contains an historical paper on Compressed Air by P. McCabe, Toronto Railway Company.

Coal-Mine Accidents.—Bulletin 69 of the United States Bureau of Mines, compiled by Fred. W. Horton, dealing with accidents in the United States and in foreign countries; and making comparisons. A booklet of 100 pages, well tabled and illustrated.

Board of Highway Commissioners, Saskatchewan.—Annual report for year ending with Feb., 1913, containing reports of Bridge, Highways, and Accountants' branches; regulations of municipal highways, and Public Highways Act; 56 pages, well illustrated.

American Society of Testing Materials.—Proceedings of the 16th annual meeting, held at Atlantic City, N.J., June, 1913, containing committee reports, papers and discussions of the Convention. A volume of 1,140 pages, illustrated and supplemented by numerous plates.

Industrial Research in America, dealing with the orderly and sustained progress that has been made in scientific achievement. A 24-page booklet, comprising the presidential address of Arthur D. Little before the American Chemical Society at Rochester, N.Y., Sept. 9th, 1913.

Phase Compensation, with Special Reference to Single-Phase Motors.—By V. A. Fynn, Consulting Engineer, Wagner Electric Manufacturing Company, St. Louis, Mo., being an amplification of articles published severally in the "Electrical World" during July, 1913; 51 pages, 43 figures.

Canadian Railway Club.—Official proceedings of November, 1913, meeting. It includes a paper and discussion on "The Conservation of Natural Resources through the Electrification of Railways," by G. P. Cole, M.Sc., Mem. A.I.E.E., Canadian General Electric Company, Toronto.

Safety in Tunneling.—An 18-page pamphlet, written by D. W. Brunton and J. A. Davis for the United States Bureau of Mines, comprising instructions to the superintendent, the foreman, and the miner, and containing a list of publications by the Bureau on mine accidents and methods of mining.

Possible Causes of the Decline of Oil Wells, containing suggested methods of prolonging yield. Issued by the United States Bureau of Mines, Department of the Interior, as Technical Paper No. 51. Prepared by L. G. Huntley. Comprises 32 pages, and contains a list of publications on petroleum technology.

Laws Relating to Liability of Employers.—Second interim and final reports by the Hon. Sir William Meredith, C.J.O., Commissioner. A 58-page publication, including the draft of an act to provide for compensation to workmen for injuries sustained and industrial diseases contracted in the course of their employment.

Portions of the Atlin Mining District, B.C.—Memoir No. 37, Geological Survey Branch, Department of Mines, Canada. Compiled by D. D. Cairnes. This book deals with the general character and geology of the district, and directs special reference to lode mining. It has 128 pages, with numerous photographic reproductions and maps.

Production of Iron and Steel in Canada during 1912.—Compiled by John McLeish, B.A., Chief of the Division of Mineral Resources and Statistics, Mines Branch, Department of Mines, Canada. This 40-page bulletin deals with iron ore, pig iron, ferro-products, steel, bounties, exports and imports of iron and steel goods for the year.

Geology of the North American Cordillera.—Report of the Chief Astronomer, Department of the Interior. A detailed report on the geology of the mountains crossed by the international boundary at the 49th parallel. This publication constitutes Volume III., and comprises 10 chapters in 300 pages, fully illustrated with plates and figures.

Relation of Manufacturer to the Patent System.—An extensive article by W. M. Grosvenor, dealing with the close inter-relation between patents and the development of modern industry, and maintaining that the subject does not receive sufficient consideration on the part of economists in the United States, advising, in conclusion, the appointment of a Patent Commission.

Psychological Aspects of the Problem of Atmospheric Smoke Pollution.—By J. E. Wallace Wallin, Ph.D., of the Mellon Institute of Industrial Research and School of Specific Industries, University of Pittsburg. A 46-page pamphlet, dealing with the pathology and the aesthetic aspects of smoke pollution. The third bulletin of the Institute on Smoke Investigation.

