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The Canadian Engineer

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BURRARD INLET BRIDGE, VANCOUVER

SOME IMPORTANT DETAILS OF THE PROPOSED DESIGN—TO BE THE LONGEST SWING SPAN IN EXISTENCE—UNFORTUNATE DELAYS IN AWARDING CONTRACT.

THE Corporation of North Vancouver has long been in need of closer connection with the City of Vancouver, from which it is separated by Burrard Inlet. The desired thoroughfare would afford access not only to the railway, but to the business and commercial district of the city. It has only been of recent date, however, that any activity has been commenced.

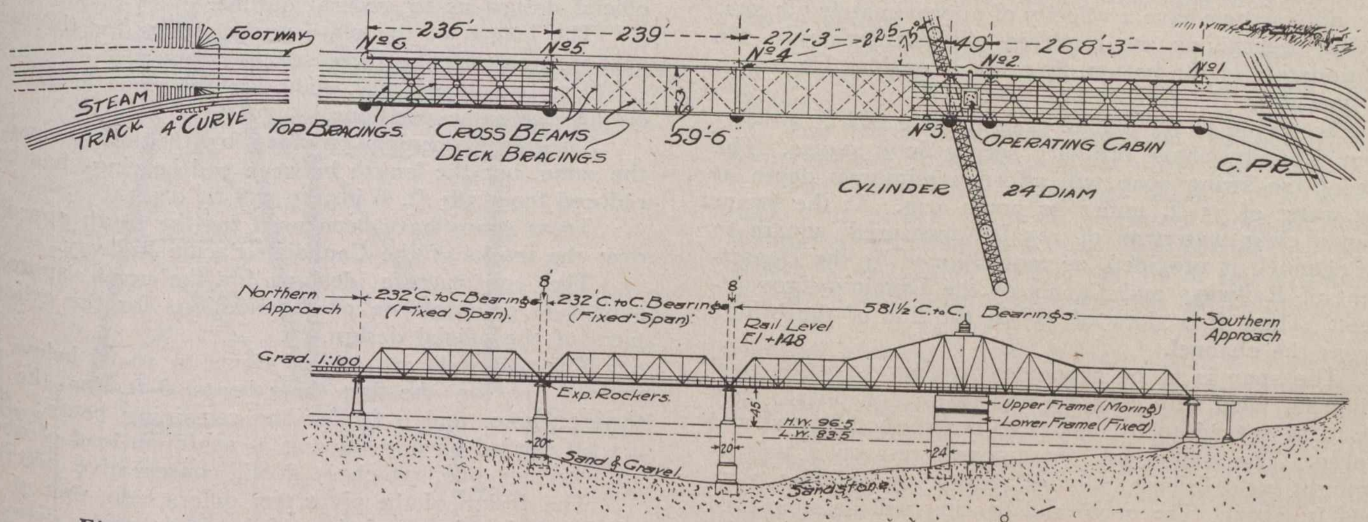


Fig. 1.—Sketch of Plans for the Second Narrows Bridge, Prepared by Sir John Wolfe-Barry, Lyster & Company, England.

Large increases of traffic, together with the advent into North Vancouver of a branch of the Grand Trunk Pacific, known as the Pacific Great Eastern Railway, has emphasized the importance to both communities of a direct connection. In addition to the access which the proposed bridge will give the Pacific Great Eastern Railway into Vancouver from the North, an electric interurban car line, together with ample driven and pedestrian traffic, is being afforded accommodation in the design under contemplation.

The location that has been chosen is over a section of the Inlet known as the Second Narrows, three miles in distance from the First Narrows, or entrance to the Inlet.

The design itself is for a complete structure to span the Inlet. The approach at the Vancouver side requires considerable embankment and cutting, while on the north side there will be quite a length of trestle work and embankment, chiefly on the railway right-of-way.

The Official Design.—An important feature of the contemplated structure lies in the dimensions of the swing span. The official design was prepared by the English firm of Sir John Wolfe Barry, Lyster and Partners, with whom is associated in Vancouver the firm of Cleveland and Cameron, as consulting engineers to the Board of Directors of the Burrard Inlet Tunnel and Bridge Company.

According to the official design, the length of the swing span will be 581½ ft. between centres of the end bearings. This length exceeds the longest present swing span by 62 ft. In width the structure will be 59½ ft., providing, as stated, for railway, highway, street car and pedestrian traffic accommodation. There will also be two fixed spans 232 ft. in length from centre to centre of bearings. These three Warren type spans; i.e., the single swing and the two fixed spans, approximately cross the entire width of the river at low water, its width at this stage being 1,030 ft. at the proposed site of the bridge. In flood stage, however, it has attained a width of 3,248 ft., the additional flooding occurring for the most part over the north bank of the Inlet. The bridge approach over this low ground consists of a plate girder viaduct, with tower spans of 29 ft. and intermediate spans of 43 ft. 6 in. The highway portion of the approach is 25 ft. 10 in. in width and is carried on vertical posts. The railway portion will rest on posts battered 1:4½. All trestles and posts will be supported by concrete foundations.

The approach to the bridge on the Vancouver side crosses the tracks of the Canadian Pacific Railway by means of two skew bridges, side by side, one to carry the steam traffic of the Pacific Great Eastern Railway and the other the roadway and electric car tracks. The railway portion of this span is to be 168 ft. in length and the highway portion will be approximately 108 ft. long. This makes up a total length of 3,449 ft. for the railway section of the bridge and 2,364 ft. for the highway section. The skew bridges are connected with the south end bearing of the swing span of the main bridge by short plate girder spans. They give a clearance of 22½ ft. over the top of rail of the Canadian Pacific Railway line.

The bridge proper will carry between trusses a single railway track on the west side, and a 37½-ft. roadway between curves, including two electric car tracks on its east side. There will be an 8-ft. cantilevered footway outside of the eastern truss for the entire length of the bridge.

The foundation work will be expensive and rather difficult owing to the great depth of water and to somewhat unsatisfactory conditions of the river bed. The depth in the channel is 96½ ft. at ordinary tide stage, with a tide range of 13 ft. The north bank consists of gravel to a depth of 155 ft., overlain with about 5 ft. of silt. The south shore is composed of sandstone rock with a considerable overlay of soft mud. In mid-channel the two strata meet in a bed of gravel and boulders. In addition to the above the tide currents through the Second Narrows have a velocity of approximately 7 knots. Diving operations are rendered difficult owing to the continuation of the bottom flow for a considerable length of time after the turn of the tide.

According to the official design, there will be a clearance of 45 ft. above ordinary spring flood stages. The line of the swing span will afford a minimum depth at low water of 35 ft. under its north arm. At the swing span a clear waterway of 225 ft., measured square to the channel, is provided, as requisitioned by the Department of Railways and Canals of the Dominion government. There is a skew of 15° in the line of the bridge across the channel.

The span is to be supported by four wrought steel cylinders, filled with concrete and resting on piles. They are to be spaced 49 ft., centre to centre, both ways, and braced. The south end bearing will rest on a pair of wrought steel braced columns resting on cylinder piers 59½ ft. apart. The north end bearing will be supported by similar columns on a solid pier, full bridge width. The fender pier, in the plane of the swing span, when open will consist of six cylinder piers 24 ft. in diameter, with bracing and timber fender work between.

The operation of the span, the locking of the bridge, the opening and closing of the gates, as well as the signalling apparatus for river and land traffic, will be electrically controlled. The operating cabin is located above and at the centre of the span.

Delays in Proceeding.—The above plans, prepared by the English firm, provide a design estimated to cost $2,500,000. The Burrard Inlet Tunnel and Bridge Co., finding difficulty in the financing of such a large undertaking, appealed to the Provincial Government to take over the entire project. The latter declined, however, and announced that it was not prepared at that time to subsidize the enterprise to a greater extent than $400,000, previously arranged, and advised the company to build a less expensive structure.

Subsequently, Mr. C. P. Moss, local representative for the Strauss Bascule Bridge Co., submitted plans for a bridge of the Bascule type to the government, which, in turn, recommended them to the company as they involved a cost of approximately $1,500,000. This design had spans of 44 ft., centre to centre of trusses, and provided for two electric railway tracks in addition to the steam railway line, and a 16-ft. roadway. Outside of the truss line an 8-ft. sidewalk was provided on brackets for pedestrian traffic. The required width of 225 ft. in the channel, overhead clearance of 45 ft. between water at high level and under side of the spans over the navigable channel, and a clearance of 22½ ft. over the rails of the Canadian Pacific Railway were all provided for. The design suggested a movable span of the Heel trunnion type, with concrete counterweights. Electrical operation by two 90 h.p. motors, in addition to a 5 h.p. motor to operate locking mechanism, was called for. The time of opening or closing under normal conditions was stated to be 1½ minutes.

Acting upon the advice of the Provincial Government the company called for tenders for a cheaper structure, and a number of plans and specifications were submitted accordingly. Chief of these were the tenders of the Dominion Bridge Co., associated with Armstrong, Morrison & Co.; the Canadian Bridge Co.; and C. A. P. Turner, associated with the Western Foundation Co. These three designs were submitted to Messrs. Cleveland & Cameron, the consulting engineers to the company, for a report. The following is a summary of their findings and conclusions, many points of interest arising therein:—

Tender No. 1.—The design submitted follows the official design as to general outline.

The length of the plate girder spans for the north approach are slightly increased.

The two fixed truss spans are the same length and occupy the same positions.

The clear opening provided by the swing span is the same, but the length between end bearings has been reduced from 581 ft. 6 ins. to 578 ft. 0 ins.

Truss spans have been used for the south approach over the tracks of the Canadian Pacific Railway.

The substructure designs for the north approach substitute pedestals on pile foundations for the cylinder piers of the official design.

The pedestals are carried down to 10 ft. below the ground line for the first three bents, 8 ft. for the following three, and 6 ft. for the remaining bents; they are all carried on piles having a maximum load of about 16 tons per pile, which is good, conservative practice.

The design of the pivot pier differs from that of the official design in consisting of a single 56-ft. diameter cylinder in place of four 24-ft. diameter cylinders, spread at the base to 28 ft. The bearing pressure is about 6 tons per square foot.

The north rest pier, on Pier No. 4, consists of two shafts in place of the solid pier called for in the official design. Sufficient bearing area is provided, but the pier is not so well able to withstand the blow from a heavy vessel. With this exception, we consider the design for the substructure an excellent one.

Wooden caissons are used in place of steel for all piers, and the piers are carried to the maximum height and the steel bents under trusses eliminated.

The superstructure has been designed for the Dominion Government especial heavy loading on the steam railway track, two 40-ton electric cars on each tramway track, and the balance of the floor has been figured for 100 pounds per square foot for the floor system and 60 pounds per square foot for the trusses.

The floor system has not been designed for a concentrated load similar to the heavy motor trucks which it will have to carry.

A unit stress of 18,000 pounds per square inch has been used in the design of the west or railway side truss, and 20,000 pounds per square inch for the east truss. We are of the opinion that since this structure carries railway traffic as well as electric railway these stresses are too high. The Dominion specifications allow 16,000 pounds per square inch for railway bridges.

The centre chord members of both trusses of the swing span, which receive their maximum stresses while the bridge is swinging, are designed for a unit stress of 20,000 pounds per square inch, due allowance being made for impact as per Clause 186 of the Dominion Government specifications.

The centre girders of the draw are designed for 18,000 pounds per square inch.

The arrangement of the centre and radial girders of the swing span is such as to load the drum at thirty-two points, but these points are not uniformly spaced, thirty of the spaces being about 4 ft. 3 ins., and two of them 15 ft. 0 ins., centre to centre. This gives uneven distribution of the load to the rollers. A portion of the load is carried to the centre pivot and the rollers and the lower track are securely tied to the pivot as required by good practice in draw-bridge designs.

In other particulars the bridge follows the lines of good practice in bridge design.

Tender No. 2.—The design submitted is similar to that of Tender No. 1, except that the swing span is the same length as on the official plans, but the pier design

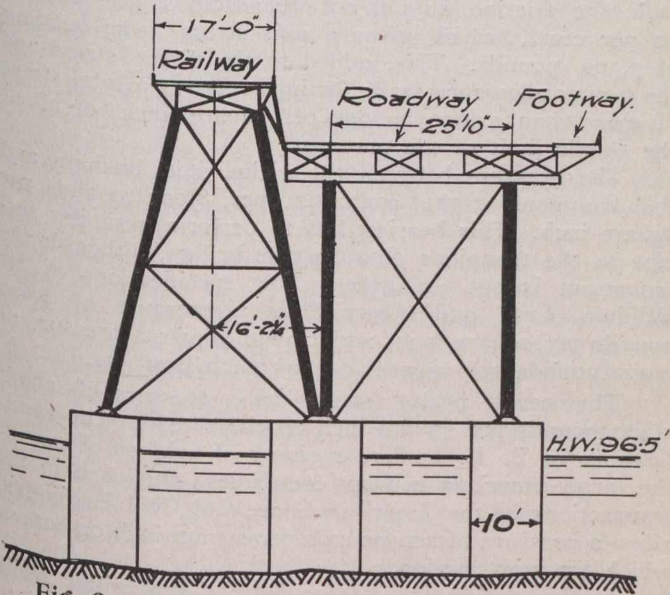


Fig. 2.—Typical Cross-Section of North Approach.

is such as to allow of this length being decreased, still maintaining the same clear opening.

Through plate girders are used in place of trusses for the highway approach over the Canadian Pacific Railway tracks.

The substructure has been designed for Dominion Government heavy loading on the railway track and two 40-ton electric cars on the tramway tracks, the balance of the floor has been figured for 100 pounds per square foot, or a 20-ton traction engine for the floor system, and 60 pounds per square foot for the trusses.

The 20-ton traction engine is practically equivalent to a modern heavy motor truck.

In proportion, the floor beams and truss members, the stresses due to dead load and railway loading have been provided for a unit stress of 16,000 pounds per square inch, tramway loading at 18,000 pounds per square inch, and highway loading at 20,000 pounds per square inch.

The centre chord members of the swing span which receive their maximum stress while the bridge is swinging are designed for a unit stress of 16,000 pounds per square inch. This unit stress has also been used in the design of the centre girders. Due allowance has been made for impact in all cases.

The drum is 42 feet diameter, which is smaller than used on other designs submitted, but the arrangement of the centre and radial girders is such that the rollers are evenly loaded and not overstressed. In this design, as in the design of Tender No. 1, a portion of the load is carried to the centre pivot, which is a desirable condition.

Two 200 horse-power motors are to be supplied for swinging the bridge. This is sufficient for rapid operation, with ample power in case one motor is under repair.

The design follows the lines of accepted good practice in modern bridge construction.

Tender No. 3.—The design follows the lines of accepted good practice in design for the channel crossing from low water to low water. It consists of one 60-ft. and one 80-ft. plate girder span, one 345-ft. truss span and the 586-ft. swing span.

The substitution of the three fixed spans for two, as on the official design, would necessitate a change in the Crown grant already obtained of portions of the bed of the Narrows.

The clearance above high water is not as great under the plate girder spans as for the same location on the official design.

The south approach consists of plate girder spans up to and over the tracks of the Canadian Pacific Railway.

The length of bridge shown on the plans for the south railway approach is about thirty feet short.

The north railway approach consists of a series of deck plate girder spans on reinforced concrete towers without longitudinal bracing. This portion of the approach is 39 ft. shorter, and the top of rail at abutment is 2 ft. 3 ins. higher than called for on the official plan.

Two designs have been submitted for the north highway approach. One of these consists of the mushroom system, or flat slab construction; the other consists of plate girder spans on concrete columns.

The alternative design submitted for the north highway approach consists of a flat, reinforced concrete, continuous slab on reinforced concrete columns on a pile foundation.

We do not consider that this is a good type of construction for this location. The strength of the structure depends upon a total absence of settlement of the supports, which it is practically impossible to get in this location with the details shown. Some of the supporting piles have a load of about 45 tons, or about 20 tons per pile overload.

The length of spans of the mushroom approach and the adjoining railway approach being different, the two lines of piers, about 9 ft. apart, obstruct about 33 per cent. of the waterway.

The plate girder spans of the north railway approach follow the lines of usual practice, but the end stiffener angles of the 60-ft. spans are too light to properly transfer the end shear from the webs to the angles and bearing plates.

No lateral bracing is shown or called for on the drawings, between the bottom flanges of the 60-ft. and 80-ft. deck plate girder spans; these are required by the Dominion specifications.

No longitudinal bracing is provided between the towers to take care of the forces due to traction or suddenly stopping a train. In the drawing presented these forces cause bending in the columns and the pedestals supporting the tower, which gives tension on the one side and excessive load on the piles under the opposite side of the pedestal. These piles, without the load due to this lateral force, are loaded with over 35 tons each.

Piers No. 0 and No. 1 are not carried as deep as the similar piers of the other two designs, resulting in a large difference in value between the different structures.

Pier No. 2 (north rest pier) consists of two shafts joined by braced side webs. The bid suggests filling the space between these webs with a lean concrete at an extra cost of $7,000. This would enable the pier to withstand a heavier blow from a colliding vessel.

The pivot pier consists of a reinforced concrete cap supported by four cylinders, each 22 ft. in diameter. The bearing area is considerably less than provided by the other designs and the pressure on the foundation much greater.

Reinforced concrete shells of 1:1 1-2:3 concrete are used for piers 1 to 3 inclusive, but for all massive work, with the exception of Pier No. 5, a leaner concrete is used composed of 1:3:5 with the addition of two parts of coarser aggregate.

The superstructure has been designed for Dominion Government heavy loading on the railway track, 40-ton electric cars on the tramway, and 60 pounds per square foot on the balance of the roadway and the sidewalk.

The floor system has been designed for traction engine or motor truck similar to that assumed in Tender No. 2.

The fixed span is of the Warren type, and is 340 ft. to centre of bearings. The maximum unit stress in the bottom chord is 18,000 pounds per square inch for the west or railway truss, and 20,000 pounds per square inch for the east or highway truss. Full allowance has not been made for impact in the centre diagonals as required by the Dominion specifications, and as allowed by the other competitors. With this allowance added, unit stresses of 24,000 pounds per square inch exist in the railway truss.

Short redundant members are used to reduce the unsupported length of the vertical posts and hangers. This is not good practice, as they introduce secondary stresses in the members.

Sway frames between the trusses are not provided at all panel points as required by the Dominion specifications.

In the design submitted the swing span has sufficient lift of the ends to make the trusses non-continuous, so that they form two separate simple spans when the bridge is closed. This is a desirable arrangement if the boat traffic is so light as to require but few openings and the bridge is used almost entirely as a fixed span.

The heaviest structure of this type which has been built is the Charlestown bridge at Boston, the weight of which is about one-third that of the span under consideration. When swinging to its closed position the ends are lifted by hydraulic jacks, requiring about eight times as much work as when the ends are only lifted enough to prevent all tendency to hammer under the rolling load. The time required for operation is also greater.

To lift the ends by the centre top chord bars as is done in the design under consideration is not economical, as it requires about four and a half times the power that is required to do the lifting at the ends. The designer may claim that the toggle arrangement reduces this, but a toggle or similar arrangement can be used in either case. It is the ends that have to be lifted; and the more direct the application of power, the less is required.

A noted authority on swing bridges in a paper presented at a meeting of the American Society of Civil Engineers on April 3rd, 1907, says: "A few bridges have been built with a lifting apparatus applied at the top chord of the centre panel. This arrangement has the additional disadvantage of using a part of the structure which carries the strain while the bridge is swinging, also as a part of the lifting mechanism, which is not good practice. If the machinery parts get out of order the structure should not be affected thereby. The writer's experience with a bridge of this kind prompts him to advise its use."

In the swing as in the fixed span redundant members have been inserted between the diagonals, and sway frames omitted at four panel points where required by the Dominion specifications and good practice.

Full allowance has not been made for impact in the diagonals, and the stresses in the diagonals and chords are high.

The centre chord eyebars are stressed by direct stress and impact to 21,000 pounds per square inch. Tender No. 1 has 20,000, and Tender No. 2 16,000 pounds per square inch for the same members under the same conditions. In this design the centre eyebars have to resist the bending due to the friction at the pins or trunnions when raising or lowering the ends of the span. As the pressure between the bushing and pin is about 8,000 pounds per square inch, the friction should not be assumed as less than 20 per cent., which gives a unit stress from bending of 7,500 pounds. This, added to the direct stress and the proper allowance made for impact gives a total stress of more than 31,000 pounds per square inch, or about the elastic limit of the material.

The pressure between the nickel steel bushing and the trunnions at the centre is over 8,000 pounds per square inch. This bearing has to perform a similar service to the trunnions of a bascule bridge, although the movement is not so great. The specifications of Sir William Arrol and others allow a pressure of 2,500 pounds per square inch, and Unwin allows a pressure of 3,000 pounds per square inch on such bearings.

The centre lifting screw has a pressure of about 1,470 pounds per square inch on the thread. The specifications of B. R. Leffler, engineer of bridges of one of the large American railway companies, published in the transactions of the American Society of Civil Engineers, allow a pressure of 200 pounds per square inch on screws which transmit motion.

In this design the total weight of the bridge while swinging is carried by the drum, which is connected to a light centre casting by radial struts. We are of the opinion that this cast-iron centre has not sufficient strength to centre the bridge when closing or to prevent its being knocked out of position. It is an advantage to carry a portion of the total weight on the centre pivot, as is done in the other designs, for it assists in resisting any tendency toward lateral movement on the part of the live ring.

The drum is loaded at sixteen points, but these points are not evenly distributed, some of the spaces being about 7 feet, while others are about 26 feet. This is most unsatisfactory arrangement, as unequal distribution, on account of the deflection of the drum between points of loading, gives unequal load on the rollers; this, besides giving excessive pressure, distorts the live ring and causes the bridge to turn hard, with unnecessary wear and tear on the rollers, track and spider.

If the load is evenly distributed the pressure on the rollers would be about 14 per cent. greater than allowed by the Dominion specifications. With the uneven distribution the load would probably be about 40 per cent. greater.

The centre pivot in this design is entirely independent of the lower track and rack. They should be connected by radial struts so that they can be erected and centred accurately in the shop, and when later put in position will occupy the same relative position.

In this design the live ring is connected to the centre pivot by radial rods, which are connected on the outside of the wheels by a flexible ring and on the inside by an angle. With this construction the centre ring around the pivot does not start to turn as soon as the wheels, but drags, and the rods through the rollers are thrown out of radial lines, so that the rollers do not run concentric with the top and bottom treads.