Provincial Board of Health of Ontario.—Thirty-first annual report, containing a résumé of the work of 1912, including reports of Provincial Medical Inspector; reports of Laboratories of the Board and official regulations. A 496-page book, illustrated, and including Bulletin No. 1, being a treatise on the design, regulation and action of slow sand filters, by F. A. Dallyn, B.A.Sc., C.E., Provincial Sanitary Engineer.

Pollution of Boundary Waters.—A preliminary report of the special committee of the International Joint Committee having supervision of the investigation relating to boundary waters' pollution. It contains a compilation of documents relating to petitions of the Erie and Ontario Sanitary Canal Company for permission to divert 6,000 second-feet from Lake Erie for the purpose of remedying the existing pollution of Niagara River.

Mines Branch, Department of Mines.—A summary report dealing with the work of the Branch during 1912, containing general report of Dr. Eugene Haanel, director, a report on the field work, chemical laboratories, statistical division, assay office, fuel-testing station, ore-dressing and metallurgical laboratories, etc. It contains 174 pages, supplemented by maps of the Yukon Mining Districts.

Tungsten Ores of Canada.—A report by T. L. Walker, M.A., Ph.D., Mines Branch, Department of Mines, Ottawa. A treatise on the metal and its uses, general geological occurrence of tungsten ores, their concentration. The bulletin includes data concerning the world's production, and enumerates in detail the location of the various ore bodies throughout the Provinces of Canada. An appendix deals with a comprehensive bibliography of Canadian tungsten literature.

Chrome Iron Ore Deposits, in the Eastern Townships of Quebec.—A Report by Fritz Cirkel, M.E., Mines Branch, Department of Mines, Canada. A 140-page book containing full information respecting chrome iron ore mines throughout Canada generally, and including several chapters upon the uses and technology of chromium and its compounds. An appendix contains notes by Mr. W. Borchers on the metallurgy of chromium. The report is supplemented by numerous plates, photographs and drawings.

Hydro-Electric Power Developments.—Bulletin No. 4966A of the General Electric Company, describing numerous Hydro-Electric installations, such as those of the Great Western Power Company, Stanilaus, Great Falls, Mississippi, Pennsylvania, Connecticut River, Utah, and other similar developments. The publication is well illustrated with transmission line equipment, lightning arresters, transformers, generators, alternators, and plans, etc., of power sites. The Canadian General Electric, Limited, Toronto, are the distributors.

Canadian Trade Index.—A directory of the manufacturers of Canada, classified according to the articles made. The 1913-15 edition, compiled and published by the Canadian Manufacturers' Association, Inc., Toronto. The index includes within its scope all reputable manufacturing plants doing more than a local business. It includes a good deal of general information in concise form concerning the kindred character that all business houses may be presumed to require. This is a noteworthy addition to previous volumes of the work. 6½ x 10 inches; 288 + 170 pages, advertising; cloth. Price, $3.00.

Diagram Giving Stresses in Beams.—By H. R. Thayer, assistant professor of structural design, Carnegie Institute of Technology, Pittsburg. Published by D. Van Nostrand Company, New York City. Size, 7½ x 11½ inches. Price, $0.20 net. This is a compact diagram whereby sizes of I-beams, steel channels, wooden beams, composite girders, etc., can be obtained with ease and comparative accuracy. From it may be speedily deduced stresses in a beam caused by a given load or moment, stress modulus required for given loadings and stresses, design of beam for given stresses and loads or moments. It will be found a valuable time-saver in designing offices and remarkably comprehensive in its service.

CATALOGUES RECEIVED.

Apollo-Keystone Copper-Bearing Steel Sheets.—Published by the United States Steel Products Company, descriptive of this product, designed to resist rust. Full information respecting types, widths, etc.

The Concrete Roads of Wayne County.—A reprint of a paper presented by Ed. M. Hines, County Road Commissioner, Detroit, to the National Association of Cement Users, distributed by the R. D. Baker Company, Detroit, Mich.

Pacific Type Locomotives. —Bulletin No. 1016, American Locomotive Company, New York City, containing tabular comparison of this type as built by that company for various roads. The bulletin is well illustrated, and contains general information that will be found of interest.

General Catalogue.—Robert Hudson, Leeds, England, manufacturer of portable railway plants, steel tipping wagons, locomotives, turntables, switches, crossings, rails, etc. Illustrating also a complete supply of contractor's plant, mining accessories. 70 pages, illustrated, and equipped with price lists.

The Milburn Light.—A handsomely printed 48-page catalogue published by the Alexander Milburn Company, Baltimore, descriptive of their portable acetylene lights for powerful out-door illumination. It contains a few pages on oxy-acetylene welding and cutting apparatus, as manufactured by the company.

Gears and Rolling Mill Pinions.—An 8-page pamphlet published by the Mesta Machine Company, Pittsburg, containing interesting data respecting gears in heavy mill machinery, and charts for determination of the dimensions of moulded gears for cast-steel. A section of the catalogue is also devoted to cut gears.

Steam Water and Air-Flow Meters.—Bulletin No. A4157, Canadian General Electric Company, Limited, Toronto, showing illustrations descriptive of accessories, parts, and installations of these products. Contains tables of pipe fittings, plugs, reducers, etc., and diagrams of dimensions of orifice tubes for measuring steam, air or water flow.

Baker Armored Concrete Pavement.—40-page illustrated catalogue, published by R. D. Baker Company, Detroit, Mich., descriptive of their armored plate to take care of expansion in concrete pavements. The catalogue also describes their installation bar. It contains interesting data about pavement materials, and includes specifications for laying concrete pavements, using the above appliances.

Hoisting Accessories.—A well-illustrated, carefully compiled 28-page pamphlet, being Bulletin No. 1805, Mining Machinery Department, Canadian Allis-Chalmers, Limited, Toronto. It is descriptive of cages and skips, landing-dogs, wire rope, sheaves, differential drums, safety hooks, mine and scoop cars, ore bins, and bin gates, etc. Photographs, line diagrams, charts and tables of strengths, weights, dimensions, etc., make this catalogue one that will be well appreciated.

ENGLISH CHANNEL TUNNEL POSSIBLE.

At the first Franco-Prussian Travel Congress, held in London the latter part of November, 1913, Sir Francis Fox, the engineer, gave an address explaining how the channel tunnel may be, and probably will be constructed between England and France. Sir Francis Fox and his partners agree that the enterprise is one that can be carried out with certainty, and at a comparatively moderate cost, the geological and other conditions being of exceptionally favorable character for the construction of a submarine tunnel. The English company would construct the double-barrelled tunnel from Dover to a point in mid-channel, and the French company would construct the other half from Sangatte. Borings would be made through the lower, or gray chalk, which is practically free from and remarkably impervious to water. This chalk bed is eighty-seven feet thick at Dover and eighty feet thick at Sangatte. Its ingredients are very similar to the components of Portland cement. It is an excellent material to work in as it "puddles" itself and becomes impervious. Sir Francis pointed out that protective works might be constructed similar to those introduced by the French, Swiss, and Italian military authorities in connection with the Alpine tunnel from the "food-supply-in-war-time" point of view. "Finally, we ought emphatically to dispel a fallacy which seems to have arisen in connection with the earlier proposals," he said, "namely: that in case of war it would be necessary to blow up or permanently destroy this great work of a channel tunnel. Both in the English and the French portions the level of rails has been so arranged that, by the simple process of opening some valves—which will be under the control of the military authorities, and within the lines of fortification at Dover—a sufficient volume of water could be admitted to fill the tunnel to its roof—for a few hundred yards. This would eventually block the tunnel without injuring it." He estimated that the "drainage heading"—a smaller boring in advance of the main boring—could be driven through the chalk at the rate of seventeen yards a day, or three miles a year each way, making a joint progress of six miles a year. It would thus take four years to complete the drainage bore, and the entire work might be completed in a little over six years. Each tunnel would, when completed, consist of a cast-iron tube, "grouted" on the outside with cement, and lined inside with concrete in cement, so as to make a smooth surface and prevent corrosion.

FILTER PATENT SUIT DECIDED.