This is the reason for a large percentage of the broken wheels of old swing spans, and it also increases the power required for turning.

With reference to the drum wheels and spider, Tenderer No. 3 states: "It approaches very nearly that of the great swing span over the Thames River at New London, Conn., which it follows very closely in general design." This bridge was built more than twenty-four years ago, and, although the span is nearly 500 feet, the construction is light.

The specifications of Sir William Arrol say: "All radial bars and the roller frame of the live ring shall be formed of rigid members with suitable tangential bars to maintain the relative motion of the parts of the frame."

One of the Past Presidents of the American Society of Civil Engineers, in a paper on "Movable Bridges," presented before the Society on April 3rd, 1907, describing this type of construction, says: "The live ring arrangement for separating and holding the rollers which was formerly popular, consisting of adjustable radial rods, one end of each rod carrying a roller, the other end being connected to a ring devolving round the centre pivot, is, to say the least, an unmechanical contrivance. Good practice requires a more substantial construction. The rollers should run between two concentric circular girders firmly connected to each other; this ring should be connected to the revolving part of the pivot by rigid struts."

The design of the end shoes does not meet the requirements of good, modern practice, which requires supports for the ends of a swing span of solid, substantial construction similar to the end shoes of a fixed span. In this design the bearing pressure of the roller on the cast steel base is excessive and the base is too shallow to distribute the reaction over its full area.

It is stated that the ⅞-inch cup at the centre of the casting is for lock and centring device when closing. Tenderer No. 3 says: "These shoes are likewise of simple but massive construction. Cast steel bearing plates having an inclined approach and a hollow provided for the seat of the 16-inch solid steel roller bearing supporting the draw-arm. These rollers are to have a 9-inch pin and bearing at each end. This roller bearing is designed to form an automatic locking device and centreing device in addition to the rail lock for the bridge when it is closed, the roller, by gravity, rolling into the cup or seat provided."

In order to have the roller and the base casting centre the bridge when closing, the ends of the span must be lowered by lowering the ends of the centre eyebars through a percentage of their travel before the span has been turned to its final position. If the lowering has been excessive the momentum of the span will not be sufficient to carry the ends up the inclined path on the base casting, while if the ends have not been sufficiently lowered the momentum will carry the span past the ⅞-inch drop provided for the centreing. The momentum of the span must be sufficient to lift the ends up an inclined plane until a point 8 inches from the centre is reached and to carry the span on a horizontal plane for a distance of about 4 inches, but it must not be so much as to carry the ends 4 inches past the centre, or the device fails to act. As the deflections of the two trusses are different and vary with the temperature, the chances of successful operation are very small.

Suddenly dropping the ends of the bridge ⅞ of an inch will produce a hammer action on the cast steel base and a racking strain all through the structure.

Summarizing, we would say that the pressure on the foundation for the pivot pier is much higher in the 3rd design than in the other designs submitted.

The piles for the north approach foundations are loaded more than twice as high in the 3rd as in the other designs.

Maximum unit stress in the chord members of the trusses are 32 per cent. higher in the 3rd and 25 per cent. higher in the 1st design than in the 2nd.

The 1st and 2nd designs follow the lines of accepted good practice in modern swing bridge construction. The 3rd design is a distinct departure, and the largest structure operated in a similar manner, of which we can find any record is a double-track swing bridge, 228 ft. long, at Hammond, Indiana. In this structure the ends of the bridge are raised by means of double toggles in place of the single toggles.

The recommendation of the consulting engineers, however, was at variance with that of the British Columbia Manufacturers' Association, the Board of Trade, and other public organizations.

Despite the fact that the Provincial Government is exceedingly desirous that the company proceed without delay in the construction of the bridge in order to have the structure completed by the time the Pacific Great Eastern Railway connects North Vancouver with Fort George, little progress can be announced. The directors of the company appealed to the Government in the matter of awarding a tender. The Government, however, expressed itself as indisposed to take the responsibility of making an award and referred the question back to the Board of Directors. Numerous alterations to tenders were permitted, all three undergoing various changes. Then the Board decided to place the whole question before a disinterested engineer, fully capable of recommending the best award. Mr. Ralph Modjeski, of Chicago, was accordingly retained on July 10th, 1914. His report is expected in a few weeks, whereupon an award will probably be made.

INTERNATIONAL IRRIGATION CONGRESS.

There will be no postponement of the session of the International Irrigation Congress, which is scheduled for October 5th to 9th. On account of the war and the fact that European countries would not be in a position to participate in the Congress, some question arose as to the advisability of holding a session this year. It has, however, been decided to go ahead as previously planned confining the work to the United States and Canada. The Dominion and provincial governments which are really most interested in the success of the gathering, have concluded that it will be better to proceed than to postpone.

In the fear that the United States government may make the coal product contraband of war, all the Rochester and Pittsburg coal company mines in Indiana county have received word to start all mines full time, give all miners employment, and get out all the coal possible. The Canadian railroads have placed big orders and want the coal shipped to Canada at once.

REINFORCED CONCRETE DOCK CONSTRUCTION.

THE study of reinforced concrete docks involves so many phases of the problem that they are difficult to cover with any degree of completeness in a single article. There are many in successful operation in Europe, the most extensive development being in England, where they have, to a certain extent, proven their practicability and commercial economy. But in America they are more or less of a novelty, and can hardly be said to have, as yet, proven themselves. For this reason there is much of interest in a review of the art of reinforced concrete dock construction given by Harrison S. Taft in a paper on May 20, 1914, before the American Society of Civil Engineers—particularly in that portion of the paper outlining the practice in the old world and examining the work in each country. Their successful use for about 50 years in Europe for structures exposed to the action of salt water leads one to the conclusion that what has been done there, and in other parts of the world, will bear investigation. We extract the following pertaining exclusively to English practice, from Mr. Taft's paper:

In building reinforced concrete docks and other concrete structures in sea or fresh water, it is only natural that a forested country should be the last to take up the development of such a material. Consequently, America has been far in the rear in regard to this question, as compared with what other and older countries have accomplished. In England, France, Germany, Italy, and other European countries, in Australia, and in Asia, as well as in certain South American countries, concrete sea-walls, breakwaters, dry docks, piers, trestles, coaling stations, etc., in salt water, have been in existence for years.

Southampton, Eng.—One of the most noted developments in reinforced concrete construction, as applied to harbor and dock development, is that of the London and Southwestern Railway Terminals at Southampton. The first and most prominent reinforced concrete structure in connection with this terminal was a coal barge jetty, 300 ft. long and 20 ft. wide, built in 1904, on the Hennebique system of driven concrete piles. The piles are about 44 ft. long, standing in 29 ft. of water at high tide, the rise and fall of the tide being about 13 ft. Each pile carries a maximum load of 17 tons.

This structure carries a very heavy traveling coal-hoisting apparatus for unloading coal from large vessels docked on one side, into harbor barges or scows which lie on the other side. Thus the jetty is subjected to constant blows from both sides, in addition to the heavy vibration due to the traveling machinery it supports.

In speaking of this jetty, Mr. Francis Wentworth-Shields, Dock Engineer for the London and Southwestern Railroad, says:

"Though the impacts from the vessels and scows cause this whole jetty to sway, there seem to have been no signs at the end of the first 2½ years of its existence of any of the concrete peeling off."

During recent years this dock or jetty is said to have shown some signs of deterioration, due to the vibration of the heavy machinery traveling along it, the supposition being that it was built too light in the first place to absorb the heavy vibrations to which it has been subjected. Still, the dock is said to have considerable elasticity. In one instance it was in heavy collision with a steamer, two piles and the beams they carried being broken. The dock was effectively repaired, but perhaps with some difficulty, though it is claimed that the repairs were easily accomplished.

The same railroad company has built several other reinforced concrete pile docks at Southampton, designed to carry the same heavy deck loads as the coaling jetty, but without the heavy vibration to which this jetty is subjected. Though built on the same system of construction as the coal jetty, the latter docks have shown no signs of wear or deterioration. It is said, on the best of authority, that they have cost nothing to date for maintenance.

The largest of these is the extension, on the Itchen Front, of "The Empress Dock," a widening of the so-called "Old Extension Quay" by a reinforced concrete pile structure, 50 ft. wide and about 1,300 ft. long, parallel to and securely dovetailed into the old quay wall. This widening dock is built of complete concrete bents, along the tops of which are steel deck-beams or stringers, which in turn are covered with 4 in. of wood, a wooden block pavement being used for the wearing surface. The depth of water at low tide at the face of this structure is 35 ft., which, with a 13-ft. rise and fall of the tide, gives a depth of 48 ft. at high tide.

One of the finest cold storage and cattle stations in existence was built at Southampton in 1905 to accommodate the foreign cattle trade. The landing stage or jetty of this station is a reinforced concrete structure, 200 ft. long and 38 ft. wide, connected with the main land by two runways, 142 ft. long and 15 ft. wide.

On the opposite side of Southampton Harbor, at Woolston, on the Itchen, there is a reinforced concrete landing dock, 136 ft. long and 100 ft. wide, built in 1899 on the Hennebique system. This was the pioneer of reinforced concrete dock construction in Southampton waters. Up to date, this dock has cost practically nothing for repairs, except for damages due to the fact that it was rammed or otherwise damaged by a large steamer; it is in excellent condition at present. The cost of making the repairs is said to have been very small.

Up to the present time, it appears that at least six reinforced concrete docks, jetties, or quays, have been built in Southampton waters.

In building one of the Southampton docks, it is stated that some of the concrete piles were sprung out of line in drying them. A prominent American engineer reports that he saw a number of piles from 1 to 2 ft. out of line, but that they showed no signs of cracks. It has been stated that, in handling Chenoweth concrete piles, up to a length of 61 ft., and 13 in. in diameter, they were rolled about like wooden piles, at times having quite a spring in them. Under this treatment they showed a remarkable degree of elasticity and no signs of cracking.

Bending of Piles.—In discussing the bending of concrete piles, it is of interest to note a series of tests made on a hollow telephone pole in Fulham, London, England, in 1911. The pole was 44½ ft. long, 17 by 17 in. at its base (outside dimensions), tapering to 8 by 8 in. at its head. The thickness of the shell was 2 in., making the inside dimensions of the pole 13 by 13 in. at the base and 4 by 4 in. at the top. The vertical reinforcement consisted of 248 3/16-in. rods of high-tension steel, the ultimate tensional stress being from 80,000 to 85,000 lb.; 56 rods were grouped at each corner, 6 rods being spaced evenly on each of the four sides of the pole. The area of the concrete at the base was 106 sq. in., and the area of the steel 6.85 sq. in., a ratio of 0.0445. In making the test, the pole was set in 5½ ft. of massed concrete, with the pulling rope attached to its upper end.

In Table I. is recorded the pull, in pounds, the deflection, and the permanent set after the loads had been released.

After applying the 6,000 lb., the test was discontinued for 3 days, and then the load was slowly increased to 9,200 lb., which gave a deflection of 66 in. and a permanent set of 21 in., with "cracks on tension side and permanent cracks more numerous and pronounced." There was no sign of failure on the compression side of the pole.

Table I.—Test of a Hollow Concrete Pole at Fulham, England.

Loads, in pounds.	Deflection, in inches.	Permanent set, in inches.
300	3/4	None that could be observed
500	2	
1,000	4 1/4	
1,250	5	
1,500	6 1/4	
1,750	8	
2,000	9	
2,250	10 1/2	
2,500	12	1/4
2,750	14	1/2
3,000	14 3/4	5/8
3,550	19 1/2	3/4
3,100	16 1/2	1/2
3,500	18 3/4	5/8
4,000	22	3/4
4,500	25 1/2	1 1/8
5,000	29	1 3/4
Load gradually increased to 5,750	34	Pulling wire broke. Pole flew back, vibrated short time and came to rest in vertical position with no permanent set.
Load gradually worked up to 6,000	37 1/2	2 in. immediately after release of load. After interval of 1 1/2 hours, set was reduced to 11/16 in.

Add to the above loads 100 lb. for weight of wire and recording apparatus, etc.

Notes on Behavior of Pile.—At 3,350 lb., slight hair cracks appeared on tension side at about 5 ft. 6 in. above foundation.

At 3,600 lb., slight hair cracks appeared at regular intervals about 6 to 9 in. apart.

At 4,100 lb., slight shear cracks appeared, starting at 33 in. above foundation and extending vertically, at a distance of 2 in. from tension side, for some 3 1/2 ft. in length.

At 4,600 lb., hair cracks occurred regularly, 3 or 4 in. apart on tension side.

At 5,100 lb., cracks on tension side were noticed to be traveling across the sides of the pole to within 6 in. of compression surface.

At 6,100 lb., the shear cracks were more pronounced. The hair cracks on tension side were about 1 in. apart, but no signs of failure appeared on compression side.

The load was again applied. When a deflection of 73 in. was obtained, signs of failure appeared for the first time on the compression side, and the pole failed, but no record of the amount of the pull was obtained. The final examination showed that the pile failed equally for its entire length on the shear and tension sides, but without any local weakness. The compression side failed from the base up for a distance of about 2 ft. The bending moment at the base of the pile was reported to be 4,863,936 in.-lb., a most remarkable test, which seems to substantiate the experience quoted above.

Liverpool.—The Mersey Docks and Harbor Board appears to have made a very limited use of reinforced concrete in its latest port developments, in spite of the extensive tidal and graving docks of concrete constructed at Liverpool. As a matter of fact, most of its first so-called reinforced concrete docks were in reality semi-concrete structures, that is, wooden piles carrying a concrete deck system. The oldest of these structures, the Cattle Wharf, Prince's Stage, was built in 1899-1901 on greenheart piles, with the usual Hennebique system of concrete deck-beams and slab. In addition to the Cattle Wharf, there are two other dock-quays in Liverpool, built on the same system, designed for a load of 3 tons per sq. yd., with a test load of 4 1/2 tons.

Another of Liverpool's reinforced concrete docks is the Prince's Dock, West Quay, completed in 1905. This structure was designed to carry a super-load of 3 tons per sq. yd., or about 66 tons per pile. The piles are of concrete, 16 in. square, spaced 15 ft. 9 in. from centre to centre, across the dock, and 12 ft. 6 in. from centre to centre, longitudinally, and resting on rock.

At the west end of Liverpool's dock system is the so-called Brocklebank Dock, 226 ft. long and 64 ft. wide, a reinforced structure built in 1908 on the Hennebique system, and designed to carry the same loading as the Prince's Dock. The test load applied was 9 tons per sq. yd. The piles of this dock are 20 in. square, and had to sustain a load of about 95 tons each, when the test load was applied.

During the first year of its existence there was considerable trouble with the Cattle Wharf and other semi-concrete structures, due to the permeability of the deck-slab part of the structure. The dampness from the salt water entered the permeable concrete and attacked the steel reinforcement on the under side of the slab, causing pieces of concrete to fall off. The defect was overcome by applying a heavy coating of cement to the under side. The upper side of the deck-slab, which is washed daily, shows no signs of deterioration. This emphasizes the fact that great care must be taken in placing concrete in structures standing over or in salt water; there must be the closest inspection during their construction. As a result of this trouble, it appears that the steel reinforcement must be kept farther from the surface of the concrete in salt water concrete structures than in ordinary work. Whereas, at first a minimum of 1 1/2 in. was supposed to be sufficient, the engineers of the London and South-western Railway have found this to be insufficient, and are now specifying a minimum of 2 in. for their new structures. Another difficulty encountered was the numerous joints in the Liverpool system of dock construction. This appears to have been overcome by cleaning out the joints and filling them with a rich cement grout, with such success that the docks are reported to be in very satisfactory condition at the present time.

Thames River, Etc.—Within the bounds of the "Port of London Authority," and at other places on the Thames, many reinforced concrete docks or quays have been constructed. One of the most prominent of these is the Thames Haven Jetty Head, near the mouth of the river. This structure was built in 1908, for the berthing of large vessels, and is 136 ft. long and 32 ft. wide. It is supported by 19 columns or piers, 5 ft. in diameter up to low-water mark but of oval shape, 5 by 2 1/2 ft. above. Each column rests on two 15-in. concrete piles of octagonal section, 45 ft. long, with a penetration of from 18 to 20 ft. After these concrete piles had been driven to refusal, a temporary iron caisson was put down over them. The reinforcing hoops were then lowered into place around the two piles and the caisson was filled with concrete. The caisson was afterward removed, being built in half sections.

Farther up the Thames, 20 miles from its mouth, is the Purfleet coaling jetty, built in 1904, a reinforced concrete structure, 250 ft. long and 34 ft. wide, carrying two heavy traveling cranes. The concrete piles are 14 in. square, from 40 to 50 ft. long, with from 15 to 18 ft. of penetration. The deck-slab is 5 in. thick. The jetty is connected with the mainland by a reinforced concrete approach, over which cars are run to the jetty itself. On one occasion this jetty was rammed by an 8,000-ton steamer, eight piles and 20 ft. of the decking being damaged. That the damage was not more extensive is said to have been due to the firmness of the horizontal decking. In repairing the dock it was necessary to withdraw the eight broken piles and drive new ones. In conducting this repair work, it was especially noticed that the steel reinforcing bars of the original structure showed no signs of rust, though it is well to note that the water at this point of the Thames may be brackish, and not real sea water. The repairs were efficiently made, and the quay is still doing duty.

Another interesting reinforced concrete coaling dock is at Dagenham-Essex-on-the-Thames, 10 miles below London, built in 1901. It is 780 ft. long and 35 ft. wide, and carries eight heavy traveling cranes, weighing 60 tons each, besides a railroad track. Each supporting column consists of three concrete piles encased in a concrete cylinder filled with concrete. Though it may seem a trifle odd, a careful study of photographs of this structure indicates that the tops of the columns are made with "capitals"—a well-proportioned and artistic structure as regards concrete dock work. A similar structure, known as the Prince of Wales Pier, was built in 1903 at Falmouth.

The Thames Iron Works and Shipbuilding Company has constructed at Dagenham a very substantial reinforced concrete dock, designed to carry a concentrated load of 60 tons, for the berthing and fitting out of dreadnought battleships. In the construction of this dock, the Williams type of concrete piles was used for the first time. This type consists of an I-beam surrounded with 3/16-in. wire, 12 in. from centre to centre, the whole being encased in concrete, with special provision at each end to take up the reaction of the driving.

In the same vicinity is the Hornchunk Dock and approaches, built in 1906. The main structure is 400 ft. long and 24 ft. wide, the approach being 280 ft. long and 16 ft. wide; both were built on the Hennebique system. The concrete pile bents are 14 ft. from centre to centre, braced diagonally and support a concrete beam and deck-slab system. Along the water-front side of this dock and its approach, a concrete curtain-wall was built between the piles. This curtain-wall in turn is protected by a wooden fender system. The plans seem to indicate that this structure was designed to carry a 27-ton crane in addition to a 27-ton locomotive.

A reinforced concrete coal dock was built in 1906 at Rochester, on "The Medway," a river flowing into the estuary of the Thames. This dock consists of a main water-front section, 32½ ft. wide and 340 ft. long, connected with the land by two concrete approaches, 100 ft. and 180 ft. in length, respectively. It was built on the Hennebique system, and carries a heavy traveling crane in addition to two railroad tracks. This was one of the first large undertakings in reinforced concrete dock construction on the Thames or its tributaries. At the time it was built it was looked on as the most important structure of its kind in England.

Though the exact number of reinforced concrete docks now in existence on the Thames or its tributaries is perhaps unattainable, it appears that they are more numerous in those waters than in any other part of England.

General.—Perhaps the largest reinforced concrete dock constructed up to date in England is at Swansea, on the southwest coast of Wales. It is a Hennebique design, almost 2,000 ft. long, completed in 1908, the whole structure being built in the dry. Some of its columns are 3½ ft. square. As this structure is used as a coal loading quay, and stands in 40 ft. of water, it is subjected to heavy loads and severe lateral shocks.

At the naval dock yard at Rosyth, Firth of Forth, Scotland, is found one of the most unique and interesting reinforced concrete docks or piers in existence. It is triangular in shape, 620 ft. long, has been finished recently, and forms the entrance pier to a tidal basin. The outer end consists of seven concrete monoliths with a mass concrete fill in the centre, making a solid concrete head, 127 ft. long and 65 ft. wide, covering an area of some 8,300 sq. ft. The rest of the pier consists of twenty concrete monoliths, 25 by 30 ft., supporting a reinforced concrete structure consisting of girders, columns, arches, braces, and deck-beams. The upper decking consists of 3 by 10-in. creosoted wooden joists covered with a creosoted planking arranged so as to prevent any water from collecting thereon. It is a most massive and homogeneous structure, well capable of absorbing any heavy stresses it may receive from warships lying alongside.

In the Bay of Bristol, at Clevedon, where the tide has a rise and fall of some 49 ft., there is another interesting reinforced concrete structure, in the nature of a landing stage. It is 95 ft. long and rests on 22 reinforced concrete piles. The piles, extending up to low-water mark only, were driven through the marl until they reached hard rock. On top of these piles the reinforced concrete landing stage was erected, a structure consisting of columns, beams, bracing, and four different decks or landings.

A reinforced concrete dock of magnitude was recently constructed at Port Talbot. Being designed for coaling operations, it is subjected to heavy loads. The designed load was 850 lb. per sq. ft., the test load being 1,390 lb. per sq. ft., covering an area of 720 sq. ft. The outer row of piling consists of two 14-in. square piles encased in a concrete cylinder, 4 in. thick, and 4 ft. 6 in. in diameter. There are six such columns at the face of the dock. Each of the other two rows consists of eight 14-in. square piles. At this port there are also a number of similar structures, the first having been built in 1907.

It is of interest to note that one of the reasons which influenced the engineers in adopting reinforced concrete for the coaling jetties and wharves at Port Talbot Docks was an extensive fire in one of the docks, due to fuel oil which had escaped from one of the vessels. The oil was ignited through carelessness, and caused a very intense blaze over an area of about 250 by 50 ft. though, fortunately, the oil did not spread out under the wooden structures. With the world-wide use of oil as a fuel for the merchant marine, it is well to consider this danger in American wooden dock structures.

Although the Port Talbot Railroad and Dock Company was among the first to adopt reinforced concrete for wharf construction in England, and so was adversely criticized "for using an alleged untried material in such types of work," the results obtained have fully justified this radical departure from what was at that time the prevailing practice the world over.

Scattered all through other English ports are reinforced concrete docks of various sizes.