A decision has just been rendered at Cincinnati sustaining the patent of J. C. W. Greth, for Water Purifying Apparatus described by claim 11, of that patent, as follows:—

"In continuous flow water purifying apparatus the combination with a single tank containing the chemical reacting compartment, and an upward flow settling compartment of a series of independent gravity filters carried on the top of the tank, fed by overflow from the settling compartment, and each having means for washing the filter and a valve to close communication with the settling compartment, whereby any one of said filters may be isolated and washed, while the flow continues through the others from said supporting tank."

The suit was originally filed at Louisville, Ky., in 1910, by Wm. B. Scaife and Sons Company, of Pittsburgh, Pa., against the Falls City Woolen Mills. The district court denied the injunction and appeal was taken with the above result.

Under the ruling of the Court in this case, it would seem that there would be no way to use plural, or continuously washable—without interrupting—filters in any continuous system in the United States. Greth having been the first to devise such structure, or, as the Court says, near the end of its decision:—

"The idea of a group of filters, each of which could be cut out independently, without affecting the work of the others was broadly old, but had been applied nowhere except in city water supply systems or for analogous uses where the lake, river or pond was the settlement basin and the water was brought therefrom in conduits to the filters. It had never been applied as a part of a unitary structure in the treatment of water to produce a comparatively small continuous flow for industrial purposes. When so united with such a structure, in a compact unitary well designed and effective form, it makes a new combination, and it produces a result different from what had before been accomplished."

COAST TO COAST.

Chatham, Ont.—It is announced that the Chatham water commission has a surplus of $5,834 for the past year.

Calgary, Alta.—The gross earnings of the Calgary municipal street car lines were $60,670, and the expenses about $1,000 less than this figure.

Vancouver, B.C.—Station work is now proceeding on 28 miles of the 38-mile section of the Hope Mountain railway which is being constructed through the Coquahalla by the Kettle Valley Railway, for the joint use of the V.V and E. and the K.V.

Winnipeg, Man.—Winnipeg's hydro-electric system continues to show steady progress and the record was obtained during November, when apparent net earnings amounted to $79,677.35 after making all allowances for discounts, possible bad debts and so on. This is an increase of $7,645.27 over the preceding month.

Ottawa. Ont.—The latest available information gives the total appropriation for improvements to the harbors of Canada as $28,214,000. The work, which involves harbor dredging and river work, has occupied the main attention of the public works department during the past season. Of the amount appropriated, $17,000,000 will represent practically the amount spent by the end of the present fiscal year.

New Westminster, B.C.—The department of public works does not contemplate letting any more contracts during this year. This is because the work provided for in the 1913 estimates is now either completed or under way and any new works will have to come under next year's estimates. Since the federal house does not meet until January it will be at least March or April before the department of public works' estimates have been considered.

Stratford, Ont.—At Stratford the Grand Trunk Railway Company has constructed and officially opened a $50,000 new station. The new station is said to be one of the finest on the road, and will also house the divisional headquarters. It is built of brick, with Roman stone facings, and has a frontage of over 150 feet. New additions were also made to the yards, and new freight sheds were erected.

Peterborough, Ont.—One hundred arc lamps have recently been installed at Kingston by the Hydro-Electric Commission at a cost of $120,000. The new light and power system has been switched on, and has so far proven satisfactory. The wires for the street lighting have been placed underground; and in the down town district, the few poles necessary will be placed in the rear of the buildings.

Port Arthur, Ont.—For the year 1913, the electric department in Port Arthur showed a net profit of $62,000, or a gross profit of $165,700. At present the city is using 2,100 horsepower from the Hydro-Electric Commission, and 700 horsepower from the Current River station. The present storage capacity of the various dams in the system is 1,843,100,000 cubic feet, and water this fall was running over all which was an unprecedented condition for this time of the year.

Ottawa, Ont.—By the middle of January, the report being made by officials of the Canadian and United States Governments on the serious pollution of international waters extending from the Lake of the Woods to the St. John River, will be before the International Joint Commission. The examination made so far is complete except with regard to the St. John River, where some further work has to be done. The report of the engineers who have been taking the levels of the Lake of the Woods will also come before the commission at the same time.

Fredericton, N.B.—Development in railway facilities in New Brunswick, and particularly in Fredericton and its neighborhood, has been decidedly marked during the past few years. When the several lines of railway now under construction are finished and in operation, and some other lines now in contemplation have also been built and are in operation, no country will possess more or better transportation facilities than New Brunswick. Within a very short time, a railway will be in operation in practically every settled portion of the province; and the days when the farmer is compelled to drive many miles by team in order to reach a market town, will soon be a thing of the past.

Montreal, Que.—According to the statements of J. G. Sullivan, chief engineer of the western lines of the C.P.R., that company has had under construction this year a grand total of 1,700 miles of railway west of Fort William. The amount of work which has been handled by the construction department of the company this year represents more material than was moved during any period in the construction of the Panama Canal and represents no less than 30,000,000 cubic yards. In regard to the grading of new lines this season, the total work accomplished amounts to 557 miles of new line, exclusive of sidings and terminal work and 262 miles of double-tracking on the main line.

Ottawa, Ont.—Doubts which have been entertained concerning the harbor possibilities of James Bay, have been dispelled by the summer investigation of the hydraulic surveys, conducted under the auspices of the Naval Service Department. These have led to the conclusion that first-class harbor facilities are to be found in James Bay in the vicinity of the mouth of the Nottaway River. Good shelter, ample room, and a sufficient depth of water have been found, and very little silt is in evidence to necessitate dredging. Soundings indicate plenty of water right out into the bay. Examination of conditions at the mouth of the Moore and Rupert Rivers shows that they are out of the question as harbor possibilities. Ice conditions will, of course, have to be contended with in James Bay, but the difficulties in this connection are by no means insurmountable for navigation.

Galt, Ont.—The report of the local Hydro-Electric Commission shows, during the past 11 months of the present year, 434 new subscribers, which will doubtless be increased in December to 475. During 1912, there were but 347 new applications for service. The capital investment of the commission is now $177,936.76 and the total increase of this account for the present year is $47,946.90, of which $25,028.74 is for ornamental lighting. The work on installing ornamental lighting this year has been very extensive, 23 miles, 184 feet of cable being laid and 252 lighting standards placed. Galt to-day has more ornamental lighting than any place its size in Canada and still has a number of streets to be supplied for which petitions are now in hand. The total cost of operation including sinking fund and interest for the 11 months of the present year is $30,463.30, while the revenue for the same period amounts to $40,509.32, leaving a gross profit of $10,046.02. The increase of business of the department is better illustrated by the increase in the connected power load of 750 horsepower one year ago to 1,103 horsepower at the present time. Galt is now paying $21.50 per horsepower.

Barriefield, Ont.—It is expected that by Christmas the new Barriefield station of the Marconi Wireless Telegraph Company of Canada will be almost complete. The two masts at Barriefield are 450 feet apart, and 185 feet high. The cross-arms are 20 feet wide and are used to space the aerial wires. The aerial, in this case, will take the form of the letter "T" so as to radiate and receive equally in all directions. There will be two gasolene engines, of eight horsepower each, and two special high frequency generators. These travel at a speed of 200 revolutions a minute. Mr. Edwin E. Robinson of the technical engineering staff of the company reports the situation at Barriefield as ideal, and expects to send one of the first messages to Midland, about 100 miles north of Toronto. The Barriefield station will give out a musical note when messages are being transmitted, probably about middle "C" on the piano. This is accomplished by a disc which has a number of points passing very close to two fixed points at a very high rate of speed. There will be in the neighborhood of 100,000 volts on the aerial. Around the outside of the operating house is buried a quantity of copper netting and zinc plates. This is to act as a return circuit to another station, the air being used in place of wire.