At Fleetwood, from 35 to 40 miles north of Liverpool, a reinforced concrete fish and coaling dock of considerable magnitude was completed in 1911. The fish shed section is 1,330 ft. long and 26 ft. wide, that is, the reinforced concrete quay part; the filled-in land behind the quay makes the shed sections some 70 ft. wide in all. The coaling section, of similar construction and carrying a coal-loading traveling crane, is 680 ft. long and 26 ft wide.

At Harwich, 40 miles northeast of the Lower Thames, is the Parkeston Quay, a reinforced concrete dock structure more than 1,000 ft. long and 51 ft. wide.

On the northeast coast of England, at Newcastle-on-Tyne, a reinforced concrete jetty wharf of extensive size lies along the water-front of a large turret shop.

The port authorities at Dundee and Aberdeen, Scotland, are gradually replacing their worn-out wooden dock structure with reinforced concrete.

On the north coast of Scotland, at Ackergill, stands a life-boat slipway, 194 ft. long, built of reinforced concrete, extending out from the rocky shore into the wide open sea. There are several similar structures in other parts of Great Britain.

A reinforced concrete dock was built in the Shetland Islands in 1910. The head of this dock is 80 by 24 ft., and is reached by a concrete approach, 113 ft. long.

In Cork Harbor and other Irish ports reinforced concrete docks of considerable size have been and are being built.

At Portsmouth, Plymouth, and Cardiff are found the first reinforced concrete docks constructed in England, having been built previous to 1906. They are small, and are used mostly for coaling purposes. Quite extensive reinforced concrete docks, constructed during the last year or two, are found at Newport (Mon.), Swancombe, Gravesend, Portencross, South Bank, Ipswich, Newlyn, and numerous other places.

A number of small reinforced concrete docks or pierheads, other than those just mentioned, exist in England in connecton with shipyards, etc. Such docks are found at Dumbarton Shipyard, on the Clyde, and at several similar establishments.

At first the Hennebique system prevailed in all English reinforced concrete dock construction, but, of late, several other systems have been introduced, the most pronounced of these being the Considère spirally armored concrete piling. Though different types of piles are used in English reinforced concrete dock work, there is a most thorough system of diagonal bracing with each type.

In using the Hennebique or other systems of dock construction, where lateral and diagonal braces of reinforced concrete are put in the structure, it appears that trouble has arisen, and might again arise, from the joints in the bracing system. As the foreign docks built on the Hennebique and similar systems seem to have been a success, it does not perhaps cause as much trouble as it did at first, or would appear to cause. In a concrete structure, of whatever design, built in the water, there is always the danger of cracks below the water line, and these cannot be seen and properly attended to.

In a recent address, Mr. Robert Porter, of "The London Times," stated that "England is one big port." From the vast number of reinforced concrete docks at present in her harbors, it does not seem amiss to say that some day soon the ports of England will be, figuratively speaking, one big reinforced concrete dock, and it will be impossible to enter that country without passing over a structure of this type. In fact, current English technical publications plainly indicate that there is hardly a port of any prominence along her coast where reinforced concrete construction is not now being carried on extensively, to the extent of five heavy coal tip docks in one harbor alone, due to the great economy of such structures over their old wooden predecessors, in the way of maintenance expenses.

In a recent rebuilding of the old wooden docks or wharves at Plymouth, constructed 30 years ago, the engineers of the Great Western Railroad have stated that concrete construction was adopted because "the cost would be about two-thirds of the cost of rebuilding in timber." These new concrete docks rest on Considère piles, and were designed for a live load of 400 lb. per sq. ft.

In closing this description of English reinforced concrete dock construction, it is well to take note of a few points in favor of this type, as set forth by an English engineer from his experience in that field: (1) Easy to build; (2) indestructibility; (3) small cost of annual maintenance; and (4) easy to repair.

QUAY WALL AT VICTORIA, B.C.

The contract will shortly be let by the Department of Public Works at Ottawa for the construction of a quay wall and for a large amount of excavation work in Victoria harbor. Tenders were called on June 4th and closed on June 27th. According to the plans, a sea-wall about 1,000 ft. in length is to be built in the inner harbor at Victoria, it being part of the large revetment scheme of the Dominion Government. It will extend from Songhees Point to the abutment of the Johnson Street bridge, and will facilitate the filling in of an area of over 13 acres that lie between it and the natural shore line. The foundation for the wall is to extend to a depth of 20 ft. below low tide, and will entail the removal of over 65,000 cu. yds. of excavation work. The foundation will consist of a lower layer of rubble about 3 ft. in thickness, over which will be placed broken stone in a layer about 1 ft. thick, which will be carefully levelled to provide a base for reinforced concrete cribs. These cribs will be constructed on a dry dock and will be towed to the site and sunk into position. This is the usual practice in work of this nature on the Pacific coast, and several references have been made to it in these columns of late in connection with other harbor and dock developments. The cribs will vary in length from 80 ft. to 100 ft., and will be 25 ft. wide by 30 ft. in height. The reinforced concrete walls and bottom of each will be 15 in. thick. The interior will be divided into sections by partitions 10 in. thick, and will, when placed, be filled with rubble. The cribs, when in position, will extend in a straight line for the full length of the wall.

With these cribs as a substructure the quay wall will be built in sections about 30 ft. in length and with an average height of 37 ft. above the foundation. Its top will project approximately 7 ft. above high water, and the fluctuation in water level is about 10 ft. at this point. Protection on the face of the quay will consist of 12 in. x 12 in. creosoted fender timbers wedge-bolted into the concrete on 10 ft. centers, spaced by three lines of walings, 10 in. x 12 in.

FOURTH AMERICAN ROAD CONGRESS, NOVEMBER, 1914.

THE mayor of Toronto has been requested by the Hon. A. B. Fletcher, president of the Fourth American Road Congress, and state highway engineer of California, to name three delegates to attend the sessions of the Congress at Atlanta, Géorgia, during the week of November 9th.

Forty-seven organizations are taking part in the Congress under the leadership of the American Highway Association and the American Automobile Association. In his letter to the mayor, President Fletcher calls attention to the fact that practically every state highway commissioner will be present and take part in discussing the important problems of road construction and maintenance, and that some of the foremost men in public life will devote their attention to the great question of federal aid to road improvement, in an endeavor to work out a policy which may be submitted to the Congress of the United States with the support of the organized road movement of America. An important move bearing upon state legislation will be made at the session to be held under the auspices of the American Bar Association, at which a joint committee, appointed at the 1913 Congress, will report progress in compilation and suggested revision of state road laws. The creation of a commission participated in by each state to work out a revision of the road laws will be urged. The National Civil Service Reform League will hold an exceedingly important session on the merit system in road administration.

President Fletcher calls attention to the exhibits to be made by the United States Government, the States, and more than a hundred of the leading manufacturers at the Congress, which will illustrate every known method, material and equipment for road construction and maintenance. He urges that the city and county be officially represented, as the Congress is in reality a training school where a very great amount of useful information can be obtained through attendance at lectures with leading specialists in road and street work, and the collecting of the many instructive bulletins which will be available for distribution.

The following is a partial list of papers and addresses to be presented:

General Addresses.—Fairfax Harrison, President Southern Railway; Logan Waller Page, Director U.S. Office of Public Roads; Col. E. A. Stevens, State Highway Commissioner of New Jersey; Brig. Gen. Wm. T. Rossell, U.S.A., retired; James R. Marker, State Highway Commissioner of Ohio. Others to be announced.

Drainage Structures—By W. E. Atkinson, State Highway Engineer of Louisiana. Discussion opened by Frank S. Rogers, State Highway Commissioner of Michigan.

System in Road Management—By C. J. Bennett, Highway Commissioner of Connecticut. Discussion opened by Paul D. Sargent, State Highway Engineer of Maine.

Maintenance Methods and Relation to Traffic—By George W. Cooley, State Highway Engineer of Minnesota. Discussion opened by H. R. Carter, State Highway Engineer of Arkansas.

Convict Labor—By George P. Coleman, State Highway Commissioner of Virginia. Discussion opened by J. E. Maloney, State Engineer of Colorado.

Rights of Way—By Austin B. Fletcher, Highway Engineer of California.

Efficiency in Highway Organization, Centralization of Purchases, Etc.—Discussion opened by John S. Gillespie, Road Commissioner of Allegheny County, Pennsylvania.

Surfaces for Light Volume Mixed Traffic—By S. Percy Hooker, State Superintendent of Highways of New Hampshire. Discussion opened by S. D. Foster, Chief Engineer State Highway Department of Pennsylvania.

State Control of Road Work as a Policy—By A. N. Johnson, Former State Highway Engineer of Illinois. Discussion opened by T. H. Macdonald, State Highway Engineer of Iowa.

Engineering Supervision of Road Construction—By W. S. Keller, State Highway Engineer of Alabama. Discussion opened by R. C. Terrell, State Highway Commissioner of Kentucky.

Economics—By J. E. Pennybacker, Chief Division of Economics, U.S. Office of Public Roads.

Educational Field for Highway Departments—By Dr. Joseph Hyde Pratt, State Geologist of North Carolina. Discussion opened by Col. Sidney Suggs, State Highway Commissioner of Oklahoma.

Heavy Traffic Roads—By Henry G. Shirley, Chief Engineer, State Roads Commission of Maryland. Discussion opened by W. A. Hansell, Superintendent of Public Works, Fulton County, Georgia.

Grades and Excavation—By A. D. Williams, Chief Road Engineer of West Virginia. Discussion opened by William J. Roy, State Highway Commissioner of Washington.

National Legislation—Addresses by: Hon. John H. Bankhead, United States Senate; Hon. Dorsey W. Shackleford, U.S. House of Representatives; Hon. William P. Borland, U.S. House of Representatives. Others to be announced.

CANADA'S STEEL INDUSTRY

Replying to an inquiry as to how the European war would affect the Dominion Iron and Steel Company's plant, Mr. J. H. Plummer, president of the company, said:—

"We have a considerable tonnage of rail orders on our books, but they are chiefly for shipment by water. The disturbed condition which affects the sending of material by sea and the further disturbance of financial arrangements of our customers caused by the war would seem to make it inexpedient to continue rolling on these orders.

"We already have several cargoes awaiting shipment, and more or less held up by those conditions. We think it probable, therefore, that we shall have to shut down much of the plant, or rather to suspend a major part of our operations for a time until we see more clearly what conditions we have to meet.

"In time of war the general iron and steel industries are usually very active and that effect is likely at this time to be more marked in neutral markets because the great centres of industry in Europe are all directly involved. It is difficult to say how this would affect us in Canada, but if there is an active market in the United States we shall follow them to a greater or less degree.

"At the moment we are preparing to damp down two of the blast furnaces now in blast, and the open hearth furnaces. The finishing mills can and will be operated so far as orders are obtainable. We have on hand a supply of billets sufficient to keep these in full operation for some months. The demand for coal is unlikely to fall off, and unless our transportation arrangements should be seriously interfered with, this portion of our business will continue without change."

President Harris of the Nova Scotia Steel Company has announced that as a result of the financial situation created by the war it has been decided to close down a portion of the plant at Wabana Mines and the blast and open hearth furnaces at Sydney mines have been temporarily stopped.

ROAD-BUILDING AND DRAINAGE WORK IN SASKATCHEWAN.

DURING the present season the Board of Highway Commissioners of Saskatchewan is undertaking a considerable amount of drainage work, which will result in the addition of much valuable agricultural land to the municipalities in which the works are situated. Five schemes are now under way, namely, at Rouleau, Invermay, Margo, Rama and Yorkton, while others are being advertised at Kuroki and Canora.

The scheme which will render available the largest amount of land is at Rouleau, and this work is at the point of completion. The work at Invermay, Rama and Yorkton will probably be all finished by the end of August. All of the works are being done by contract under the drainage Act. The schemes in every case went through without difficulty, as there were not enough appeals against the assessments to block any of them. Under the drainage Act the expense is borne by the owners of the lands affected, and also by the rural municipalities whose roads may be benefited. The cost is in the first place met by the government, which is repaid by debentures covering a period up to twenty-five years.

Road-Building.—The carrying out of the road-building programme of the board for the year 1914 is progressing very satisfactorily. Over 100 road gangs have been actively engaged in various parts of the province, and it is considered that the standard of the work being done this year is higher than has been achieved in any former season.

The payment of direct money grants to rural municipalities for road work was found to entail many disadvantages, chief amongst which was a lack of uniformity in construction methods, and it has accordingly been almost entirely discontinued. Some eight rural municipalities, however, had entered into a three-year contract with the board, whereby they receive a grant up to $5,000 in each year on the dollar-for-dollar basis. With these exceptions the work is done almost entirely by the government gangs, although in some cases contracts have been let, where the work was of sufficient magnitude and of such nature as to permit of contracts being awarded economically. About twenty other rural municipalities were found to have well-equipped and competent road gangs, whose work during the last year was fully up to the required standard. The board retained the services of these organizations, and put them to work in the regular way under its own inspectors, and the workmen will be paid direct by the Commission off pay-sheets submitted.

Rural municipal councils have scarcely done as much as they ought in the way of maintenance of roads that have been built, but still there is a noticeable improvement in this respect. Municipalities that show themselves alive to their responsibilities as to maintenance will in future have better chances for assistance from the board. From year to year farmers see the advantages being derived from the use of the road-drag, and its educative effect, which is of the highest, is bound to make itself felt.

Road-Dragging.—At a recent meeting of the Board of Highway Commissioners the matter of maintenance was very thoroughly discussed, and it was regretted that so many rural municipalities appear to have overlooked their responsibilities in connection with maintenance of works undertaken not only by the board, but also out of their own funds. It was decided to send a general letter to all municipalities pointing out to them that it is considered waste of money to improve roads and afterwards let them fall into ill-repair.

The board started a road-drag competition with the sole object of proving the value of this simple implement as a road-maintainer, and it was hoped by the numerous examples scattered throughout the province that the practice would become general, and that every municipality would at an early date see the advantages to be derived from its use.

A great many municipalities have already inaugurated a systematic maintenance programme for their roads, and it is urgently requested that this matter be dealt with in a substantial way by every rural municipal council in the province.

Interest in this year's road-drag competition is much keener than last year, and this is due not so much to the increased prize money, but because of the splendid results achieved. The province has been divided into six districts, in each of which the same prize money be awarded, and all of them are eligible for the $400 championship prize. The list of rural municipalities entered are 68, in all, covering 209 miles of road.

NEW ELECTRIC CRANE CONTROLLERS.

The Westinghouse Electric and Manufacturing Company has recently put on the market a new line of magnet switch crane controllers. This line is complete and includes the following controllers for single motors or for the motors in series or in parallel:—

Trolley; bridge, with or without speed control; and hoist, with or without speed control and dynamic braking.

Dynamic braking is very desirable for hoist operation because it gives the operator complete control over the load. He can hoist or lower at high speed and stop instantly with no over-run, and he can "inch" the load with precision.

The controllers are characterized by reliability, durability, and simplicity. The magnet switch contacts cannot stick together. The parts are few in number and all are strong and substantial. The number of interlocks, with their multiplicity of contacts and complicated connections, is reduced to a minimum. Inspection and repair of wearing parts can be easily made so that time lost on account of controller repairs is negligible. Each switch is mounted on an individual slate base and the whole assembly is mounted in a very substantial manner on a pipe frame work.

Overload protection is provided for by means of two overload relays (one in each side of the line). After the relays have operated, they are automatically reset by bringing the master switch to the "off" position. Since these relays open both sides of the line, failure of operation due to grounded wires is made impossible.

The no-voltage release opens the control circuit on failures of the supply voltage and the motor cannot be started again until the master switch is returned to the "off" position.

In order to secure safety during inspection and repair of crane apparatus, there is a device for locking the main line switch employed. The switch is locked open when the safety key is removed and cannot be closed until the latter is replaced. Several holes are provided for padlocks, which may be inserted by men working independently on the apparatus and prevent the insertion of the safety key as long as they remain in place.

RAILWAYS IN PERU.

Very little progress has been made in the construction of railways in Peru, owing principally to the mountainous nature of the country, which makes it both difficult and costly. The only addition in recent years has been the Lima to Huacho Railway. There are in course of construction a line from Cuzco to Santa Ana and another from Lima to the small port of Chilca. No work has as yet been begun on the projected railway to navigable waters of the River Ucayali.

SURGE TANK PROBLEMS II.

CONTINUATION OF ANALYSES OF PROBLEMS ARISING FROM SUDDEN SHUT-DOWN AND SUDDEN OPENING OF OUTFLOW.

By PROF. FRANZ PRASIL

Authorized Translation by E. R. Weinmann and D R. Cooper, Hydraulic Engineers, New York City

Special Case of Sudden Shut-Down (Continued).

(2) Graphical Demonstration.—For the graphical demonstration of the velocity, a very simple construction may be used. We may divide the equation 32 into two equations which, using $\phi = t/T_1$, may be written:

$$B = Re^{-\frac{T_1}{2T_0}\cdot\phi} \qquad y = B\,.\sin(\beta + \phi) \qquad (47)$$

The former gives in the polar system of co-ordinates (Fig. 3) (ϕ in radians) with β as the vector radius a logarithmic spiral with the slope $\alpha = -T_1/2T_0$.

The second equation may be demonstrated in the rectangular system of co-ordinates, where y and therefore z is a function of ϕ, if we consider the axis of abscissæ in the continuation of this ray of the polar system, which is turned from the initial point with the angle β, and if we plot from an initial point in that system the values of ϕ projecting the points of the spiral on the ordinates which apply to the same values of ϕ. As $\phi = \dfrac{t}{T_1}$, the time may be measured as abscissæ showing the water surface fluctuations with respect to time.

The equation 35, which determines s, has the same form as equation 32. It follows that for the graphical demonstration of s, the same method may be applied as s becomes o when $t/T_1 = \gamma - \beta$ and we see that the axis of the abscissæ for the rectangular system of co-ordinates which demonstrates s, is in the continuation of that ray of the polar system which corresponds to the maximum and minimum values of z and also of y. By projection of the points of the spiral to the corresponding ordinates, we get the z curve, whose ordinates, as may readily be seen, cannot be measured by the same scale as those of the z curve. We have to take: If (for the z curve) an ordinate of one inch equals m feet, then for the s curve an ordinate of one inch $= \dfrac{m}{T}$ feet per second. The demonstration of the acceleration is similar.

(3) Practical Example.—We may now compute for this case an example to which the graphical demonstration also applies. The dimensions are the following:

$L = 9{,}050$ feet $\quad p = 32.8$ feet
$a = 80$ square feet $\quad Q = 530$ cubic feet per second

For a flow of 530 cubic feet per second, according to the usual method of computation, a friction coefficient $K = 101{,}000$ in the formula $h = \dfrac{L.a}{K.p}\,.\,v^2$ and, therefore, $v_1 = 6.63$ feet per second and $h_1 = 9.6$ feet, are determined.

The surge tank section may be constant and $A = 5{,}380$ square feet. According to the theory, we assume that $h = n.v$, $n = \dfrac{h_1}{v_1} = 1.45$ sec. $= \dfrac{9.6}{6.63}$. Therefore, except for the conditions $v = o$ and $v = v_1$, the friction is greater than it would be according to the friction formula commonly used $h = \dfrac{L.a}{K.p}\,v^2$. If we take

$$\frac{L.a}{K.p} = n^1 \qquad h = n^1v^2 \qquad n^1 = \frac{h_1}{v_1^2} = \frac{9.6}{43.96} = .22.$$

Thus we get for equal values of v the difference $v\,(1.45 - .22\,v)$ which, for $o < v < 6.63$, is always greater than zero.

The assumption $h = n.v$ is right in so much as by the derivation of the principal equations the dampening influences of the friction and the water quantities in the surge tank were not considered.