Toronto, Ont.—This year Toronto has acquired four continuous stretches of good roadway, which the city has not known before. Since Yonge Street has been repaired, there is a splendid straight road from Toronto Bay to York Mills, a distance of seven miles at least. Since University Avenue has been newly paved, a splendid connection of about six miles of roadway has been afforded along that avenue to College Street, west on College to St. George Street, north throughout the length of St. George to Dupont Street, west on Dupont to Spadina Road, north on Spadina to Davenport Road, west on Davenport to Walmer Road, north on Walmer to Theodore Road, west on Theodore to Bathurst Street, north on Bathurst to St. Clair Avenue, and thence along St. Clair to Prospect Cemetery and West Toronto. The third roadway connection, which is about seven or eight miles long, follows University Avenue to Anderson Street, west along St. Patrick Street to Bathurst Street, and thence west on Arthur and Dundas Streets through West Toronto to Lambton. The fourth follows east along Wilton Avenue, crossing the Wilton Avenue bridge, and along the Wilton Avenue extension beyond Broadview Avenue to Bolton, north on Bolton to Gerrard Street, along Gerrard to Logan Avenue, north on Logan to Danforth Road, and finally along Danforth to East Toronto and the Kingston Road.

PERSONAL.

CLARENCE W. NOBLE, contracting structural engineer, Toronto, who has been on a trip throughout the Canadian West during the past five weeks, is expected to return next week.

J. E. GRIFFITH of the British Columbia Civil Service, and previously associated with the construction department of the Canadian Pacific Railway west of Winnipeg, will, it is announced, succeed W. W. Foster, resigned, as Deputy Minister of Public Works for British Columbia.

R. H. CUNNINGHAM, B.A.Sc., has been appointed manager of Canadian Hoskins, Limited, Walkerville, Ont. For several years Mr. Cunningham was connected with the Hoskins Manufacturing Company of Detroit, and received the above appointment upon the opening of the Canadian branch factory.

J. W. STEWART, of Foley, Welch and Stewart, railway contractors, has assumed the managing directorship of the construction of the Pacific Great Eastern Railway, now under construction from Vancouver to Fort George. This change was necessitated by the illness of Mr. Welch. The firm is striving to have about 1,100 miles of the road completed by next August, giving direct connection between Vancouver and Lillooet.

COPIES WANTED.

About six copies each of *The Canadian Engineer*, issues of July 31st and September 4th, 1913, are desired. We would be glad to advance by one month the date of expiration of subscription of any subscriber who may care to forward a copy of either of these dates from his own file.

VICTORIA BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

The annual meeting of the Victoria branch, Can. Soc. C.E., was held on Thursday, December 11th, at the branch club rooms, 534 Broughton Street, when the following officers were elected for 1914—viz.:—

Executive—F. C. Gamble, chairman; D. O. Lewis, vice-chairman; A. E. Foreman, treasurer; R. W. Macintyre, secretary; E. H. Harrison and Lewis W. Toms. The auditors are H. A. Icke and F. A. Richardson.

The chairman gave a brief review of the work accomplished by the branch during the past year, and whilst advocating a change of officers from year to year, at the same time expressed his appreciation of being elected by acclamation to a third term in the chair.

Mr. J. B. Holdcroft, A.M., read an interesting paper, illustrated with diagrams, on the "Cellular design of vibrated concrete construction, with especial reference to its use in sub-aqueous work," which evoked an animated discussion between the members present.

STEAM TURBINES.

At the first regular meeting for the season, on December 19th 1913, Mr. J. A. MacMurchy of the Westinghouse Machine Company, Pittsburg, Pa., addressed the Toronto section of the American Institute of Electrical Engineers, on "Steam Turbines." The address was illustrated, and created much interest.

THE CENTRAL RAILWAY AND ENGINEERING CLUB.

The regular monthly meeting of the Central Railway and Engineering Club of Canada was held in the Temple Building, Toronto, on Tuesday, December 23rd. A very interesting paper was read on "Scientific Illumination," illustrated by lantern views, by Mr. J. W. Helps, late Industrial Engineer, Toronto Hydro-Electric System. Mr. C. L. Worth, Toronto, is Secretary.