We compute now the example assuming a complete shut-down, therefore $\epsilon = o$.

$$T = \sqrt{\frac{9050 \times 5380}{32.2 \times 80}} = 137.5 \text{ sec.}$$

$$T_0 = \frac{9050}{1.45 \times 32.2} = 194.5 \text{ sec} \qquad T_1 = 147 \text{ sec.}$$

$$R.\sin\beta = -(1 - \epsilon)\,h_1 = -9.6 \text{ feet.}$$

$$R.\cos\beta = (1 - \epsilon)\left(\frac{T_0}{T^2} - \frac{1}{2\,T_0}\right) h_1\,T_1 = 10.9 \text{ feet.}$$

$$R^2\sin^2\beta = 92 \qquad tg\beta = -\frac{9.6}{10.9} = -.881 \qquad \beta = -41^\circ\,24'$$

$$R^2\cos^2\beta = 119$$

$$R^2 = 211 \qquad \text{arc}\,\beta = -.722$$

$$tg\gamma = \frac{2\,T_0}{T_1} = \frac{389}{147} = 2.65 \quad \gamma = 69^\circ\,18'$$

$$R = 14.54 \text{ feet} \qquad \text{arc}\,\gamma = 1.21$$

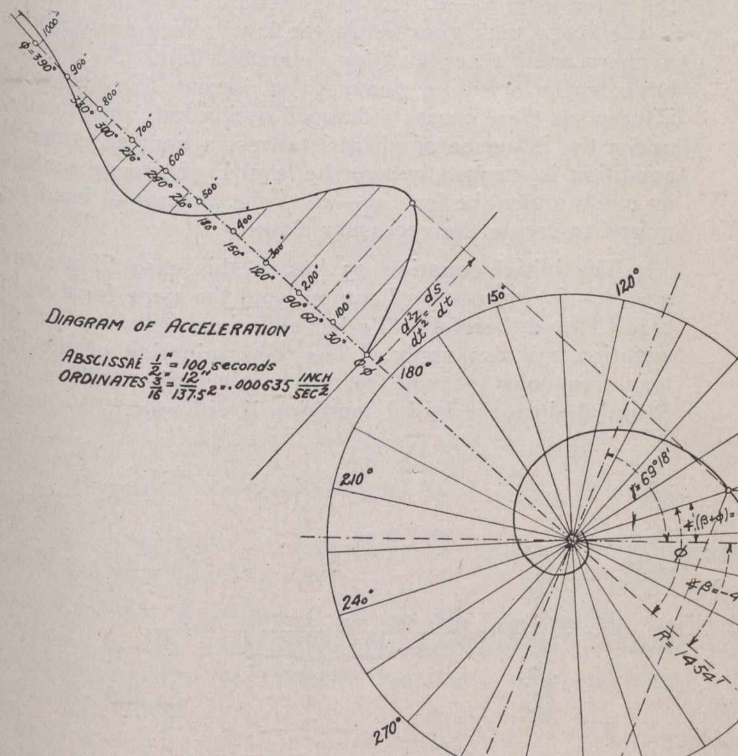
$$z = 14.54\,e^{-\frac{t}{389}}\,\sin\left(\frac{t}{147} - .722\right)^*$$

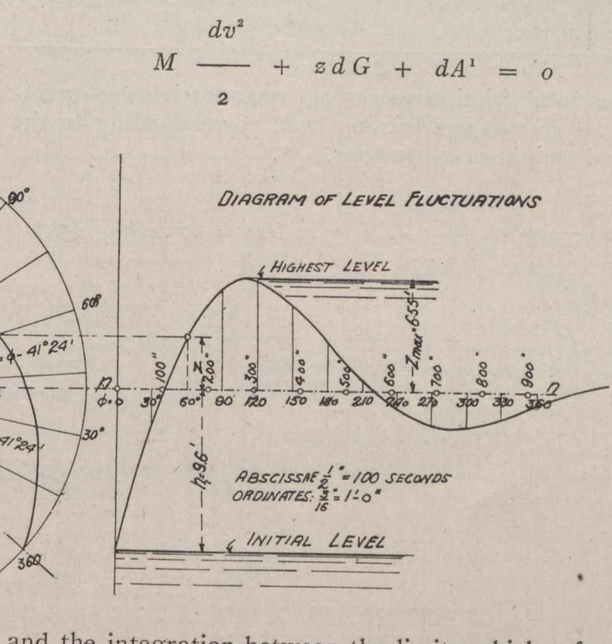
*The proportion t/T_1 is in radians, but must be changed into the usual measurements as soon as we use the trigonometric functions.

$$s = .106\, e^{-\frac{t}{389}} \sin\left(1.932 - \frac{t}{147}\right).$$

The values (in seconds) for the first occurrence of the maximum and minimum are

$$t_1 \max = (\gamma - \beta)\, T_1 = [1.21 - (-.720)]\ 147 = 284 \text{ sec.}$$
$$t_1 \min = (\gamma - \beta + \pi)\, T_1 = (1.93 + 3.14)\ 147 = 746 \text{ sec.}$$





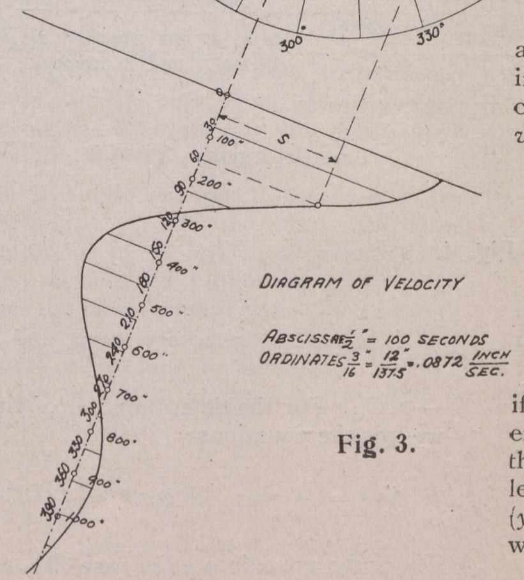


Fig. 3.

z max I. = 6.55 feet, z min II. = — 2.00 feet,
$\delta = 2\pi T_1 = 924$ sec. = 15 min. 24 sec.

The graphical demonstration using these values shows very clearly the water level fluctuation in the surge tank in function of the time (Fig. 3 and Fig. 4).

(4) WORK DONE.—For the case of a sudden complete shut-down, it is interesting to strike a balance of the work done. The basis for such a balance may be secured by a variation of the principal equation 16, considering also the continuous equation 17. If we multiply the equation 16 by $(w.a.v\, dt)h$ we get

$$\frac{w\,a\,L}{g}\, v\, dv + (w\,a\,v.dt)\, z + (wavdt)h = o$$

$$\frac{w.a.L}{g} = M = \text{mass of the}$$

main conduit volume and for $\epsilon = o$, $w.a.v.dt$ becomes $= w\,A\,s\,dt = w.A\,dz = dG$, i.e., the increase of weight of the contents of the surge tank during the time dt. Also $(w.a.dt\,v)\ h = A^1 =$ to the amount of friction work in the main conduit during the time dt. The above-mentioned equation becomes

$$M \frac{dv^2}{2} + z\,d\,G + dA^1 = o$$

and the integration between the limits which refer to the initial condition and to the highest elevation for z max., considering that at the beginning $v = v_1$ and at the end $v = o$:

$$-\frac{M v_1^2}{2} + \int_{-h_1}^{+z \max} z\,d\,G + A^1 = o \qquad (49)$$

We may place

$$\int_{-h_1}^{+z \max} z\,d\,G = G.z_1$$

if we consider G as the weight of the water that has entered the surge tank during that period and if z_1 is the distance of the centre of gravity of G above static level $n - n$. But we may as well say $z_1 = y_1 - h_1$ (50) (y_1 = distance of the centre of gravity of G from the initial water level). It follows then, that

$$\frac{M v_1^2}{2} + G h_1 = G y_1 + A^1 \qquad (51)$$

This is the equation for the work done, which is correct also when the cross-section A is variable. As potential energy, we must introduce: (1) The kinetic force of the volume of the main conduit, and (2) The potential energy of the weight G due to the first difference of level h_1 between the elevation in front of the forebay, (i.e., the static level $n - n$) and the initial level.

As used work we must introduce:

(1) The lifting work due to the lift of the weight G through the height y_1.

(2) The friction work.

We may strike the balance in the following manner:

Useful work in foot-tons.		Used work	
15800	Kinetic Energy of the Conduit Contents		$\frac{62.5 \times 80 \times 9050}{32.2} \times \frac{6.63^2}{2}$
26600	Potential Energy of G = 2770 Tons for h_1 = 9.6 Feet		5380 (9.6+6.55) ×62.5×9.6
	Lifting Work for 2770 Tons for height of 8.07 Feet	22400	$\frac{16.15}{2} \cdot 2770$
	Friction work	20000	42,400 — 22,400
42400		42400	

The total friction work of 20,000 foot-tons corresponds to an average friction head corresponding to the conveyed weight of 2,770 tons.

$$h_1 \text{ (average)} = \frac{20{,}000}{2{,}770} = 7.22 \text{ feet} = .752 . h_1 \quad (52)$$

in case (A), where we assumed that all these influences and variations are a very small amount, we consider q as constant from the instant that the opening occurs.

The following will now happen at this juncture: Immediately after the opening the water surface in the surge tank goes down. The head, due to this difference between the water level in the main conduit and that in the surge tank, creates a movement in the main conduit, but on account of the inertia of the mass and the increasing friction, the velocity does not increase in the same proportion as the drop of the surface in the surge tank below the static level $n — n$. On this account the water surface in the surge tank goes below the level which corresponds to the normal water level for a constant flow. So that we have first a dropping down to a lowest level whereas afterwards there occurs a damped oscillation, until finally, under the influence of all resistances, a normal balanced condition is reached, where the level in the surge tank is as much under the level $n — n$ as the amount of head required to create the necessary slope.

The initial equation 23 has in this case (if we say $q = \epsilon Q_1$ for purposes of comparison) the same form as in case (A) and therefore all other equations (growing out of equation 23) also apply. The determination of the integration constant will, however, give other values for R and β since the initial condition is different. We have

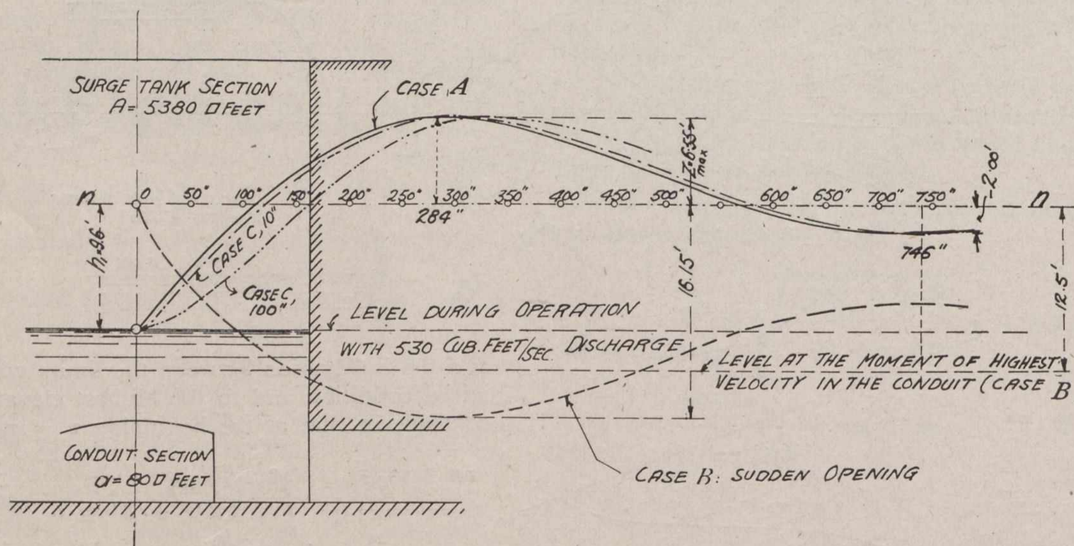


Fig. 4.

We might use this result to determine the necessary surge tank volume in a similar case, if in the equation 51 we write: A^1 is similar to:

h (average) . G which must be equivalent to $.752\ h_1 G$

A supplementary formula to determine the value h (average) follows in the final chapter.

Case B.—Sudden Opening.

Before the beginning of outflow through the penstock, the water in the main conduit and in the surge tank is quiescent. The water surface in the surge tank is at the level $n — n$ and z = zero. As soon as the opening occurs, which is considered as taking place instantaneously, the outflow begins. However, the full amount of the outflow does not occur instantaneously because of the inertia of the mass; also during the time following the opening, q will not be constant even with a constant opening, as with the variation of the water surface elevation the slope due to the outflow velocity also varies. As

at the time t = zero, z = zero, and $s = s_0 = -\epsilon \frac{Q_1}{A} = -\epsilon . C_1$. For the determination of the constants R and β we get the equations:

$$R . \sin\beta = + \epsilon h_1 ; \quad R \cos\beta = -\epsilon \left(C_1 - \frac{h_1}{2\, T_0}\right) T_1 \quad (53)$$

The same procedure as in case (A), referring to the signs of $\sin\beta$ and $\cos\beta$, shows in this case that β lies in the second quadrant, if $\frac{A}{a} < \frac{2L}{n^2 g}$, and in the first quadrant when $\frac{4L}{n^2 g} > \frac{A}{a} > \frac{2L}{n^2 g}$.

We get, further,

$$R = \epsilon h_1 \frac{T_1 T_0}{T^2} \qquad tg\,\beta = \frac{1}{T_0/T_1 - \frac{1}{4}\,T_1/T_0} \quad . \qquad (54)$$

If we open the penstock so that the outflow has the full value $q = Q_1$ ($\epsilon = 1$) then R assumes the same value as in case (A) for a complete shut-down. β has in both cases the same form, therefore, (referring to the above-mentioned investigations) it follows that the initial radius vector in the polar co-ordinate system for the case (B) is turned through 180° from case (A). The duration of the period is the same as in case (A). The graphical demonstration may be begun also from the same spiral with the slope $tg\,\alpha = - T_1/2T_0$. The analytical results (assuming a full opening from zero to 530 cubic feet per second, that is, $\epsilon = 1$, $n = 1.45$ sec., assuming the same dimensions) are as follows:

$T = 137.5$ sec. $\quad T_0 = 194.5$ sec. $\quad T_1 = 147$ sec.

$R = 14.54$ feet $\quad \beta = 180 + (-41° 24') = 138° 36'$

$\text{arc}\,\beta = +2.420$

$$z = -9.6 + 14.54\,e^{-t/389} \sin(2.42 + t/147)$$

$\gamma = 69° 18' \quad \text{arc}\,\gamma = 1.210$

$$s = .106\,e^{-t/389} \sin(-1.21 - t/147)$$

$$= -.106\,e^{-t/389} \sin(1.932 - t/147)$$

Therefrom we determine the time for the first minimum of z

$$t_1 \min = 1.932 \,.\, 147 = 284 \text{ sec.}$$

and for the first maximum:

$$t_1 \max = (1.932 + 3.142)\ 147 = 746 \text{ sec.}$$

These are the same values as were reached before for the occurrences of the first maximum and minimum. Finally follows

$z^1_{\min} = -9.6 - 6.55 = -16.15$ feet;

$z^1_{\max} = -7.6$ feet.

As z^1 max is negative, we see that with the assumed dimensions and for full opening to 530 cubic feet-seconds, the water surface does not rise any more above the level $n - n$ after the first dip. (Fig. 4.)

The velocity in the main conduit at the time of the greatest drop becomes $v_1 = Q_1/a$ but the velocity increases continuously thereafter, as in the following period of rise of the water surface, besides the outflowing quantity Q, also that water from the main conduit which is necessary for the refilling of the surge tank has to flow in. And the increase lasts until v becomes a maximum. Because $v.a = s\,A + Q_1$ the velocity v becomes a maximum if s is a maximum and we get:

$$s \max = \frac{R}{T} e^{-\frac{\pi T_1}{2\,T_0}} . \sin\gamma = .03 \text{ feet per second.} \qquad (55)$$

$$v \max = \frac{A}{a} \,.\, s \max + v_1 = 8.65 \text{ feet per second.}$$

The conclusion of practical value is that the greatest drop below the static level $n - n$, resulting from a sudden full opening, reaches the same value as the greatest rise from the initial level for a sudden full shut-down.

(To be continued.)

DESIGN OF INTERCEPTERS FOR A LARGE SEWERAGE SYSTEM.

The recently issued progress report on the plan of sewerage for the City of Cincinnati contains a number of important solutions to problems typical of those to be found in large sewerage systems. The report, to which we have previously called the attention of our readers, is most complete in that it contains all data used in connection with the development of the system and the projected improvements.

One of the outstanding sections is that descriptive of the design of the new intercepting sewers. This section was prepared by Mr. E. J. Miner. The designs were worked out under Mr. Victor T. Price, Director of Public Service, and Mr. Henry M. Waite, chief engineer. Mr. H. S. Morse was engineer in charge of all sewerage investigations and Mr. H. P. Eddy was consulting engineer.

The following study of the Cincinnati requirements

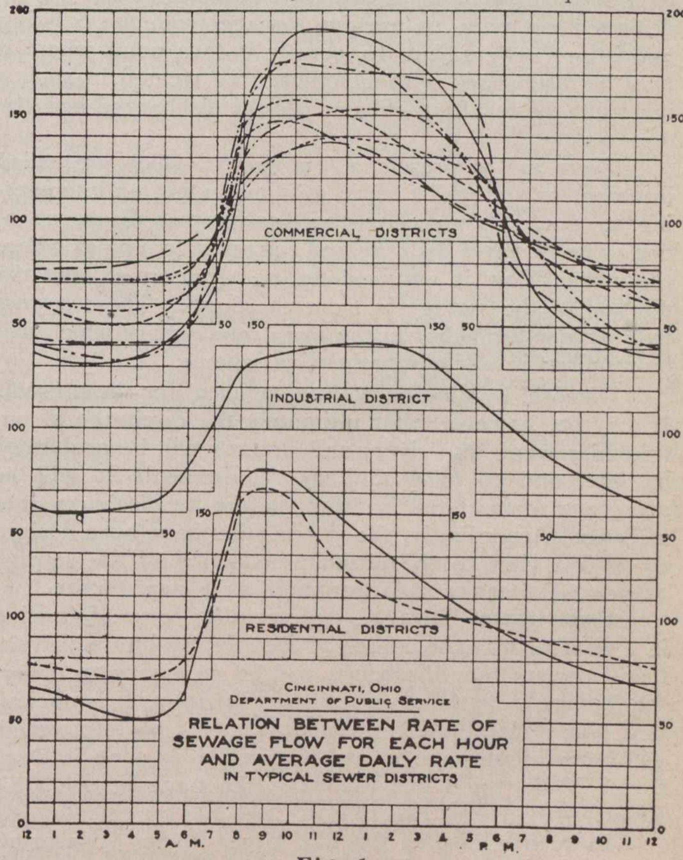


Fig. 1.

and of the resulting design will undoubtedly be found of considerable service.

General Problem.—The present sewerage system consists of a large number of disconnected sewers, each serving a limited district. In some cases these districts are very small; in others, very large. Each sewer has been constructed to discharge into the nearest water course thought adequate to take away the sewage. Nearly all of the existing sewers are built on the combined system, during dry weather the sewers discharging domestic sewage into the streams and during storms, street washings and roof water, combined with the sewage.

In the case of districts adjoining the Ohio River this method of discharge has not in general proved objectionable. As a rule, the trunk sewers empty into the river below the water level, so that, except in the immediate vicinity of the outlet, the fact that sewage is being discharged into the river is hardly noticeable. In the case of the small streams flowing through the city, however, conditions are very different. During dry weather these streams carry very little water, and the result is that the sewage flow constitutes a sufficient percentage of the water flowing in the streams to be noticeable and offensive. Stagnant pools of putrifying sewage are not uncommon, and during the dry months these streams are a menace to the health of the community. At times of storm the accumulated sewage is flushed out and carried to the Ohio River.

With the exception of the sewers discharging into the Ohio River, practically all of the sewage of the city is discharged into Mill Creek and its tributaries and Duck Creek. These two streams receive at least 65 per cent. of the sewage of the city, and are accordingly in very bad condition.

It is necessary to provide intercepting sewers to receive the sewage from the trunk sewers and to convey it to a suitable point of disposal. These intercepters were designed not only to receive sewage from the existing and future sewers, but to convey it to a point where it may be discharged without offense, or treated in such a way that the resulting effluent may be discharged into the streams.

There are at present a few sewers which are called intercepters and which serve to some extent as intercepting sewers. They receive the dry weather discharge of one or more sewer districts and convey it to a point where the stream flow is assumed to be greater, so that the dilution of the sewage is more thorough. These sewers will serve as branches to the main intercepters which will be required in any comprehensive scheme.

Disposal by dilution will be sufficient for the present. It may be, however, that ultimately the discharge of untreated sewage into rivers and streams will be prohibited by law, and to fulfil sanitary requirements it will be necessary to treat all sewage before its discharge into streams. Accordingly, the intercepters have been designed with a view to the ultimate collection of the sewage at suitable sites for such treatment as it may require.

Collection of Sewage.—Intercepting sewers following in a general way the course of the streams into which the trunk sewers now discharge will be necessary to collect the sewage from the several sewer districts. It is obvious that three main intercepters or systems of intercepters will be required: one in Mill Creek Valley, one in Duck Creek Valley and one following the bank of the Ohio River.

In such a case as the Mill Creek Valley it is sometimes practicable or desirable to construct two or even three intercepters. For instance, conditions might make it desirable to build high level intercepters at the edge of the high land on both sides of the stream, each of which would intercept the greater part of the sewage tributary to the stream from its side. The third intercepter, which might not be needed if the valley below the high land were not developed, would closely adjoin the stream and would receive the sewage from the districts lying below the high level intercepters. Such a project is particularly desirable where pumping the sewage is necessary, in order to collect as much of the sewage as possible at a high level and thus reduce the amount to be lifted or the height to which it must be pumped. This method was not found practicable for Cincinnati, and it is planned to construct a single main intercepter closely adjoining Mill Creek, a similar one near Duck Creek and a third along the bank of the Ohio River.

Economic Period of Design.—In designing intercepting sewers it is obviously necessary to make provision for a reasonable amount of growth in order that they may not be soon outgrown. It is also necessary, first, that engineering works should not be constructed on too large a scale, so that they cannot operate efficiently under present conditions, and, second, that expense of construction for future requirements should not be so great that the burden of debt imposed at present becomes unreasonable. It may readily be seen that in some cases the saving of expense resulting from providing works sufficient for the present may be sufficient amply to provide for the additional construction that may be made necessary when larger works are needed.

The economic period for which provision should be made in the design of intercepting sewers depends on various conditions, among which the rate of growth of

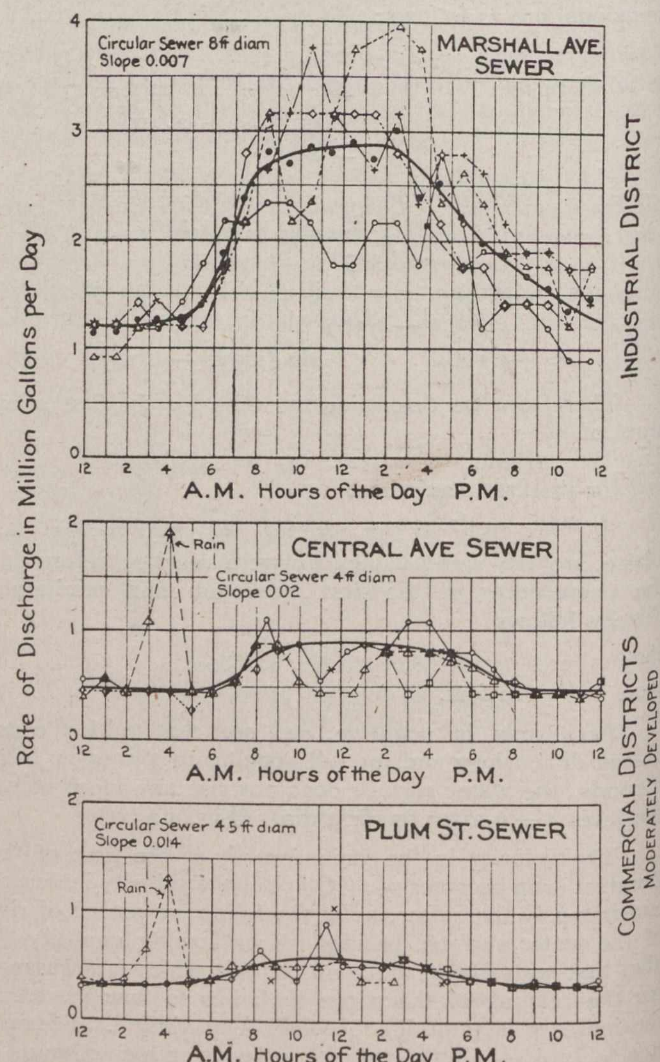


Fig. 2.—Hourly Variation in Rate of Sewage Flow in Commercial and Industrial Districts.

the city is one of the most important, and is a condition which cannot be absolutely fixed. In general, it is desirable to provide for a period ranging from 30 to 50 years from the date of design. In the present study it has been concluded that approximately 40 years is a suitable period for which to make provision and, rounding off the figures, designs have been made on the basis of the requirements of the year 1950.

Area.—From 1802 to 1848 the area of Cincinnati was three square miles. Various small areas were annexed from time to time until, in 1910, the total area was approximately 50 square miles. During 1911 an area of over 16 square miles was annexed to the city and in 1912 the area annexed was about 3.5 square miles, bringing the total area of the city up to about 70 square miles.

After due consideration it has been decided to base the design of the comprehensive system of sewers upon an estimated future area of about 140 square miles.

Population.—Cincinnati has had an exceptionally slow rate of growth, but the natural advantages, its location and the enterprise of its citizens would seem to warrant the opinion that a more rapid growth will occur in the future. Careful consideration of the data which has been accumulated in connection with this study, and of the local conditions, leads to the conclusion that a comprehensive system of sewers designed at the present time for a period of about 40 years in the future should be based upon a future population of about 720,000 persons and a rate of growth averaging from 20 per cent. per decade in the immediate future to 17 per cent. per decade 40 years hence. The population of the city at the end of each decade, should this estimate prove correct, will be: 1920, 440,000; 1930, 520,000; 1940, 615,000; 1950, 720,000.

By basing the designs for a sewerage system upon these estimates provision is made for a future population approximately twice as great as that of Cincinnati at the present time.

As a basis for computing the quantity of sewage to be provided for by the intercepting sewers, the estimated future population was distributed among the several sewer districts.

The boundaries of each voting precinct and of the several sewer districts were plotted upon a map, scale of 1,000 ft. to 1 in. By combining the populations in the several precincts and parts of precincts within a given sewer district the total population now residing in each sewer district was determined. In determining the density of population in the various districts allowance was made for unpopulated areas, as parks, cemeteries and railroad yards, by deducting these areas from the area of the district.

Table I.—Density of Population, City of Cincinnati, 1850-1950.

Year.	Population.	Area, sq. miles.	Density, persons per acre.
1850	115,435	6.16	29.3
1860	161,044	6.93	36.3
1870	216,239	19.05	17.7
1880	255,139	23.53	16.9
1890	296,908	23.73	19.6
1900	325,902	35.27	14.5
1910	364,463	50.26	11.3
1912	380,305	69.85	8.5
1920	440,000	82.45	8.3
1930	520,000	99.30	8.2
1940	615,000	119.35	8.1
1950	720,000	141.50	8.0

The areas of the sewer districts vary greatly, the small districts for the most part being those which are directly tributary to the Ohio River and in the older portion of the city. The area of the smallest district is 10.5 acres, while that of the largest well-sewered district is 4,068.7 acres. The present density of population varies from 0.2 person per acre to 104 persons per acre. The estimated future density of population varies from 0.4 person per acre to 110 persons per acre. This is considered to be a liberal basis for the design of the intercepting sewers, as the deficiencies of some districts will offset the excesses of others; but where individual sewer systems are to be designed a more liberal allowance for future growth should be made, because no such compensating conditions can be relied upon for the relatively small sewer districts.

Main Drainage Districts.—The city may be naturally divided into three main drainage districts, that served by Mill Creek, that draining directly into the Ohio River, and that served by Duck Creek; to which should be added two small areas within the estimated future city limits, one of which is naturally drained by Rapid Run and Muddy Creek, and the other by Sycamore Creek. It appears that provision has been made for an estimated future population of over 300,000 persons in Mill Creek Valley and approximately an equal number in the Ohio River District, and that the estimated future population in the Duck Creek Valley is nearly 100,000 persons.

Classification of Future Area of City.—The quantity of sewage contributed from residential areas is much less than that from industrial and commercial areas. To arrive at a reasonable basis of design, a study was made to determine the proportions of the city which in the future will be devoted to residential, industrial and commercial purposes, and to parks and cemeteries. From the last two the quantity of sewage for which provision should be made is very small, being made up chiefly of ground water. As hereinbefore stated, it has been assumed that the area of the city in 1950 will be approximately 140 square miles. With the aid of the opinions expressed by representatives of local real estate firms an estimate has been made of the probable limits of the industrial and commercial areas. The distribution of the area within the assumed limits of Cincinnati as of 1950 is as follows:

Area.	Square miles.	Percentage.
Industrial	12.79	9.04
Commercial	1.13	0.80
Residential	123.30	87.11
Cemetery and park	4.02	2.83
Railroad yards	0.31	0.22
Total	141.55	100.00

Quantity of Sewage to be Handled by the Intercepting Sewers.—The system of intercepting sewers was designed to receive and convey to a point of discharge all of the sewage contributed in 1950 by the several district sewers with which they connect, at times when storm water is not actually running into the city sewers. It is therefore important that the intercepters be large enough to carry the maximum quantity of sewage collected by the trunk sewers. This quantity will vary from hour to hour, from day to day and from season to season. In the spring, when the ground water is high and relatively large quantities of it seep into the sewers, the quantity collected will be large and the intercepters should have sufficient capacity to convey it to the point of discharge. It is not intended, however, to provide capacity in the intercepters for any substantial quantity of actual storm water, the plan being to provide overflows from the trunk sewers, so that when the capacity of the intercepters is reached the excess flow may discharge directly into the neighboring water-courses.

When first constructed the intercepters will have a surplus capacity, intended to provide for the expected increase in area and population of the city, which may be utilized to carry small quantities of storm water so that overflow from the trunk sewers will not take place quite as frequently as in later years, when the normal flow of sewage has reached approximately that for which the intercepters have been designed. The quantity of sewage collected varies greatly from hour to hour, as the report shows by numerous curves of hourly variation in rate of sewage flow in the various districts. It also varies materially from day to day during the week, the smallest quantity usually being produced on Sundays and holidays and the maximum quantity as a rule on Mondays. The quantity of sewage from commercial districts is greatest during business hours, as indicated, Fig. 1.

The quantity of industrial waste fluctuates, depending upon the character of the industry, the condition of business and the hours of work. Paper mills are usually

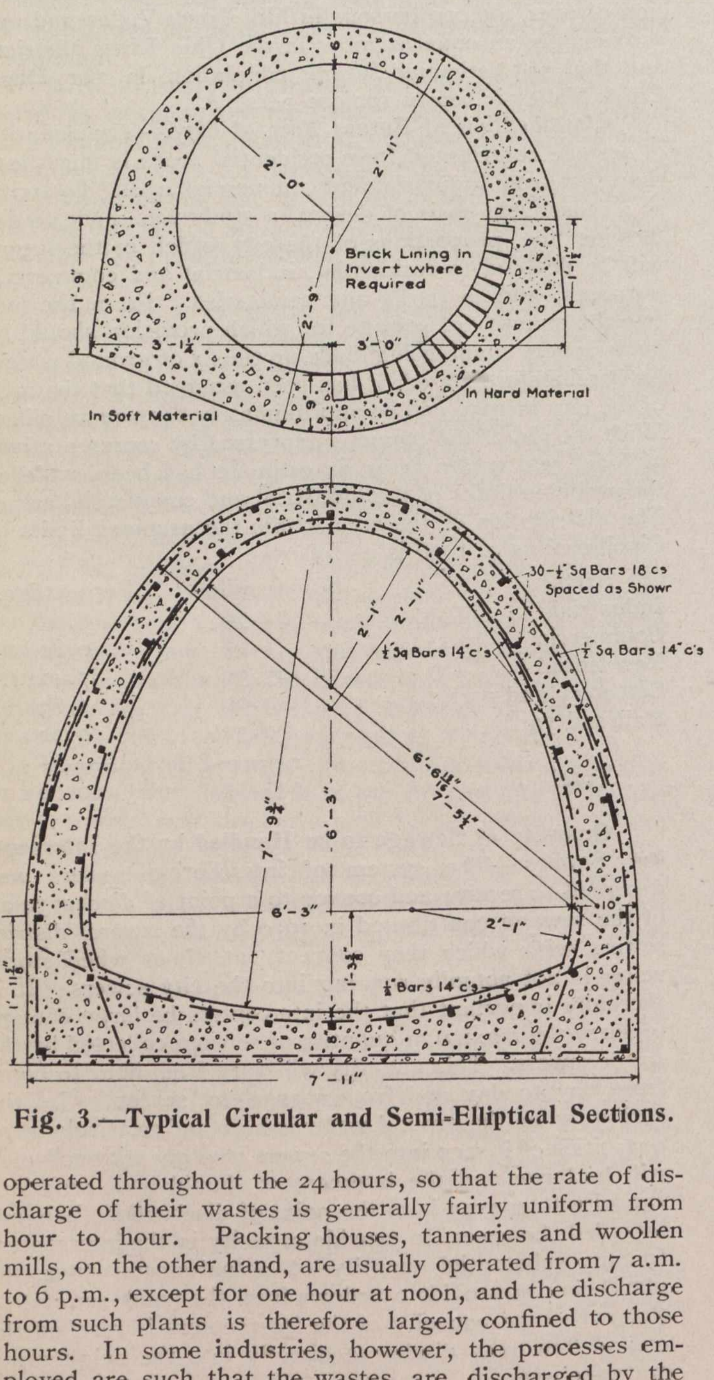


Fig. 3.—Typical Circular and Semi-Elliptical Sections.

operated throughout the 24 hours, so that the rate of discharge of their wastes is generally fairly uniform from hour to hour. Packing houses, tanneries and woollen mills, on the other hand, are usually operated from 7 a.m. to 6 p.m., except for one hour at noon, and the discharge from such plants is therefore largely confined to those hours. In some industries, however, the processes employed are such that the wastes are discharged by the emptying of vats or otherwise, so that the discharge takes place intermittently, with corresponding fluctuations in the rate of flow.

The quantity of ground water which finds its way into the sewers varies in a general way with the variations in rainfall. Usually a hard and long-continued rain is followed by a material increase in the flow of sewage, due to infiltration of ground water. In the spring when the frost is coming out of the ground, leaving it more porous than at other seasons of the year, considerable surface water finds its way into the earth, so that the rate of infiltration into the sewer system is then usually much higher than during other seasons. The least quantity of ground water seeps into the sewers during seasons of extreme drought, or during the winter when the ground is securely sealed by frost.

In order that the intercepting sewers may perform their functions it is necessary that they shall have sufficient capacity to carry the sewage, not only on the day and at the hour when the normal flow of sewage is greatest, but also at times when the discharge of wastes from the commercial districts is highest, when the discharge from the industrial districts is a maximum, and also in the spring of the year when the infiltration of ground water is greatest. These maximum quantities may all occur at the same time, so that they must all be taken into consideration in determining the size of the sewers. At the same time it is important not to lose sight of the fact that the maximum rate of flow in the intercepter at any point is not the sum of the maximum rates of discharge of all the contributing trunk sewers.

Ordinarily the maximum discharge from trunk sewers occurs between the hours of 10 a.m. and 2 p.m. If the intercepter is so long that several hours are required for sewage discharged into it at its upper end to reach the point of discharge of the last trunk sewer, near its lower end, the maximum discharge from the lower sewer will have left the intercepter before the maximum discharge from the upper sewer has reached the lower point. In other words, there is a tendency for the peak flows in the several contributing trunk sewers to compensate each other, and on this account the rate of flow in an intercepting sewer is always more uniform than the rates of flow in the contributing trunk sewers. For example, the maximum rate of flow in one Vine Street sewer on a certain date, was 179 per cent. of the average for the 24 hours, whereas it is to be expected that the maximum rate of flow in the Ohio River intercepter, into which that sewer will discharge, will not ordinarily exceed 135 per cent. of the average flow for 24 hours.

Quantity of Sewage from Residential Areas.—The quantity of sewage collected by a system of sewers serving a strictly residential district depends upon the quantity of water used and discharged into the sewers and upon the amount of ground water seeping into them. It is therefore important to take into consideration the consumption of water, as well as to measure the flow of sewage in trunk sewers serving large residential areas in which there are no manufacturing and substantially no commercial districts.

The flow in two such trunk sewers has been measured. It was not practicable to place weirs in either of them, and it was therefore necessary to make measurements of the depth at frequent intervals of time and to compute the quantity from these measurements. These computations have been made by Kutter's formula with $n = 0.015$.

All of the measurements were tabulated and for each sewer the several observations made at the same hour of each day were averaged and smooth curves were drawn to represent these averages. It is believed that these conventional curves represent with reasonable accuracy the rates of flow which may be expected at any hour of the day, between Monday noon and Saturday night, of any week during which the ground water is low and no storm water is reaching the sewers. Similar diagrams in which the rates of flow are shown in terms of per cent. of the average rate for the twenty-four hours were made from the conventional curves, and are included in Fig. 4.

The measurements of the quantity of sewage produced by the two residential areas showed averages of 92 and 80 gals. per capita per day, respectively, while the maximum rates were 157 and 128 gals. per capita, respectively.

Water Supply.—Very complete records of the quantity of water consumed have been kept by the Water Department. A table was prepared showing the total quantity of water consumed, the quantity of water per capita, the number of services, the number of meters in use and the per cent. of services metered, together with the census, or estimated population served for the years specified. In 1912 47.6 per cent. of the water services were metered.

From the data so compiled it appears that in the last 23 years the minimum daily rate of water consumption was 114.5 gals. per capita in 1890, that the maximum rate was 154.01 gals. per capita in 1895; and the average daily rate for the last 23 years was 130.6 gals. per capita.

During recent years an effort has been made to increase the proportion of services metered so as to check the waste of water, the experience of other cities proving that by the use of meters the quantity of water consumed can be held down to reasonable figures. In Cincinnati the consumption has been considerably higher than in a number of other large cities, but while the tendency of the times is toward a greater per capita consumption, it is expected that if a large proportion of the services are metered the daily rate of consumption will not materially exceed that of the present time, which may be fairly taken to be 125 gals. per capita. It is possible that this rate might be somewhat reduced, possibly to as low a rate as 100 gals. per capita daily. Taking into consideration, however, the tendency towards greater consumption, it does not seem wise to plan for a period of 40 years in the future without allowing for some increase. In these studies it has therefore been assumed that the daily consumption will ultimately, and within the period for which the intercepting sewers are designed, reach 150 gals. per capita.

It is commonly thought that practically all of the water supply eventually reaches the sewers. This, however, is a fallacy, for a very considerable part, probably not less than 40 per cent., is disposed of in other ways. It is evident that the water used for steam purposes, much of that used for manufacturing and mechanical purposes, that used by street and lawn sprinklers and the leakage from mains and services, as well as that used by water consumers not connected to the sewers, fails to reach the sewers.

An estimate of the quantity of water used for these several purposes in Milwaukee was made by the Milwaukee Sewage Disposal Commission in 1911 as follows:

Purposes.	Gals. per capita per day.	Per cent. of total consumption.
Steam railroads	5	4.76
Manufacturing and mechanical	5	4.76
Street sprinklers	5	4.76
Lawn sprinklers	2½	2.38
Consumers not connected to sewers	7½	7.14
Leakage from mains and services	15	14.28
Totals	40	38.08

The percentage of the water used for these purposes in Milwaukee was based upon a total average daily consumption of 105 gals. per capita. Applying the same percentage in Cincinnati, it would appear that the quantities of water given in Table II. would be used for the several purposes indicated in the years 1912 and 1950, respectively.

With an assumed daily use of water of about 150 gals. per capita, 56 gals. of which do not reach the sewers, it has seemed reasonable to take the average quantity of domestic sewage exclusive of ground water, at 90 gals. per capita per day and the maximum rate at which it will reach the intercepter at 135 gals. per capita per day. These estimates seem to be justified by the determinations of the daily flow of sewage in the Mitchell Avenue and Ross Run sewers, which were 80 and 92 gals., respectively, with maximum rates of 128 and 157 gals., respectively, per capita.

Quantity of Sewage from Commercial Districts.—The commercial district in Cincinnati is unusually well defined, and it is served by a number of parallel sewers, each draining a relatively small district, it was deemed wise to make measurements of the flow so that an intelligent estimate might be made of the quantity of sewage which will have to be taken into the intercepting sewers.

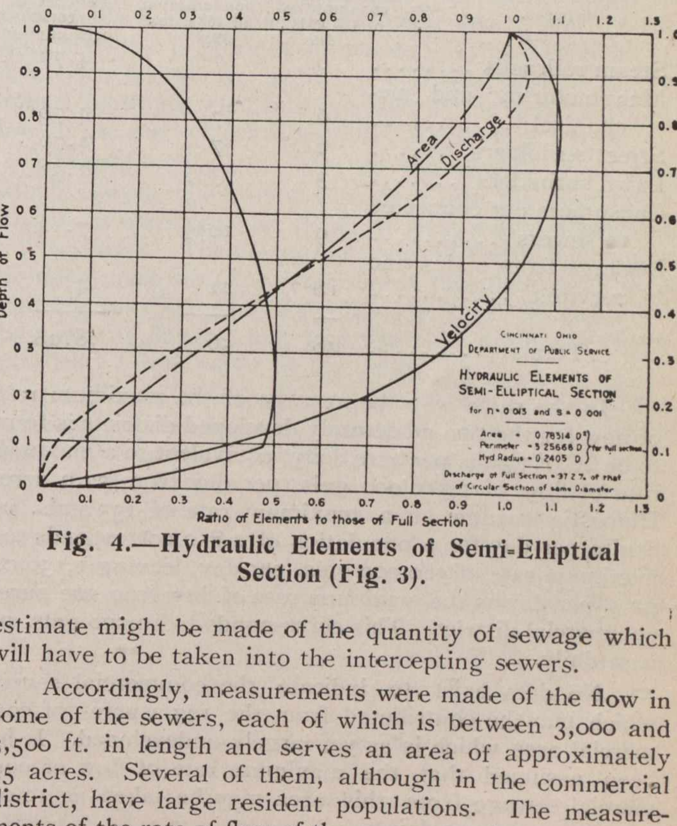


Fig. 4.—Hydraulic Elements of Semi-Elliptical Section (Fig. 3).

Accordingly, measurements were made of the flow in some of the sewers, each of which is between 3,000 and 3,500 ft. in length and serves an area of approximately 35 acres. Several of them, although in the commercial district, have large resident populations. The measurements of the rate of flow of the sewers serving commercial districts were made during the extremely dry season, and it has been assumed that the infiltration of ground water at the time the measurements were made was negligible.

Of the total area of 227.2 acres in the commercial sewer districts gauged, certain districts, with a combined area of 169.3 acres may be considered as highly developed. In these districts will be found hotels, high-class office buildings, department stores and public buildings, with relatively few apartment houses. The streets are paved with asphalt and granite blocks. Other districts, comprising an area of 57.9 acres, may be classed as moderately developed. In these districts will be found smaller hotels, smaller stores, wholesale houses and second-class business blocks, with a considerable proportion of tenement houses. A further area of 133 acres is considered as a semi-commercial area lying around that moderately developed.

The estimation of maximum rate of sewage flow from commercial areas (in addition to sewage contributed by the resident population, and not including ground water) has been made as follows:

The average of the maximum rate of flow for the six "highly developed" districts above mentioned is 81,508 gals. per acre daily (maximum points taken from conventional curves), which may be taken to fairly represent the maximum flow of sewage per acre from these districts if combined. The area is 169.3 acres, so that the maximum rate of discharge would be 13,800,000 gals. per day. The resident population is 4,744, and the maximum rate of flow of domestic sewage corresponding to this population at 135 gals. per day per capita would be 640,000 gals. per day. The difference, 13,160,000 gals. per day, is taken to represent the maximum rate of sewage flow due solely to the commercial development of the district, equivalent to 77,700 gals. per acre daily.

Table II.—Estimated Quantities of Water Used, But Which Do Not Reach Sewers.

Purposes.	Gals. per capita per day based on total consumption of 125 gals., 1912	Gals. per capita per day based on total consumption of 150 gals., 1950	Per cent. of total consumption
Steam railroads	6	7	4.76
Manufacturing and mechanical	6	7	4.76
Street sprinklers	6	7	4.76
Lawn sprinklers	3	3½	2.38
Consumers not connected to sewers	9	10½	7.14
Leakage from mains and services	18	21	14.28
Totals	48	56	38.08

In the same way the average of the maximum rates of flow for the two moderately developed districts is found to be 26,025 gals. per acre daily, equivalent to a maximum rate of flow of 1,510,000 gals. per day from 57.9 acres. Domestic sewage at a maximum rate of 135 gals. per capita per day for a population of 2,810 corresponds to a maximum rate of 380,000 gals. per day, leaving 1,130,000 gals. per day as the maximum rate of flow from the purely commercial district. This corresponds to 19,500 gals. per acre daily.

No data exist to indicate the commercial sewage which may be contributed from the 133.3 acres of commercial area which is as yet largely undeveloped. It has been assumed that the maximum rate of flow of commercial sewage from this area may be taken as 12,000 gals. per acre per day.

Assuming that the relative proportions of highly developed, moderately developed and substantially undeveloped area will remain practically unchanged, the average maximum rate of sewage discharge from commercial area, due solely to their use for commercial purposes, has been estimated as equivalent to 44,000 gals. per acre daily; or, in round figures, 40,000 gals. per acre daily in addition to domestic sewage from the resident population and ground water.

From the estimated future commercial area of 721 acres the maximum rate of flow has been computed on the basis of 40,000 gals. per acre per day for commercial sewage; 750 gals. per acre per day for ground water, as hereinafter explained, and 135 gals. per capita per day for domestic sewage.

Quantity of Sewage from Industrial Areas.—As certain portions of the city are and will continue to be devoted to industrial enterprises from which large quantities of liquid wastes will be discharged into the sewers, an effort has been made to secure data which might aid in forming an estimate of the quantity for which provision should be made in the intercepting sewers.

It should be noted that there is always a tendency for certain classes of industrial planks, such as packing houses, dairies and the like, to discharge into the sewers large quantities of solid or heavy semi-fluid wastes. Precautions must be taken to prevent the entrance of such matter into the intercepting sewers, if necessary, by requiring all such plants to maintain settling tanks upon their branch sewers.

It is extremely difficult to determine the quantity of wastes which will be discharged from an area devoted to industrial purposes, as the amounts produced by manufacturing establishments vary enormously and because such an area is also developed for residential purposes to a considerable extent. Actual measurements were desired and were made for four districts which were selected for that purpose.

The Marshall Avenue District is probably more nearly a typical industrial area than any of the others, although the quantity of wastes per acre discharging into the sewers is probably greater than is to be expected from the industrial areas of the city as a whole. The conventional curve and other data for the district are shown in Fig. 2.