COMING MEETINGS.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.—**Seventh Annual Convention will be held at Great Northern Hotel, Chicago, December 29th to 31st. Secretary, I. W. Dickerson, Urbana, Ill.**

MINING AND METALLURGICAL SOCIETY OF AMERICA.—**Annual Meeting will be held in New York City, January 13th, 1914. Secretary, W. R. Ingalls, 505 Pearl Street, New York.**

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

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

20999—December 11—Authorizing C.P.R. to construct spur for Merchants' Trust and Trading Co., Limited, town of Nanaimo, Vancouver Island, B.C.

21000—December 11—Extending, until March 1st, 1914, time within which C.P.R. reconstruct culvert on Chalk River Sub. Div., Eastern Div., bridge No. 53.2, near Arnprior, Ontario.

21001—December 9—Directing that, within 15 days after Applicant, G. A. Farrill, of Kenilworth, Ont., notifies C.P.R. that he has dug ditch "H. G." to right-of-way of fence at point "G," said Ry. Co. extend ditch on north side of crossing to right-of-way of fence, at point "G," and place at least six inches of gravel on farm crossing approaches.

21002—December 12—Authorizing C.P.R. to construct road diversion in Sec. 9-34-18, W. 3 M., Sask.; and construct, at grade, its Wilkie-Anglia Branch across said diversion at mileage 40.2.

21003—December 13—Authorizing C.P.R., to construct, at grade, its Snowflake Westerly Branch across road allowance between Secs. 14 and 15-1-11, W. P. M., Manitoba, at mileage 9.11 on said Branch.

21004—December 11—Amending Order No. 20878, dated Nov. 1st, 1913, by adding words, "except Sunday," after word "daily" and before word "passenger," in second line of operative part of Order.

21005—December 9—Amending Order No. 17522, dated 18th, 1913, by adding words, "in so far as it relates to Chemainus Road only," after "plan 'A,' " in second last line of operative part of said Order.

21006—December 15—Authorizing C.P.R. to construct siding for Canadian Bag Co., Limited, Montreal, Que., subject to certain conditions, and approving and authorizing clearances as shown on plan, subject to condition that men be kept off tops and sides of cars while operating said siding.

21007—December 10—Authorizing London and Lake Erie Ry. and Trans. Co. to connect with the M.C.R.R., for interchange of traffic between said Railways, just northeast of station in St. Thomas, Ont.; M.C.R.R. put in switch, at its own expense, and do work on its right-of-way, furnishing, free of cost, land therefor, as shown on plan; cost of remainder of work paid by London and Lake Erie Ry. and Transportation Co.

21008—December 11—Authorizing C.P.R. to construct sidings for city of Montreal, Que., at Mile End.

21009—December 11—Authorizing, temporarily, and until interlocking plant is installed, C.L.O. & W. Ry. (C.P.R.) to operate its trains across C.N.O.R. in Lot 27, Con. 2, Tp. Pickering: interlocking plant to be installed by June 15th, 1914; pending installation crossing be protected by flagmen, appointed by C.N.O.R. at expense of C.L.O. & W. Ry.

21010—December 9—Rescinding Order No. 17667, dated Oct. 4th, 1912, in so far as it relieves C.P.R. from fencing that portion of its right-of-way from mileage 29.5 to 32, east side, and mileage 29.5 and 31.5 on west side. 2. Directing C.P.R. fence said portion of right-of-way from mileage 29.5 to 32, on east side, and from mileage 29.5 to 31.5 on west side, on or before May 31st, 1914.

21011—December 15—Declaring that charge of thirty-four ($34) dollars for demurrage on shipments of coal, consigned to Canadian Coal and Commission Co., Bienfait, Sask., and shipped on 9th and 11th days of December, 1912, was illegal.

21012—December 11—Authorizing C.N.R. and C.P.R., pending installation of interlocking plant, to operate over crossing in N.W. ¼ of Sec. 16-52-24, W. 4 M., Alta., until June 15th, 1914, subject to condition that crossing be protected by flagmen, appointed by C.P.R., at expense of C.N.R.