The effect of the industrial wastes in increasing the per capita rate of flow in this district is clearly shown by comparing the average rate of 363 gals. per day with that obtained in the residential district, where the average quantity of sewage was found to be 80 and 92 gals. per capita per day respectively.

Quantities of Industrial Wastes.—In connection with the studies of the purification of sewage, a careful census of the industrial establishments of the city and of those lying north of the city in Mill Creek Valley has been taken. The quantity of water used in the several industries obtained from the canal, wells and other sources, and the quantity obtained from the municipal water supply, together with the estimated quantities of liquid wastes, were tabulated.

Nearly all the industrial plants are located in Mill Creek Valley and the McLean Avenue Sewer districts. The industrial water consumption in this region amounts to about 17,000,000 gals. per day. Not all the water so used is discharged in the form of wastes. The total amount of these wastes is estimated at 16,000,000 gals. per day, which is equivalent to 5,500 gals. per acre daily, the area under discussion being approximately 2,900 acres.

In view of the fact that nearly all of the plants run but 10 hours per day, the maximum rate of discharge of industrial wastes has been estimated on the assumption that 75 per cent. of these wastes are discharged at a uniform rate during these 10 hours. The corresponding maximum rate of flow is 9,900 gals. per acre daily.

Similar estimates of the quantities of industrial wastes from smaller manufacturing districts tributary to the Ohio River show quantities equivalent to 6,000, 1,100 and 2,350 gals. per acre per day, the corresponding maximum rates of discharge being 10,800, 2,000 and 4,200 gals. per acre per day, respectively.

Giving due weight to the extent and the character of the development of the several districts, it is believed that a fair estimate of the maximum rate of discharge of industrial wastes into the intercepters is 9,000 gals. per acre per day. This quantity is assumed to be in addition to the domestic sewage from the resident population and the ground water.

Ground Water.—The quantity of ground water which reaches the sewers depends on the rainfall, the character of the soil and upon whether the sewers and their connecting drains are well or poorly built. Many of the older sewers were laid without precaution to prevent the infiltration of ground water, which even under the best conditions cannot be entirely avoided. The quantity of ground water thus entering the sewers, as previously explained, varies greatly from time to time and is usually highest after rains in the spring of the year.

It has been assumed, as previously explained, that a great increase in the area of the city will take place during the next 40 years. The estimated density of population over this large area is relatively small, being but eight persons per acre, whereas the density of population in a number of other large cities of this country is found to be from 15 to 25 persons per acre. The small number of persons per acre makes it evident that the number of miles of sewers per square mile of area is likely to be relatively small.

The report of the United States Census Bureau upon Statistics of Cities for 1907 contains data from which the number of miles of sewers per thousand inhabitants in cities having populations of more than 30,000 can be derived. From this information it appears that a well-sewered city of 720,000 persons should have about 900 miles of sewers, and it has therefore been assumed, in estimating the quantity of ground water to be provided for, that there will ultimately be that length of sewers contributing to the intercepters. Numerous measurements and estimates of the infiltration of ground water into sewerage systems indicate that 75,000 gals. per mile of sewer is a reasonable daily maximum. It has therefore been assumed that the total quantity of ground water which will eventually reach the intercepting sewers will be 67,500,000 gals. per day, from an area of 140 square miles, equivalent to 750 gals. per acre per day. This unit has been used in computing the quantity of sewage likely to reach the intercepters from each of the several sewer districts.

Storm Water.—It will be noted that in the foregoing discussion of quantity of sewage there is no allowance for storm water. In other words, when the city shall have attained the degree of development herein estimated as probable in 1950, if the quantities of domestic, commercial and industrial sewage and ground water correspond to the estimates, the intercepting sewers designed to take those volumes of sewage will flow full at the time of maximum sewage flow, and there will be no surplus capacity for storm water at that time.

Even then the flow of sewage would not fill the intercepters except during hours of maximum flow, so that during perhaps half of the day there would be a small surplus capacity. The first, and therefore the foulest, run-off from storms occurring at such times could therefore be taken into the intercepters.

The maximum rate of sewage flow estimated for the present time is but little more than half that to be expected in 1950, and after adding the ground water there would still be available at the present time about one-third the capacity of the intercepter at times of maximum average flow. That is to say, storm water could be received up to a quantity approximately equivalent to one-half the maximum rate of flow of sewage and ground water. Thus the first storm water flowing off from the streets and roofs would be conveyed with the sewage to the point of ultimate disposal.

As the years go on the surplus capacity available for storm water would grow less, until ultimately the maximum sewage and ground water flow would fill the intercepters, as stated above.

At the points where the combined sewers discharge into the intercepters adequate storm water overflows must be provided to convey to the nearest watercourse the excess storm water beyond the quantities which the intercepting sewers may be able to receive. The subject of storm water overflows and sewage flow regulators will be discussed in a subsequent article.

Specific Data on Adopted Designs.—Sections—Two forms of cross-section will be employed on the new intercepters, namely, circular and semi-elliptical. The circular type will be used for sections 5 ft. in diameter and less. On all larger sections the semi-elliptical section will be used. In the larger sewers this latter section has the advantage of economy, since the quantity of concrete and excavation are both somewhat less than for a circular section of the same capacity. This type of section is more satisfactory structurally, also, since the flatter invert is more easily built than a large circular invert, and the reinforcing steel is more easily placed. Typical sections of both types are shown in Fig. 3 and the relations of the several hydraulic elements involved in the calculation of flow in the semi-elliptical section are shown in Fig. 4.

Profiles.—The elevations of the several trunk and branch sewers which must discharge into the intercepter govern its elevation and slope, at least within somewhat narrow limits. The design for the Mill Creek intercepter has been made with the requirement that there shall be a scouring velocity of not less than 3½ ft. per second when the sewer is flowing full, and when the discharge is not retarded by high water at the outlet.

Conditions are complicated in the case of Mill Creek intercepter by the frequent high-water stages of the Ohio River. Whenever the river reaches or passes the 20-ft. stage on the Broadway gauge the effect of back water will begin to be felt in the intercepter, and when the river reaches the 30-ft. stage, if not before, the lower portion of the intercepter will be entirely submerged, and much, if not all, of the sewage will then be discharged through the storm overflows into Mill Creek.

When the velocity of flow is checked by the rise of the river deposition of silt will occur in the intercepter. It is desirable that when the river falls again as high velocities as are reasonably possible be obtained to scour out the accumulated deposits.

The average number of days per year when the Ohio River has been at or above any given elevation indicates that there have been on an average 122 days per year when the flow in the Mill Creek intercepter would be checked, and 53 days per year when it would be almost entirely suppressed in the lower section, these periods corresponding to the 20- and 30-ft. stages of the river, respectively.

The Mill Creek intercepter is 4 ft. in diameter in its smallest section. For this section the slope is 0.0015, and this slope continues until a size of 5 ft. 9 ins. is reached, where it changes to 0.0010. At the 7 ft. 3 in. section the slope again changes to 0.0006 and continues at that rate to the outlet where the size of the section is 8 ft.

The Duck Creek intercepter is below the bed of the creek throughout its course and is therefore low enough to receive the tributary trunk sewers without difficulty. The outlet is well above the level of extreme high water in the river and consequently the intercepter will not be affected by fluctuations of river stage. This sewer ranges in diameter from 2 to 4 ft. and in slope from 0.0052 to 0.0012.

When built, the Ohio River intercepter will be substantially parallel to the Ohio River to intercept the present and future trunk sewers which would otherwise discharge directly into the river. No direct comparison of the several projects for the Ohio River intercepter is possible, since none of the projects is complete without the inclusion of the corresponding scheme for sewage treatment and a definite plan for sewage treatment will not be adopted for several years to come.

Unit-Prices.—In all estimates of cost, except those made in connection with the studies of sewage treatment plants, the following unit prices have been used:

Excavation (including refill, sheeting, pumping) for trench with bottom width of 8 ft. and less, per cu. yd.	$ 1.25
Excavation (including refill, sheeting, pumping) for trench with bottom width more than 8 ft., per cu. yd.	1.00
Plain concrete masonry, per cu. yd.	10.00
Reinforced concrete masonry in sections from 5 ft. 3 ins. to 8 ft. 3 ins. diameter, inclusive, per cu. yd.	15.00
Reinforced concrete masonry in sections greater than 8 ft. 3 ins. diameter, per cu. yd.	14.00
Duck Creek outfall sewer, 45-in. section in tunnel, complete, per lin. ft.	27.00
Mill Creek outfall sewer, 8-ft. section in tunnel, complete, per lin. ft.	55.00
Manholes, per lin. ft.	6.00

ASPHALT PRODUCTION IN TRINIDAD.

The production of asphalt in Trinidad constitutes the chief source of mineral wealth of the colony. At Brighton the company which has the exclusive right to dig for asphalt on Government lands has built a jetty capable of accommodating ocean steamships. It also has extensive works for handling the crude asphalt and refining it. This company has also acquired large petroleum concessions in the neighborhood of the "Pitch Lake" and is now exploiting them on an extensive scale. The quantities of asphalt exported from 1910 to 1912 are given in the Chamber of Commerce Journal as follows:—

	1910. Tons.	1911. Tons.	1912. Tons.
Crude	143,249	149,844	155,908
Pure	15,734	19,283	20,169

The United States was the largest purchaser of Trinidad asphalt in 1912, receiving about 55 per cent. of the total amount exported; whereas the United Kingdom imported only 16 per cent., Germany 13 per cent., and Holland 8 per cent., the remainder going to different countries in small quantities. Mining for manjak was continued in two districts of the colony during the year and 1,530 tons of that mineral valued at £3,060 were exported to the United States and the United Kingdom.

A Boston publication reported recently that the British Columbia Copper Company has but one furnace in blast, indicating operations of no better than 33 per cent. of capacity. It is understood the management will consider closing down the entire plant. In May, there were produced 528,458 pounds of copper, 2,114 ounces of gold and 9,337 ounces of silver.

UNITED STATES' OPPORTUNITY AS BANKER.

CANADIAN municipalities are looking to the United States for funds. With the prevailing conditions in Europe, it is impossible to raise loans in Great Britain. The last municipal flotation overseas was that of South Vancouver early in July. The amount was £223,287 5 per cent. consolidated stock, at 91. In June, the city of Moose Jaw made a private sale in London of $465,000 5 per cent. debentures. This week a bond house of Montreal has offered to market a loan of $7,300,000 for that city in New York. The price is 96.

Despite the attitude of the United States government respecting loans to European governments engaged in warfare, it seems improbable that Washington will frown upon the bankers who undertake to help to finance Canada's peaceful enterprises. In the early part of last century the United States depended on Europe, and especially on Great Britain, for most of the new capital needed for its development. To-day the accumulations of the United States people are greater than those of any other nation. It is true that additional amounts of foreign capital are still invested in the United States, but the amount is insignificant in comparison with the country's own savings. The wealth of the United States is growing, according to Sir George Paish, at the rate of about $7,000,000,000 per annum, whereas the investments of Europe in the country rarely exceed $300,000,000 in a single year.

The annual growth of banking deposits in the United States in normal years is about $1,000,000,000; the issues of new capital by subscription, so far as the amounts are ascertainable, are about $3,000,000,000; and the sums spent on buildings in the leading cities of the country alone reach $1,000,000,000. Allowing for a certain amount of duplication in these totals on the one hand and on the other for the large sums spent in buildings in all the small cities and villages, upon farm improvements, new factories, mines, lumber propositions, additional stock and machinery, etc., the rapidity with which the wealth of the United States is growing will be evident. There is an excellent opportunity for the United States to strengthen financial relations with the Dominion. Canadian banks and bond houses will continue to do their share of the business as in the past, but obviously the temporary loss of Great Britain as a buyer of Canadian securities should benefit the United States.

REINFORCED CONCRETE PONTOON.

A reinforced concrete pontoon has been constructed to the order of the Sydney Harbor Trust by Stone and Siddeley, of Sydney, Melbourne, and Geelong. The pontoon is to be placed in position at the eastern end of Circular Quay for the use of the Lavender bay and Parramatta river ferry services.

The dimensions of the pontoon are: 100 feet in length, 53 feet 3 inches wide at one end, and 67 feet 7 inches at the other; depth, 7 feet 9 inches, with a 32-inch freeboard. The bottom is flat and the sides and ends are sloped to an angle of 70°. Special attention has been given to the design of the steel work with a view to enable the construction to withstand the excessive strains likely to occur should vessels be berthing at each side of the pontoon at the same moment. In the construction of the top and bottom of the pontoon allowance has been made for a live load of 150 tons, which will be distributed between the posts.—Commonwealth Engineer.

Editorial

ENGINEERING ADMINISTRATION.

It is the purpose of a new course to be started this fall at the Massachusetts Institute of Technology to take the middle way and afford to the students practical proportions both of engineering and of administration. The man who graduates from this new course will set out into practical life equipped with the essential things in the training of an engineer and a man of business. His later success will depend, as in all other cases, on his innate capacity and his power of profiting by the experiences of life.

The new course is, apparently, not designed to make bookkeepers, auditors or accountants in any professional sense, but to furnish the fundamentals in these practices to business men holding administrative positions involving financial responsibility. The student will be instructed in the terminology of the accountant, will learn the places of assets, liabilities, good-will, franchises and the balance sheet; the meaning of profit and loss account, the theory and analysis of accounts in general and of depreciation. Cost accounting will be set forth in principle, with standard methods of determining costs not only of material but of processes, labor and machines. Distribution of indirect costs and overhead expenses will be shown, and the value of cost data toward economy together with various of the inventories and wage payment methods. There will be information given the student on the relative value of investments, of different kinds of securities, government, railroad, industrial, public utility, etc., and of different kinds of bonds.

In matters of transportation, it is proposed to introduce studies in handling freight, terminal facilities and warehousing, the making of railway rates and the classification of freight. Export business will naturally bring with it some study of the nature of this business, ocean rates, customs regulations, tonnage duties and port regulations. Port and inland differentials will be discussed, and private car lines and special transit privileges.

In matters of industrial organization, the new course will enter into the study of the kinds of such organization from the individual to the trust or holding company, the differences in corporation laws and the influences determining the choice of state in which to secure the charter. There will be lectures on the internal organization of the corporation, the directors, their duties and liabilities, the rights and responsibilities of the different factors to the corporation and the principles governing elections and meetings. Financing of corporations, dissolution, reorganization, state supervision and taxation will be other items in the study of corporations.

The courses that consider business management will take cognizance of the organization of the establishment. There will then be the management of labor, selection and placing of employees, bonuses, efficiency methods, welfare inducements, and the training of the men.

This is an important step towards preparation for that new kind of engineering, the problems of which are those of organization, administration and finance. There is a world-wide demand for men who are not only capable constructive engineers but men who can co-ordinate and organize the resources of a community or of a nation for the accomplishment of a mighty purpose. It is in this relation that Col. Goethals has been spoken of as the greatest engineer in the world to-day. He is a prototype of the engineer of a few years hence.

PROGRESS IN THE IRON INDUSTRY.

There are two usual routes open to the man who wishes to reach the head of a great industrial corporation; one is, as the shop phrase expresses it, "through the boiler room," and the other through the office. The one who begins at the bottom of the mechanical plant gets of necessity a thorough knowledge of the technical end of the work. He must acquire what is nearly as essential to him, the business knowledge, as best he can and usually in irregular fashion and from persons not experts in teaching. The man who enters the office must, to an extent, work down and will be obliged to learn as best he can something of engineering.

However interesting and picturesque the work of the iron master may be, from the taking of the crude material from its bed in the earth to the turning out of the finished iron and steel, the industry, like the great majority of others, is constantly undergoing great changes. They are not only in the interests of a more uniform and a purer product, but for greater safety of life and a smaller amount of labor. A few details showing the rapidity and cheapness with which some of the work is carried on may interest our readers.

In the Messabe range in the Lake Superior district, the iron ore is loaded by steam shovels carrying from four to six tons each. A twenty-ton car is loaded in five minutes or less. These cars are hauled in trains to the ore docks, from which the steamers, carrying from ten to twelve thousand tons each, are loaded in from two to four hours.

Forty to fifty million tons of ore were brought down from Lake Superior last year and unloaded at the various lake ports by machines, which take from five to seventeen tons per shovelful. The largest machine is able to load a fifty to seventy-ton car in less than five minutes. This ore is carried to blast furnaces in trains, often numbering 100 cars; and some trains carrying over 7,000 tons of ore.

The blast furnaces are of enormous size and production. Most of them exceed 500 tons of pig iron per day. Many of them turn out over 200,000 tons per year.

The steel works are on an enormous scale, twenty-ton Bessemer converters being not uncommon, while open-hearth furnaces, making 100 tons per heat, are quite numerous. No one thinks in these days of building smaller than fifty-ton open-hearth furnaces, except for steel castings. The first open-hearth furnace built in this country, forty-three years ago, had a maximum capacity of five tons. Four to six open-hearth furnaces are charged by one open-hearth charging machine, which is controlled by one man. To do this work in the old-fashioned way, by hand labor, would take from thirty to forty men.

The rolling of the steel shows the same progress in labor saving. The great rail mill at Gary, Ind., if kept supplied with ingots, can easily produce 5,000 tons of finished rails in twenty-four hours. This is more than one month's production of many mills in Europe.

These figures show what has already been done and the magnitude of the business. It has gone far beyond what the most optimistic a few years ago thought possible.

INDUSTRIAL SITUATION IN GERMANY.

MILITARY and naval Germany in its insane war lust is paralyzing industrial Germany. At the conclusion of hostilities, the nation's industry and commerce will have suffered a blow, from which it will take at least a quarter, perhaps a half century, maybe more, to recover. Modern Germany presents two outstanding facts, the great increase of the population since 1871 and the growing dependence of the population upon industrial and mercantile pursuits. Industry and trade in Germany maintain directly a population of about 34¾ millions, or more than half the entire population of the German Empire.

Chief among the causes which have helped to place Germany into the front rank of industrial nations is its possession of valuable mineral wealth and of capital to develop them. It has the largest known reserves of coal of all European countries. Upon that foundation, its iron and steel industries have been built rapidly and efficiently. It has copper, lead, zinc and other minerals in fair quantity and great wealth in its salt mines. It has practically a monopoly of potash, and supplies the world with that product.

The industrial hub of the country is the district which stretches from Dusseldorf on the Rhine land to Hamm in Westphalia, and covers a large part of those provinces. Speaking of that district, the Cologne Gazette prophesied some time ago that before long the district between Duisburg and Hamm would form "one enormous settlement, a single expanse of houses from 45 to 50 miles long and from 15 to 20 miles broad."

While Germany is still lagging behind in shipbuilding—the Clyde yards alone turning out a larger tonnage than all the German yards together—good progress is being made nevertheless. That is in some measure due to the naval policy of Emperor William, which would have been well if confined to peaceful work, but directed partly to the building of a gigantic navy, it likely will prove disastrous in the comparatively near future.

Year by year, Germany has become more independent of other countries in industrial products. Comparing the statistics of 1897 with those of 1911, the value of Germany's imports increased in that period by 49 per cent. and that of the exports by 129 per cent., while the increase of population was 23 per cent. Although the country is still largely agricultural, it is no longer able to feed its population. About one-half of the agricultural land is divided into relatively small holdings, while one-quarter is held by large proprietors.

The railways have been State-owned for a generation. Four years ago the country had about 18 miles of railway to every hundred square miles of surface, a ratio exceeded in Europe only by Belgium, Holland, the United Kingdom and Switzerland, in the order named. In his striking picture of the growth of industrial Germany, Mr. W. H. Dawson, in a notable volume on the subject, states that the railway system of that country and the development of its natural and artificial waterways have helped to build up industry and commerce and economic efficiency each to an equal degree.

Another powerful factor in the industrial life of Germany has been the concentration of capital. For instance, ten industrial concerns and nine financial institutions have aggregate capital of $638,750,000, an average of over $33,000,000. Nearly all these large undertakings, including the Krupp gun and shipbuilding firm, with capital of $45,000,000, and the Deutsche and Dresdner Banks, each with $50,000,000 capital, have grown to their present size as a rule by amalgamation with rival enterprises. The firm of Krupp, in which Emperor William has a substantial financial interest, employs 70,000 persons. Now industrial Germany and its 35,000,000 workers, with the other half of that Empire's population, is thrown into war by Germany's military madmen.

ONTARIO STEEL PRODUCTS' REPORT.

The profit and loss account of the Ontario Steel Products Company, Limited, shows net profits for the year ended June 30th, of $106,437. This amount is after providing for depreciation of properties, reduced market value of securities and the entire cost of organization. Deducting bond interest of $36,000 and preferred dividends of $52,500 there remained a sum of $17,937. The company's fixed assets including real estate plant, power rights and goodwill total $1,785,451. The current assets, amounting to $2,259,689 are divided as follows:—Cash, $3,351.94; bills and accounts receivable, $96,459.33; inventories, $346,107.45; securities (at market price), $26,144; deferred charges to operations, $2,175.

On the other hand the company has current liabilities of $118,913, made up as follows:—Bank overdraft, $14,881.27; bills and accounts payable, $72,907.14; bond interest due July 2nd, 1914, $18,000; preferred dividend payable August 15th, 1914, $13,125. The reserve for depreciation, etc., is $22,838.94.

In discussing the company's report, Mr. W. Wallace Jones, the president, states:—"The company shared in the generally unfavorable conditions which existed during the past 12 months, and consequently all the plants were not run to their full capacity. Furthermore, a disastrous fire at the Gananoque Spring and Axle plant seriously interfered with operations, at a most inconvenient time; and while the direct loss was fully covered by insurance, the disorganized conditions that obtained during rebuilding operations seriously affected profits from these works. This fire, which completely gutted the spring works and damaged the axle works at Gananoque, occurred on October 1st, 1913. Rebuilding operations were commenced on October 15th, the building being completed on December 20th, and manufacturing operations resumed on January 2nd. The new building, which is larger than the one destroyed, is strictly fireproof construction, and the insurance rate has been substantially reduced in consequence.

"During the year large extensions and improvements at the shovel plant have been satisfactorily completed, but owing to trade conditions are not being operated at the present time. In view of the development in the auto spring business, the directors recently purchased the property of the Canadian Malleable Range Company, at Chatham. This property is very conveniently situated, and the price paid was reasonable. The directors also have purchased from the Thousand Islands Railway Company a piece of land which later on will be used for an extension to the shovel plant. The McNee property, adjoining the spring and axle warehouse at Gananoque, has also been purchased at a reasonable price, and will give additional and badly-needed storage capacity for springs and axles. The directors have not deemed it prudent to proceed with the suggested factory at Windsor at the present time.