21013—December 10—Authorizing G.T.P. Branch Lines Co., and C.P.R., to operate over crossing at Regina, Sask., without their first being brought to a stop.

21014—December 11—Approving plans, on file with Board under file with the Board under file No. 22913, showing G.T.R. Ry. Co.'s 88′ 6″ and 75′ turntables.

21015—December 11—Authorizing G.T.R. to reconstruct abutments of bridge No. 63, mileage 152.51, carrying 20th Dist. of its railway over public road at Holmesville, Tp. of Goderich, Co. Huron, Ontario.

21016—December 13—Authorizing, temporarily, pending installation of interlocking plant at crossing, C.P.R. and G.T.R. to operate their trains over crossing in West Half of Lot 14, Con. 2, Twp. of Trafalgar, Co. Halton, Ont., at mileage 32.56 from Toronto, subject to condition that trains of both companies be brought to a full stop before crossing diamond.

21017—December 12—Authorizing G.T.P. Ry. to divert Government Road at mileage 212 west of Yellowhead Pass, Cariboo District, B.C.

21018—December 13—Approving revised location of G.T.P. Ry. main line through Chig-ni-Kath Indian Reserve, from mileage 125.55 to mileage 127.08, Range 5, Coast Dist., B.C.

21019—December 13—Authorizing G.T.P. Ry. to construct highway in N.E. ¼ Sec. 8-45-1, W. 6 M., Dist. North Alberta, Alta., at mileage 1028 West of Winnipeg, under its main line of railway.

21020—December 13—Authorizing G.T.R. to construct siding into the premises of the Lyster Wood Box Turning and Enamelling Co, on Cadastral Lot 16-A, original Lot 16, Rge. 5, Tp. Nelson, Co. Megantic, Que.

21021—December 15—Authorizing C.P.R. to operate its trains over bridge No. 0.85, on Temiskaming Branch, Lake Superior Div., Ont.

21022—December 16—Approving proposed location of C.P.R. shelter station on E. ½ of Lot 18, Con. 4, Tp. Asphodel, Ontario.

21023—December 10—Approving location C.P.R. station at Reeder, in S.E. ¼ of Sec. 19-13-27, W. P. M., at mileage 21.4 on Co.'s Virden-McAuley Branch.

21024—December 9—Approving further proposed alterations required to be made in C.L.O. & W. Ry. (C.P.R.) railway in order to accommodate extra tracks in Ry. Co.'s station grounds in town of Bowmanville, so as to include those portions of subdivisions Lots 3, 5 and 6, Block 2 of said town.

21025—December 12—Approving Supplement No. 1 to Express Classification for Canada No. 3, amending and superseding Section 2 of Article T of Tariff of Rates on Money, Securities, etc.

21026—December 15—Approving revised location C.N.R. spur for Thomson, MacDougall and Company, Woodlands, Man., through Sec. 18-14-2, and Secs. 13 and 11-14-3, W. P. M., Man., from mileage 3.38 to 4.92; and authorizing the construction of said revision over two (2) road allowances,—1, Secs. 13 and 12, and 14 and 11, Tp. 14, R. 3, W. 1 M., and 2, Secs. 13 and 14, and 12 and 11, Tp. 14, Rge. 3, W. 1 M.; and rescinding Order No. 19970, dated Aug. 6th, 1913.

21027—December 5—Authorizing C.N.R. to open for traffic its line of railway from mileage 83 to Moose Jaw, in Prov. Sask., on its Radville-Moose Jaw Line, a distance of three miles.

21028—December 20—Requiring C.P.R. to extend to Ontario and Manitoba Flour Mills, Limited, privilege of milling all-rail grain at Sudbury, Ont., in transit from Port Arthur, Fort William, and points west thereof, at through rate to all points east of Sudbury, and the Detroit and St. Clair Rivers reached by millers west of Fort William under milling in transit arrangements, subject to regulations and restrictions thereof; and subject, also, to same additional toll of 1c. per 100 lbs. for terminal service at Sudbury, said rate to come into force not later than January 12th, 1914.