"During the year the plants have all been put in a state of high efficiency, and several new lines of goods have been put on the market. Contrary to the usual custom, the company has written off all organization expenses this, the first year; and have also set up a substantial reserve for future bad debts."

The company has first mortgage 6 per cent. bonds of $600,000. These are due on July 2nd, 1933. It has authorized capital stock of $1,500,000 of which $750,000 are 7 per cent. cumulative preferred shares and $750,000 ordinary shares. All this is paid up.

On August 15, the Panama canal will be opened to commerce for ships not needing more than 30 feet of water. At present war department officials at Washington are perfecting plans for this opening, though the official opening and ceremony will not take place until March, 1915, when a much greater depth will be available.

ENGINEERS' LIBRARY

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

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BOOK REVIEWS.

Business Administration, Its Models in War, Stagecraft and Science.—By Professor Edw. D. Jones; published by the Engineering Magazine, Co., New York. 275 pp.; size 5½ in. x 7½ in.; cloth. Price, $2.00

The subject of this book is treated in three directions: the administrator as general, the administrator as scientist, and the administrator as diplomat. Professor Jones is not an apostle of any special doctrine or practice of management. He looks at the subject in a prospective state by familiarity with the world's greatest thought and action, and he seeks to find in the life and achievements of great generals, statesmen and scientists fundamental principles applicable to the more limited work of modern industrial leaders. He looks upon administration as a process dealing chiefly with the human factor and the operation of universal laws. He conceives of the administrator as a leader of men, even more than a trustee of properties. He realizes that there has been a deplorable diversion between modern industrial and business conduct and modern ethical and moral ideals, and he seeks to show that by a change of viewpoint they may be brought into reconcilement and harmony. He conceives indeed that the recent and rising activity of interest in industrial management is a symptom of the effort at this reconcilement—a movement like the rise of chivalry which tempted the rugged virtues of the warrior with the gentler characteristics of religion, loyalty and courtesy.

Apart from the book itself a seeker of foremost literature upon the subject at hand might well define from the following brief outline of the author's career his ability and comprehensive grasp of the essentials underlying business administration. Professor Jones was educated at Ohio University and the University of Wisconsin. Later at the universities of Halle and Berlin he enlarged upon the subject of economics. Since 1895 he has been in the University of Michigan, first as instructor in statistics and economics, later as assistant professor in economics and commercial geography, and since 1902 as professor of commerce and industry. In the United States Commission to the Paris Exposition he was an expert in social economy. At the St. Louis Exposition he was a member of the International Congress of Arts and Science. As author of "Economic Crises" and of various monographies on the resources and industries of the United States Professor Jones has become recognized as an authority, and the book now under consideration as the latest publication of the Works Management Library of the Engineering Magazine Company will be received with interest and satisfaction.

It is not a book for those who are seeking a ready-made system, but it is a book which will be unusually interesting and profitable to those who are seeking stimulus and direction for their ideas.

American Machinists' Handbook.—By Fred. H. Colvin, A.S.M.E., and Frank A. Stanley, A.S.M.E.; published by McGraw-Hill Book Company, New York; 673 pp.; fully illustrated; size 4 in. x 6½ in.; bound in leather; price, $3.00 net.

This is the second edition of a very useful reference book of machine shop and drawing room data, methods and definitions. The writers had in mind, in the compilation of the work, the fact that every man engaged in mechanical work of any kind, regardless of his position in the shop or drawing-room, frequently requires information that is seldom remembered and is not usually available when wanted. By their endeavor to supply this information in the most convenient form the authors have rendered a great service to young mechanics as well as to practical men in all branches of machine work. The co-operation which manufacturers and individuals tendered them in its construction is an evidence of the general need which has been recognized for a long time in the mechanical arts.

The second edition is larger than the first edition by 160 pp. It has been very carefully revised and each section has been brought up-to-date to correspond with the changing conditions of shop and drawing-room work. Many of the changes therein are due to the suggestions made by the users of the handbook.

In a review it is somewhat difficult to give a clear idea of the scope of a work of this kind. The following section headings, however, each of them divided into various subsections, which will not be numerated, will be found of value:

Screw Threads; Pipes and Pipe Threads; Twist Drills and Taps; Files; Work Benches; Soldering; Gearing; Milling and Milling Cutters; Turning and Boring; Grinding and Lapping; Screw Machine Tools; Speeds and Feeds; Hunch Press Tools; Broaches and Broaching; Bolts, Nuts and Screws; Calipering and Fittting; Tapers and Dovetails; Shop and Drawing Room Standards; Wire Gauges and Stock Weights; Horsepower Belting and Shafting; Steel and other Metals; Steam Hammers and Drop Forging; Knots, Eye-Bolts, Ropes and Chains.

In addition, there are many general reference and miscellaneous tables and a general outline of shop trigonometry.

The dictionary of shop terms is well illustrated and comprises almost 100 pp. It is one of the most useful, not merely owing to its comprehensiveness but to its connection with, and incorporation in, the handbook itself. The index relates to nearly 2,000 items receiving consideration in the work. It has been very carefully worked out and is a valuable asset to speedy reference, so important in a work of this kind.

Asphalts, Their Sources and Utilizations, 1914 Edition.—By T. Hugh Boorman, C.E.; published by the Wm. T. Comstock Co., New York; 192 pp.; 55 plates; size 7 in. x 10 in.; cloth; price, $2.00.

This new edition contains much additional information, practically all of which deals with the developments in road building during the last five years. Five chapters have been added treating respectively of rock asphalt, maintenance, asphalt macadam roads, coal-laid asphalt roads, bituminous road surfaces, and asphalt blocks for roads. The new edition contains eight new plates, including a series of standard tests for asphalt cements for pavements and roads. The book will be found useful by commissioners of highways and municipal engineers because of its authoritative information and the completeness with which the subject is covered.

An addendum has been published in connection with it and is being sold at 25 cents. The pamphlet has been provided so that those having copies of the former edition may be able to obtain the additional matter without having to purchase a new complete volume.

Practical Calculations for Engineers.—By C. E. Larard and H. A. Golding; published by Chas. Griffin & Co., Limited, Strand, London; 387 pp.; 175 illustrations; 31 tables; size 5½ in. x 7½ in.; cloth. Price, $1.00.

This is the third and considerably revised edition of the authors' work, written primarily for engineering students, apprentices, mechanics, foremen, draughtsmen, and others practically engaged in engineering work. The first edition was published in 1907, and none of the information and calculations is old or out of use.

The general principles which the authors have kept steadily in view in the preparation of this work include modern methods of making rapid calculations by the use of the slide rule; some of the more important engineering problems with which every young engineer should be familiar; graphical methods (illustrated by engineering problems) for the ready interpretation of the results of experiment and other work; and, the importance of making a study of the business side of the profession. The first few chapters are confined to elementary calculations, approvals, approximations, technical and mensuration, and calculation of weights. The work goes on to discuss calculations by common logarithms, mechanical calculating devices and the use and value of squared paper. Section 2, comprising 7 chapters, is devoted entirely to mechanics taking up the principles of work, power and energy, acceleration, momentum and centrifugal force, etc., applying them to practical examples in each case. Section 3 is devoted to steam engineering and its various calculations, while the concluding chapter takes up comparative costs of power production for steam, gas, and oil engines.

For the non-technical mechanical engineer engaged in power production the book will be found of considerable assistance. It is not recommended for those who have had extensive technical training in this work, as there is little new information contained therein that would be of further assistance to them, but the work will be found especially suited to satisfy a long-felt want for a book that goes into the subject of steam engineering in such a way that the man who has little more than an average grounding in the principles of arithmetic can very well understand.

Flight Without Formulae.—By Commandant Duchene of the French Genie, translated into English by John H. Ledeboer, B.A.; published by Longmans, Green & Co., London and New York; 211 pages; 84 illustrations; size 6 in. x 9 in.; cloth. Price, $2.25.

The translator in his preface states: "Formulae and equations are necessary evils; they represent, as it were, the shorthand of the mathematician and the engineer, forming as they do the simplest and most convenient method of impressing certain relations between facts and phenomena which appear complicated when depressed in everyday garb. Nevertheless, it is to be feared that their very appearance is forbidding and strikes terror into the hearts of many readers not possessed of a mathematical turn of mind." The writer goes on to state that it is this prejudice that has deterred many from the study of the principles of the aeroplane, and the book under discussion forms an attempt to cater to this class of reader. When it is stated that there is not a single formulae in the whole extent of the work, those who have refrained from studying the literature of aeronautics owing to the many mathematical computations which almost invariably appear in the books devoted to the work, will be relieved to know that there is now on the market a volume which treats of every one of the principles of flight and of the problems involved in the mechanics of the aeroplane without demanding from the reader the most elementary knowledge of arithmetic.

The book is divided into 10 chapters, the first 5 being on flight in still air, taking up the subjects of speed, power and the power plant. The next 4 chapters discuss stability in still air; viz., longitudinal, lateral and directional stability and turning. Chap. 10 takes up the effect of wind on aeroplanes.

Taken altogether, the book consists of simple discussions on the mechanics of the aeroplane that have been so masterfully handled by the writer as to absorb the attention and interest of the non-mathematical mind.

Metal Statistics, 1914.—By B. E. V. Luty and C. S. J. Trench; published by the American Metal Market Co., New York; 287 pp.; size 3½ in. x 6 in.

This is the 7th annual edition of this work on Metal Statistics, and a great deal of useful information is to be found therein for buyers and sellers, as well as for plant managers and engineers, as the data is remarkably comprehensive in the ferrous and non-ferrous metal fields. The latest edition is considerably larger than previous publications. The editors make acknowledgment to the United States Geological Survey, the New York Metal Exchange, and other authorities whose statistics have been used with respect to metal production, etc., in the United States and other countries.

High Power Gas Engines.—By H. Dubbel, translated from the German and edited and expanded, so as to include British engines and British practice, by F. Weinreb; published by Constable and Co., London; 197 pp.; 423 illustrations and 13 folding plates; size 7¼ in. x 10½ in.; cloth. Price, $4.50 net.

When one encounters a text book with this size of page one is generally inclined to petition for some standardization, long talked-of in the matter of size of text books. In this particular instance, however, the grievance is counteracted by the clearness characteristic of the many illustrations which the book contains. The half-tones are exceptionally clear, whereas the sectional drawings and diagrams in most cases are, if anything, on the large scale—which reflects again upon the question of size. With this off his mind the reviewer, in turning to the subject-matter of the work finds it a treatment of the theory, principles of operation and the most important constructional features of large 4-cycle and 2-cycle gas engines. As a guide for the student or designing engineer it will be found to contain the same essential and technical details as have been typical of similar works on steam engines in years past. Further, its value to engineers who have not specialized upon large gas engine work is to be emphasized.

The book, or rather the theoretical part of it, deals with the question of efficiency, also compression and mixture ratios, the latter being dealt with under assumption of both constant and variable specific heats. More special attention has been given, however, to the constructional features and conditions governing the design of various engine parts which makes the book, with its clear and carefully drawn illustrations, one of great assistance in design.

Other points that have received attention are the question of cooling and the consideration of large forces acting upon the piston, these points being so important as to have influenced the design of large gas engine parts in a very distinct manner.

In translating the work Mr. Weinreb calls attention to the German text dealing only with large size double-acting gas engines, whereas the growing tendency in Great Britain is the use of the multi-cylinder single-acting type up to, for example, 1,500 b.h.p. For this reason he has included this type in the translation, observing that the troubles formerly experienced with large cylinders seem to have led to the development of the more moderate sizes. The chapter headings throughout the work are as follows: The Cycle of the Gas Engine; Output and Cylinder Dimensions; the Governing of the Four-Cycle Engine; Valve Gear of Four-Cycle Engines; the Two-Cycle Engine; Valve Gears; Ignition; the Cylinders; Valves and their Cooling; Pistons and their Cooling; Piston Rod Couplings; Stuffing Boxes; General Design of Principal Parts; Calculation of the Flywheel Weight; Starting; Piping.

Technical Mechanics, Statics and Dynamics.—By Edw. R. Maurer, Professor of Mechanics in the University of Wisconsin; published by John Wiley & Sons, New York; Canadian selling agents, the Renouf Publishing Co., Montreal; 356 pp.; 529 illustrations; size 6 in. x 9 in.; cloth. Price, $2.50 net.

The first edition of this work was published 10 years ago and it will be remembered that it was received with considerable satisfaction by students of engineering. As stated in the preface of the book, "Although the title might suggest such, it is not comparable to books commonly called 'Theoretical Mechanics,' generally intended for students of mathematics or physics nor to books on applied mechanics, generally including a treatment of strength of materials, hydraulics, etc." In 'Technical Mechanics,' the subjects discussed from the theoretical side have each a direct bearing on engineering problems and the applications illustrate principles of mechanics with a view to training students in the use of such principles rather than in the furnishing of direct information.

The present edition is a practically rewritten book and contains considerably more material than the previous work, including a new collection of problems. The chapter on attraction and stress which appeared in previous editions has been removed so that the new arrangement is as follows: Chap. 1, Composition and Resolution of Forces; Chap. 2, Forces and Equilibrium; Chap. 3, Simple Constructions; Chap. 4, Friction; Chap. 5, Center of Gravity; Chap. 6, Suspended Cables, Wires, Chains, etc.; Chap. 7, Rectilinear Motion; Chap. 8, Curvilinear Motions; Chap. 9, Translation and Rotation; Chap. 10, Work, Energy and Power; Chap. 11, Momentum and Impulse; Chap. 12, Two-dimensional (plane) Motion; Chap. 13, Three-dimensional (solid) Motion. The book contains two appendices, the first of which entitled "Theory and Dimensions of Units" is substantially the same as Appendix "A" of the first and second editions of the work. Appendix "B" devoted to moment of inertia and radius of gyration of plane areas, has been added, as writers on strength of materials usually refer to works on mechanics for a discussion of this subject. The volume concludes with 193 problems illustrated and arranged to follow consecutively the general method of analysis adopted throughout the book. With each problem has been given a number, in parenthesis, which refers to the article pertaining to that problem. The work as a whole is a technical discussion written specially for engineering students, the author himself a professor of mechanics in a well-recognized university has made evident throughout the work his authoritative conception of the academic requirements necessary for the modern method of training in an engineering school. It will be found to reiterate the satisfaction with which the previous editions have been accepted and its thorough revision will make it of extreme value as an authority on the subject.

Mechanical Movements, Devices and Appliances.—By Gardner H. Hiscox, M.E.; published by the Norman W. Henley Publishing Co., New York City; 409 pp.; fully illustrated; size 6 in. x 9 in.; cloth. Price, $2.50.

This book is the 14th edition, considerably enlarged over previous editions, of a work describing mechanical movements and devices used in constructive and operative machinery and in the mechanical arts. Practically speaking, it is a sort of mechanical dictionary, illustrated by over 1,800 engravings, and commencing with a rudimentary description of the early non-mechanical powers and detailing the various motions, appliances and inventions used in the mechanical arts up to the present time. The latest edition contains about 160 new and added mechanical movements and devices and includes a chapter on straight line movements, which makes the work a useful book of reference for those engaged in mechanical studies and pursuits, particularly for those who have to do with inventions and machine design.

The section headings are as follows: Mechanical Powers; Transmission of Power; Measurement of Power; Steam Power; Steam Appliances; Motive Power; Hydraulic Power Devices; Air Power Appliances; Electric Power and Construction; Navigation and Roads; Gearing; Motion and Devices Controlling Motion; Horological Mining; Mill and Factory Appliances; Construction and Devices; Drafting Devices and Miscellaneous Devices.

Scales for Ascertaining the Dimensions of Pipes, Drains and Sewers.—By C. E. Housden, Sanitary Engineer to the Government of Burma, Eastern Bengal and Assam. Published by Longmans, Green and Co., London, England; 16 pp.; 5 plates; size 5 in x 7 in.; price, 40 cents.

This small book contains a number of scales for ascertaining the dimensions to the nearest inch of pipes or half-pipes and of any design of drain or sewer in which a semi-circle or circle can be inscribed, adopting at will any discharge co-efficient. The scales are taken from the author's book entitled "Water Supply and Drainage, Systematized and Simplified," in which work their construction has been fully explained. The book contains two very useful tables, Table 1, giving the value of the water area in square feet, the wetted perimeter, the hydraulic mean depth, and the discharge reduction co-efficient for different slopes of masonry drains and for drains in earth. Table 2 is similarly a useful table to be used in connection with the plates or diagrams for ascertaining pipe dimensions. Doubtless these scales will be found of considerable assistance to engineers of sewerage works.

PUBLICATIONS RECEIVED.

Coal Mine Fatalities in the United States, June, 1914.—The monthly statement of the Bureau of Mines, Department of the Interior, Washington, giving the statistics for coal mine fatalities in June, and also revised figures for preceding months. Compiled by Albert H. Fay.

Pollution of Boundary Waters—A 4-page leaflet, being a resume of testimony of consulting sanitary engineers in the matter of the pollution of boundary waters between the United States and Canada. Issued by the International Joint Commission, and published by the Government Printing Office, Washington.

Report of the City Waste Commission of the City of Chicago.—A 69-page report of the Commission created by the order of the Chicago City Council to make a comprehensive study of the subject of the collection, delivery, and disposal of garbage and waste. T. McLean, Jasper, M.Sc., Assistant Secretary, Engineer of the Commission, publishes the report.

Waste of Oil and Gas in the Mid-Continent Fields, United States.—A 57-page report, compiled by Raymond S. Blatchley, and issued by the Bureau of Mines, Department of the Interior, Washington, showing the past and existing waste of gas and oil in states including Kansas, Oklahoma and Northern Texas, and attempting to show the importance of conserving these natural resources.

Forest Insect Condition in British Columbia.—Bulletin No. 17 of the Second Series. An illustrated 41-page booklet, giving the result of a preliminary survey made by J. M. Swain, Assistant Entomologist for forest insects, the object being to further the effort of conserving the timber resources of British Columbia. Issued by the Division of Entomology, Department of Agriculture, Ottawa.

Report of the Sewage Disposal Commission, 1913, Fitchburg, Mass.—Being the seventh semi-annual report which has been published since the establishment of the Sewage Disposal Commission at Fitchburg in 1910, and presenting an account of the doings, receipts, and expenditures of that body on the improved sewer system of the municipality for the six months ending December 31, 1913. The report contains illustrations and maps, and consists of 48 pp.

Report of Mining Operations in the Province of Quebec, 1913.—Issued under the authority of the Mines Branch, Department of Colonization, Mines and Fisheries, Province of Quebec; and submitted by Theo. C. Denis, Superintendent of Mines, as the annual report of the Mines Branch on the mining operations, mineral production, and geological field work of the Province of Quebec during the calendar year 1913. This report supersedes a preliminary statement which was published on February 23, 1914, was mainly statistical, and was submitted subject to revision. This report is 163 pp. in length, including a few illustrations.

Annual Report of the Topographical Surveys Branch, 1912-13, Department of the Interior, Ottawa.—This report consists of 226 pp., and, as a preliminary, gives the report of the Surveyor-General of Dominion Lands. The bulk of the work consists of 52 appendices, 10 of which are devoted to schedules and statements compiled by the Topographical Surveys Branch, the remaining 42 being reports and abstracts of reports from various surveyors. The book includes also 17 maps and profiles, and a fair amount of illustrations. The surveys made in Northern Manitoba and the Peace River district may be considered most interesting; since these were made on a larger scale than previously. Progress, however, is shown in all provinces of the Dominion.

Second Report of the Quebec Streams Commission.—Vol. 1, a 121-page booklet which has been translated from the French and contains a statement of the studies of a general nature which were carried on by the Quebec Streams Commission, Montreal, during the course of the year 1913, exclusive of the work accomplished during that period in connection with the proposed St. Maurice River water storage; Vol. 2, of 100 pages, being a supplement to the year's report, or the work done under the direction of the Commission in connection with the project for regulating the flow of the St. Maurice River, together with the plans and specifications of the works to be erected; and an appendix, under separate cover, containing maps made by the Commission.

Annual Report of the Minister of Mines, 1913.—459 pp., 7½ in. x 10½ in., containing illustrations and maps, and being an account of mining operations for gold, coal, etc., in the Province of British Columbia, and printed by authority of the Provincial Legislative Assembly. The work is compiled by William Fleet Robertson, Provincial Mineralogist, and gives the total mineral output of the province up to the year ending December 31st, 1913, showing in considerable detail the actual mineral production of the last year as based on smelter or mill returns, and making a summary of the production of each of the last four years. It thus illustrates by comparison the progress made in productive mining during this period.

Wood-Using Industries of the Maritime Provinces, Bulletin No. 44.—An illustrated 100-page bulletin compiled from reports received from over six hundred manufacturers in the Maritime Provinces using wood as a raw material. It reports on the quantity, value, and source of supply of the different kinds of wood used by the industries of the provinces; includes detailed descriptions of the different classes of industries and of the properties of the woods; takes up the ten kinds of wood used in greatest quantity and shows the extent to which the industries respectively use these; and appends a classified directory of the manufacturers who supplied the data used in the compilation. The report is the work of R. G. Lewis, B.Sc.F., assisted by W. Guy H. Royce, and is published under the Forestry Branch, Department of the Interior, Canada.

Evidence Given Before the Select Standing Committee on Agriculture and Colonization, Third Session, Twelfth Parliament, 1914.—This is the first of a series of four reports presented by the committee, and is compiled of the evidence of Mr. Wilson, M.P. for Wentworth, and Messrs. F. F. Espenchied and J. W. Purcell, of the Ontario Hydro-Electric Power Commission, taken by the Committee during the current session of parliament, and dealing with hydro-electric power as applicable to the farm; the evidence of Mr. John Bright, Live Stock Commissioner of the Department of Agriculture, on the production and marketing of live stock; the evidence of Mr. J. B. Spencer, of the Distributions Branch of the Department of Agriculture, on the methods of distribution in vogue in that Branch; and the evidence of Miss Wileman on the establishment of a free labor bureau system in Canada. The book includes maps and a fine list of illustrations.

Report of the Building and Ornamental Stones of Canada, Vol. II.—This report, which is published by Wm. A. Parks, B.A., Ph.D., under the Mines Branch, Department of Mines, Ottawa, forms the third part of the Monograph on the Building and Ornamental Stones of Canada, of which Part I. constitutes a general introduction and Part II. deals with the stones of the Province of Ontario. The work consists of 264 pages, 6½ x 9½ inches, including appendices and illustrations. The field work upon which the report is based was done during the summer of 1911, when, within a period of two and a half months, sixty quarries were visited, as well as a considerable number of abandoned quarries and prospects. But, though this report is by no means confined to quarries in actual operation, it does not pretend to include every opening that has been made for the production of building stone. The object was to represent by a typical example every important district and to give due consideration to every stone commercially available at the present time. The sketch maps accompanying the report were prepared by Mr. R. R. Rose, and are designed to show the general geology of the region, and more particularly to point out the location of the important quarries; only a few quarries not in actual operation being indicated, and no attempt being made to show the numerous small pits that have been opened for the obtaining of limestone for flux or for lime-burning.

CATALOGUES RECEIVED.

Gurley Automatic Water Stage Registers.—A 31-pp. pamphlet showing and illustrating the use of water stage registers manufactured by W. & L. E. Gurley, Troy, N.Y.

Railway Motor Gears and Pinions, Bulletin "A" 4199.—A small booklet showing the various grades of gears and pinions handled by the Canadian General Electric Co., Limited, Toronto.

Evidence of Toncan Metal.—A small booklet of illustrations issued with a view to giving visual evidence of Toncan Metal in actual use. Published by the Stark Rolling Mill Co., Canton, Ohio.

Clyde Land-Clearing Machinery.—An attractive 16-page catalogue, finely illustrated to show the logging, hoisting, excavating, stump-pulling, and land-clearing machinery manufactured by the Clyde Iron Works, Duluth, Minn.

Industrial Buildings, Limited, designing and supervising engineers and contractors of building construction and equipment, Toronto, has issued a small booklet showing the company's method of construction in modern industrial buildings.

The Cement-Gun, the Apparatus, Process and Product.—A well illustrated 106-pp. booklet, being a compilation of the record of the development of the cement-gun since its inception as a commercial enterprise three years ago. Edited by Arthur E. Lee, and published by the Cement-Gun Co., Inc., New York, N.Y.

The "Badger" Catalog, No. 13.—A 32-page booklet issued by the Canadian Allis-Chalmers, Limited, and descriptive of badger engines for gas, gasoline, or kerosene, built by the Christensen Engineering Co., Milwaukee, Wis., and dealing with those which are specially adapted for the operation of grain elevators and grist mills.

Drinking Water Systems.—A 45-pp. booklet, illustrated, to show the value of Nonpareil Cork Covering for drinking water systems in mills, factories, hotels, office buildings, hospitals, public buildings, etc. Issued by the Armstrong Cork and Insulation Co., Pittsburgh, Pa., for which firm the Kent Co., Limited, 705 Lumsden Bldg., Toronto, are the Canadian distributers.

Ice-Handling Equipment.—A 64-page booklet, fully illustrated, and containing general information for purchasers of ice elevators, conveyors, lowering machines, ice tools, and icing station equipment, manufactured by the Gifford-Wood Co., with New England headquarters at Nos. 51-52 North Market St., Boston, Mass., and western headquarters at No. 103 North Jefferson St., Chicago, Ill.

Power, Its Economical Distribution.—A well finished and well illustrated booklet issued by the British Aluminium Co., Limited, 109 Queen Victoria St., E.C., London, England, being No. 108 publication on aluminium insulated cables. The object is to show the economy of the product, the easy solution of working and jointing problems in the use of the metal, and the low scrap value of these cables.

General Catalogue of the Dominion Equipment & Supply Co., Limited, Winnipeg.—A 414-page book, illustrated and indexed, describing in a brief and comprehensive manner the various lines of machinery, equipment, and general supplies manufactured and handled for the use of steam and electric railroad contractors, general contractors, bridge builders and structural steel erectors, coal mines, stone quarries, blacksmiths, factories, mills, municipalities, electric light plants, waterworks plants, etc., etc. The descriptions are carefully prepared and cover the essential points in representing the goods clearly and concisely. The lists and tables are the latest up to the time of going to press. The catalogue is issued for the year 1914.

BREAKING UP PAVEMENT BETWEEN CAR TRACKS.

An unusual and efficient method of breaking up old block pavement between the rails of a street railway track in preparation for replacing the track has been devised and is being used in Cleveland. To a car with a heavy steel framework and wooden sides about 2 feet high is attached a plow consisting of a heavy steel casting of suitable shape for lifting the paving blocks, and at the same time cutting the tie rods which hold the two rails of the track together. A counterweight is placed in the car to hold the plow in the desired position when the car is pulled along. The plow car with its counterweight weighs about 11 tons.

The plow is pulled by a service motor car equipped with four Westinghouse motors. This car is of steel, of the hopper type, behind the motorman's cab and the motor mechanism, and is loaded with blocks, then weighing about 50 tons. Three men and the crew of the motor car are all that are necessary to operate the plow.

With this apparatus it has been found that 1,300 square feet of pavement can be removed in one minute. On one occasion the pavement in a stretch of track 2,600 feet long was removed in 35 minutes. The only difficulties experienced have been breakages of the cable, which have not occurred often. The plow is used only one or twice a week, since an hour's work with it gives enough track to work on for about ten days. The plow has been in use for several months. It is described in a recent number of the Electric Railway Journal by its designer, Charles H. Clark, engineer of maintenance of way for the Cleveland electric railways.

On August 16 the Canal zone celebrated the opening of the Panama Canal. The official celebration of international significance has been set for next spring. The steamship Ancon, owned by the United States War Department, and leased to the Panama Railroad for service in the New York-Colon trade, was chosen as the first big boat to be put through, signalizing the opening of the canal to all ships up to 10,000 tons register.

Coast to Coast

Toronto, Ont.—A passenger train service was opened by the C.N.R. between Toronto and Ottawa on August 18.

Montreal, Que.—The repairs to the water supply conduit were completed last week, and the city is being served again with its regular water supply.

Grand Falls, N.B.—On August 13th, the new bridge which has been constructed just below the Grand Falls and has just been completed, was formally opened for traffic.

Moose Jaw, Sask.—The new armory which has been erected at Moose Jaw at a cost of $110,000 has been formally taken over by the department of militia of the Dominion Government.

Ottawa, Ont.—A recent communication from Ottawa says that in that city there will be constructed this year about $600,000 worth of pavements, which is twice the amount that was undertaken last year.

Toronto, Ont.—It is anticipated that a definite compromise will be reached very shortly between the civic and provincial hydro-electric commissions relative to the much discussed question of hydro-electric power rates.

Sarnia, Ont.—Under the supervision of Town Engineer McLean, of Sarnia, a new concrete bridge for foot passengers has been completed across the canal in Bayview Park. The structure is of a very permanent as well as artistic design.

Montreal, Que.—The question of proceeding with public works being undertaken by the federal and provincial governments and by the municipal administration of Montreal, is being studied very carefully by the various labor organizations and associations of the city.

Winnipeg, Man.—The city council of Winnipeg has passed a report and supplementary report of the board of control containing accounts to the number of 455, totalling $158,007.98. Also accounts of the hydro-electric department were passed, numbering 59 and totalling $24,971.91.

Hamilton, Ont.—Steel contracts have been awarded and satisfactory bulk tenders have been secured for the erection of the Royal Connaught hotel in the city of Hamilton. The cost is now placed at about $1,000,000, or about $100,000 more than the early estimates. The commencement of the erection of the building will soon be in progress.

Brantford, Ont.—The raising of Lorne Bridge at Brantford by Mr. Reuben Rogers, contractor of Guelph, is proceeding at the rate of two feet per day; and the work is expected to be finished within the next 10 days. The new White Bridge, which has been constructed on the Hamilton road in the township, has been completed and publicly opened for traffic.

Valcartier, Que.—Mr. William Perry, hydraulic engineer of Montreal, is engaged upon the installation of the pumping plant for supplying the military camp at Valcartier, consisting of duplicate electric-driven pumps, having a capacity of 80,000 gallons per hour under a pressure of 80 pounds per square inch. Pipes are being laid over the ground for a general water supply.

Trenton, N.S.—A water system is in process of construction at Trenton, N.S., at a total cost of about $20,000. A reservoir has been almost completed about 250 feet above the business part of the town; and at present, a deep well Deane pump with 20 h.p. motor is being installed beside the reservoir by the Messrs. Doane Engineering Co., of Halifax. This same firm has just secured the contract for extensions to water pipe in the town.

Victoria, B.C.—Mr. J. F. Whitson, Commissioner of Roads for Northern Ontario, has finished his program of work for this year, which has entailed an expenditure of $850,000 out of the $5,000,000 appropriation voted two sessions ago by the provincial government. The remainder of the $1,000,000 which was to be expended this season is still proceeding under contract and is chiefly clearing.

Edmonton, Alta.—Representatives of the Edmonton Industrial Association have waited on the city commissioners regarding the contract between the city and the association relative to the gas well at Viking. The association is advocating that the city take over the drilling operations, pay the amount called for under the contract between the association and the drilling company and reimburse the citizens who have been financing the scheme.

Victoria, B.C.—Difficulty in establishing a satisfactory foundation for the Hudson's Bay Company's new block at Victoria is being experienced. The architects have insisted that, before the superstructure is started, a footing must be made entirely on solid rock. Up to date, bed-rock on the north-east corner of the site had not been obtained; though, in one case, excavation had been carried to a depth of 60 feet, and nothing beyond blue clay reached. The work is in the hands of the B.C. Construction and Engineering Company, general contractors for the building.

Point St. Charles, Que.—Work has been progressing very rapidly at Point St. Charles upon the excavation of a cave-in which occurred recently to the sewer in Mill Street. Four emergency pumps, each with a capacity of 2,000 gallons per minute, had to be erected to remove the stagnant sewage from the streets affected by the damaged sewer; and a steam shovel was also employed to hasten the repair work necessary. The result of the break has been to draw attention to the necessity for widening the Wellington Street subway, which was made entirely impassable by the overflowing sewage.

Victoria, B.C.—The province of British Columbia is to benefit by the construction of a fair share of public buildings, should the Dominion Public Works Department proceed with the awarding of contracts for those for which tenders have already been called and received. The projects in view comprise post offices for Merritt, Courtenay, Ashcroft, and Prince Rupert; a detention house and examination warehouse at Union Bay; and a third-class immigration shed at Prince Rupert. In the event of there being no alteration in the original programme, it is expected that this work will be inaugurated without loss of time.

Quebec, Que.—From across the ocean, built by Cammell and Laird at their Birkenhead works, has come the "Leonard," a costly car ferry and ice-breaker for the N.T.R. Company. It is to be used to connect the Quebec and Levis ends of the line until the Quebec bridge is completed. The naval architecture of the ferry is interesting. Her tidal and promenade decks are built a considerable distance above her main deck. Her speed is about 15 knots an hour, and she has four funnels. Her tidal deck has three lines of tracks, each 270 feet in length. She is propelled by two sets of triple expansion engines, and she has a length of 326 feet, a beam of 65 feet and a draft of about 15 feet.

Winnipeg, Man.—The board of Greater Winnipeg Water District passed recently estimates amounting to $190,815. Included in these were $61,000 to the Algoma Steel Corporation for steel rails; $45,000 to the Northern Construction Co., and $48,000 for ties to O'Brien and McDougall. The board also received reports on constructive work and supplies, showing as the most important progress which has been made: the completion of clearing the right-of-way, involving 2,583 acres; the completion of more than one-third of the work in connection with the Falcon River diversion dyke; and the completion of boring operations for water at Deacon, which has resulted in the obtaining of a supply of 40,000 gallons per day.

Wallaceburg, Ont.—A progress report on the work being done by the Thrasher Company of Toledo states that all the work at the pumping station for the new waterworks system has been completed, and the construction of the station has been commenced. While dredging for the pipe line to be laid across South Wallaceburg, about 25 spiles and many old trees had to be dug out of the sewer bank, and divers had to be employed frequently. The work in the town is somewhat behind due to trouble being experienced by the contractors on account of sand cave-ins. On Wellington Street, where the pipe has to be laid at a depth of 20 feet to pass under the river, the entire sewer is being planked to the full depth. The lack of pipe also is delaying outside construction.

PERSONAL.

CHAS. J. GIBSON, formerly of Haileybury, has been appointed by the town council of Bowmanville to the office of Town Engineer.

H. C. COX, president of the Canada Life Assurance Company, has been elected a director of the Canadian General Electric Company in succession to his brother, E. W. Cox, recently deceased.

R. W. McCONNELL, a member of the staff of the Geological Survey, Dominion Government, Ottawa, has been appointed Acting Deputy Minister of Mines, following the resignation of R. W. Brock, as Deputy Minister of Mines.

DR. C. W. DRYSDALE, of the Geological Survey of Canada, who has engaged at the government's camp at Rossland, B.C., has completed his work there and is now at Ymir, in Nelson mining division of West Kootenay, B.C., making a study of the ore deposits at that camp.

ROBERT ROSE, of 295 Jarvis Street, Toronto, and also of Victoria, B.C., an engineer who has gained much knowledge of the Orient and its languages, as well as much experience among British and Canadian manufacturers of power machinery, is perfecting arrangements with several large engineering firms in Eastern Canada to represent them in Shanghai, China. It is understood that in that country there is an ever-increasing demand for transport and power machinery, and Mr. Rose, with his qualifications, will doubtless be successful in the undertaking of opening this new export business.

JOS. BILLINGHAM has been appointed to the position of Superintendent of Motive Power for the Grand Trunk Pacific Railway Company, and succeeds G. W. Robb, who resigned recently from the office. Mr. Billingham is a native of England, and his first position of importance was with the London and Northwestern Railway. Subsequent to his connection with this railway company, he has been master mechanic for the Burlington and Ohio Railroad, European manager for the Galena Signal Oil Company, and, directly previous to his new office, superintendent of works for the American Locomotive Company at Schenectady, N.Y. Mr. Billingham's new headquarters will be at Transcona, Man.

JOHN S. BATES has been appointed to succeed A. G. McINTYRE, resigned, as superintendent of the Dominion Forest Products Laboratories in connection with the McGill University. Mr. McIntyre is now in charge of a new paper mill at Bathurst, N.B. Mr. Bates was born at Woodstock, Ont., and is a graduate of Acadia University in arts and science. After leaving Acadia, he went to Columbia University, New York, and graduated in chemical engineering, specializing in pulp and paper. He made a study of the utilization of Southern pine waste while at Columbia, and since the conclusion of a brilliant course there has had practical experience with the Union Bag and Paper Co., of New York, and Arthur D. L. Little, Inc., chemists, of Boston. Mr. Bates has already entered upon his new duties.

THOMAS TURNBULL has received the appointment of assistant chief engineer for the Canadian Northern Railway Company, with offices at Winnipeg, Man. Mr. Turnbull began his engineering experience in 1881 as transitman on location for the Canadian Pacific Railway, and later became resident engineer on construction on that road. In 1889-91 he was employed by the Newfoundland government as engineer in charge of a location party and construction work on the Halls Bay Railway. From 1891 to 1897 he was assistant engineer of maintenance and construction on the Western Division of the Canadian Pacific. For three years following he was chief engineer of the Canadian Northern Railway lines west of Winnipeg. In 1900 he was engaged in contract bridge work on the Canadian Pacific, and during the following year on reconnaissance work for the Dominion Government. From 1902 to 1904 Mr. Turnbull was again in the employ of the Dominion Government as inspector of surveys. From 1904 to 1910 he occupied the position which he now holds, that of assistant chief engineer for the Canadian Northern Railway. In 1910 he went to the Hudson Bay Railway as assistant chief engineer, and remained in that position until 1912, since when he has been chief engineer of the Edmonton-Dunvegan Railway.

REGINALD W. BROCK has resigned the office of Director of the Geological Survey and Deputy Minister of Mines, and has accepted an appointment as head of the Applied Science Department of the new University of British Columbia. Mr. Brock was a student of the University of Toronto from 1891-92. During the summers of these years, Mr. Brock acted as field assistant to the Geological Survey. On the organization of the School of Mining in Kingston, he enrolled as a student in Queen's University, graduating in 1895. The summer of 1895 was spent at the University of Heidelberg; and the subsequent autumn, Mr. Brock was given temporary charge of the Department of Mineralogy at Queen's University, from which he resigned to become a permanent member of the staff of the Geological Survey of Canada, chiefly in British Columbia. After five years in the office of this department, another year was devoted to study again at the University of Heidelberg; following which, Mr. Brock became Professor of Geology in the School of Mining at Queen's University. Since that time, also, he has maintained his connection with the Geological Survey branch, spending the field seasons in British Columbia, where his most recent work has been the detailed examination of the Rossland mineral area, and his valuable report on several mines of that district made about three years ago at the requests of the different companies.

OBITUARY.

The death occurred recently of William R. Sinclair, railroad and general contractor, at his home, 1412 Portage Avenue, Winnipeg. The deceased was 67 years of age, was a native of Scotland, and has been a resident in Manitoba for 50 years. Mr. Sinclair was one of the promoters of the South Eastern, now a part of the Canadian Northern Railway, being one of the first contractors engaged on that work.

BERTRAND G. DYE met death by drowning on August 23rd at Balmy Beach, Toronto. Mr. Dye was an engineer, occupying the office of superintendent with the firm of Tate Electrics, Limited, and previously was connected with the work upon the Toronto filtration plant. The deceased was a native of South Norwood, Surrey, Eng., and a graduate of King's College, London.

SECOND INTERNATIONAL WATER-POWER CONGRESS.

The second International Water-Power Congress will be held during September 7 to 10 at Lyons, France, under the auspices of the Ministers of Public Roads and Agriculture. After the convention trips will be conducted to important hydro-electric developments in the Alps. There will be three sections, one on legislation, another on finance and a third on technical questions. The first section has seven questions to deal with—(1) summary of water power legislation in Austria, Canada, England, Germany, Italy, Norway, Russia, Spain, Sweden, Switzerland and the United States, (2) water rights on unnavigable streams where no logging is prevailing, (3) laws for water-power plants using water on public domain, (4) laws for water-power plants using water in unnavigable streams, (5) international rules for the utilization of rivers belonging to two countries, (6) export and import of electrical energy, and (7) laws for regulation of rivers and utilization of water powers in government forest districts. The second section will discuss the following topics: (1) Economical results connected with the management of the River Rhone, (2) reservoirs for river regulation, (3) levees and their influence on industries using the energy of water, (4) the influence of the government on the economical development of water power, (5) capitalization of water powers developed by private interests and those developed by governments or municipalities, (6) local profits due to utilization of power, (7) undertakings for regulating river discharges, (8) water power and the metallurgical industries, (9) water power and the electrification of railroads, and (10) water power and agriculture. The section for technical questions will deal with—(1) hydro-electric plants bypassing rivers, their dams and other structures, (2) protection of rivers, (3) measurement of discharges, (4) surge tanks, (5) hydro-electric laboratories, (6) metal pressure conduits, (7) pressure conduits of reinforced concrete, (8) turbines, (9) backwater from dams, and (10) transmission of energy.

AMERICAN HIGHWAY ASSOCIATION CONGRESS.

Governor Slaton, of Georgia, has requested the Governors of all the other states to act favorably upon the invitation of Austin B. Fletcher, president of the Fourth American Road Congress, to name official delegates to the Congress, to be held at Atlanta, Ga., November 9 to 13, 1914. Already forty-seven organizations have signed the official call. The parent organizations are the American Highway Association and the American Automobile Association. Co-operating prominently through the holding of special sessions, the American Bar Association, the American Bankers' Association, and the National Civil Service Reform League will cast the weight of their prestige in behalf of the Congress. Hundreds of county boards will be represented by their chairmen or county engineers to profit by the discussions of the most eminent road builders of America; to study the eminently instructive government exhibit, which includes designs of every known type of road; and to compare critically the machinery, materials and engineering instrument exhibits from hundreds of manufacturers. So closely are city, street and county road problems now related that an exceptionally large number of cities will this year delegate their street superintendents and city engineers, or their mayors, to the Congress.

Logan Waller Page, Director of the United States Office of Public Roads, will preside at one or more sessions of the Congress. Austin B. Fletcher, State Highway Engineer, of California, will open the sessions as President, and will be assisted by the Vice-Presidents, E. M. Bigelow, State Highway Commissioner of Pennsylvania; A. N. Johnson, formerly State Engineer of Illinois; W. E. Atkinson, State Highway Engineer of Louisiana; and Charles A. Magrath, Chairman, Ontario, Canada Highway Commission.

An elaborate series of social entertainments has been planned by Atlanta, which will include receptions, banquets, and excursions. At least six thousand delegates are expected, or two thousand more than attended the 1913 meeting in Detroit. And co-operation of a most thorough character is assumed by the railroads, as they have already granted a round trip lower than has been granted for years to national meetings.

SIXTEENTH ONTARIO MUNICIPAL ASSOCIATION MEETING.

On September 2nd and 3rd will be held in the City Hall, Toronto, meetings of the Ontario Municipal Association, at which will be discussed the following questions, introduced by the following officials of various municipalities: "A Government Minister and Department of Municipal Affairs," Mr. S. H. Kent, City Clerk, Hamilton; "Municipal Accounts and Audits," Mr. A. K. Bunnell, City Treasurer, Brantford; "Settlement of Administration of Justice Accounts," Mr. N. Vermilyea, Reeve of Thurlow; "The Relation of a University Education to the Performance of Municipal Duties," Prof. James Mavor, Toronto University; "The Cost of Roads," Mr. W. A. McLean, Chief Engineer, Government Highways Department; "County Municipal Associations," Mr. K. W. McKay, County Clerk, Elgin; "Purification and Protection of Water Supplies," Dr. J. W. McCullough, Secretary of Provincial Board of Health; "Railway Taxation for Municipal Purposes," Mr. W. Johnson, City Solicitor, Toronto.

An address of welcome will be delivered by Mayor H. C. Hocken, of Toronto, and an address upon the present position of municipal affairs will be delivered by the President, Mr. J. G. Richter, of London.

Copies of the programme of this, the sixteenth annual meeting of the association may be had from F. S. Spence, City Hall, Toronto.

COMING MEETINGS.

NATIONAL PAVING BRICK MANUFACTURERS' ASSOCIATION.—Secretary, Will P. Blair, 832 B. of L.E. Building, Cleveland, Ohio. Eleventh annual convention and paving conference, Buffalo, N.Y., September 9th, 10th, 11th, 1914.

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

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

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

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