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TERMINAL PASSENGER STATIONS; THEIR DESIGN AND OPERATION.

By J. L. BUSFIELD, B.Sc., A.C.G.I.

(Continued from last issue.)

Another interesting feature which is quite prevalent in British railway terminals is the cab and carriage driveway between the two inbound platforms. This enables passengers to step right from the train to the cabs and carriages without any delay. The platform may also be reached by means of stairways from a footbridge in the middle of the station. The baggage is handled from the baggage room to the train platforms by means of subways and elevators.

The American Railway Engineering Association have designed a typical track layout suitable for a dead-end station of medium size. This layout is illustrated in Fig. 5, and it is of interest to look into the general requirements and conditions met with in a terminal of this type.

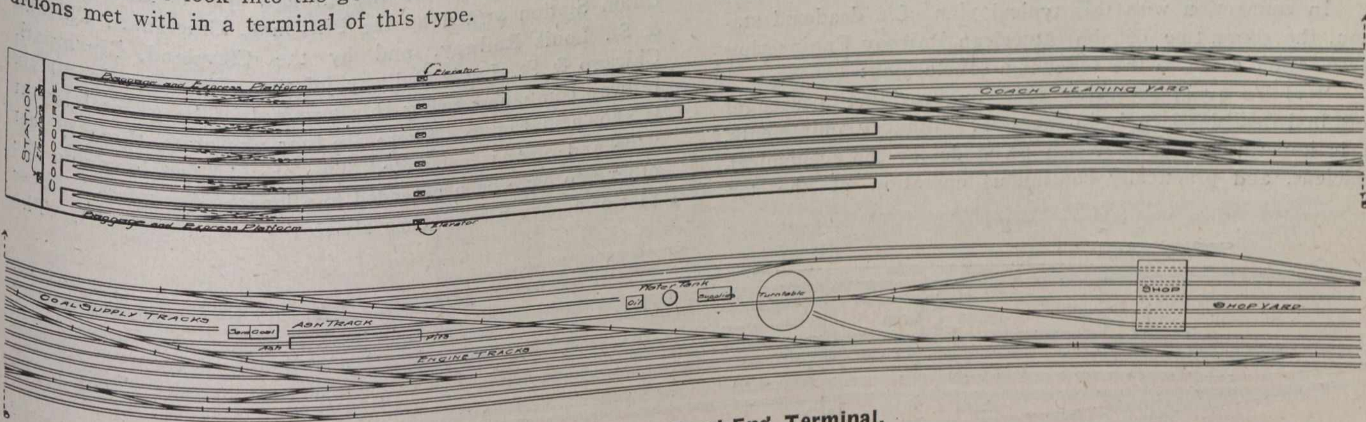


Fig. 5.—Typical Dead-End Terminal.

In order to secure the maximum efficiency of tracks and facilities and the minimum installation expense, the terminal facilities must be designed so as to provide such an arrangement of tracks and platforms that will permit the greatest freedom of movement with the least interference, so that incoming and outgoing trains may be handled without delay.

In most terminal stations facilities have to be provided for hauling the majority of the trains out of the station proper and placing them in a special cleaning yard, and frequently after they have been cleaned they have to be placed in a storage yard, previous to their being placed in the train shed ready for the outgoing journey.

It is sometimes necessary to arrange for trains at a terminal to arrive and depart in rapid succession, and it is in this case that great care must be taken in designing the track layout so that there will be the minimum of interference between the inbound and outbound movements. If the track layout is properly designed it will be possible in many cases to permit trains to enter the station at the same time as other trains are leaving and to fill vacant tracks with the least delay. This will insure maximum efficiency and a minimum of installation cost.

The number of trains that can be handled at a platform or, in other words, the track capacity, depends largely on the rapidity with which the baggage and express can be handled while the train is at the platform, so that in order to have the maximum number of trains operated on the minimum number of tracks the baggage and express handling facilities must be the best possible, and arranged to give the minimum amount of interference to the movement of passengers. This feature is best obtained by handling all the baggage and express either below or above the train floor and transferring it to the platforms by elevators. This method eliminates the annoyance and discomfort to passengers which results from trucks on long and busy platforms.

The time required to handle a train in the terminal, i.e., to load and unload passengers, baggage and express, depends largely on the nature of the train, as it takes longer to put the baggage and express on to a main line train than it takes the passengers to embark, while in the case of a local train the conditions are exactly reversed, but is has been found that the number of trains that can be conveniently handled per hour per track varies from two for main line trains up to a maximum of eight for locals, with an average of 4.1 trains per hour. These averages were obtained from a number of large terminals, but they are naturally liable to large variations, depending on the nature of the traffic.

If facilities are provided for the continuous and rapid handling of baggage and express without interfering with passengers it is believed that a terminal can be operated with such efficiency as to give an average of 6.5 trains per hour. In order to obtain this high efficiency, the track layout and all facilities must be designed with this object of saving time.

In the plan shown in Fig. 5, representing a typical dead-end station, with eight platform tracks, it will be noted that the double-track arrangement is preserved at the entrance to the train shed in such a way as to give practically continuous use of the platforms and tracks. This double-track arrangement is only made possible by the use of slip-switch cross-overs which allow a train to keep to its own right-hand track until it reaches the outer end of the platform to which it is assigned. Similarly a train can arrive at outermost platform at the same time and without interference from an outgoing train from any of the other platforms. With the old layout of a single ladder, the incoming train would have to wait at the throat of the yard until the outgoing train had passed on to its own main line track.

In connection with this typical plan of a dead-end station, the committee of the American Railway Engineering Association came to the following conclusions:

"(1) To avoid excessive cost in providing passenger terminal facilities largely in excess of ordinary requirements, it is imperative that provision be made for the economical, efficient, and practically continuous operation of the terminal during the periods of greatest activity, which may reasonably be expected within a period of, say, twenty years. To this end the track layout may be designed to permit incoming and outgoing movements to be made at the same time without interference as far as possible to arrange this."

"(2) At passenger terminals where large quantities of baggage and express must be handled, and it does not appear expedient to use intermediate platforms exclusively for this service, it is recommended that (where conditions permit) baggage and express be received, delivered and handled below the train floor and raised and lowered by elevators, conveniently located, to avoid interference with the movement of passengers."

The plan in Fig. 5 shows, in addition to the train shed trackage and platform arrangements, typical recommended arrangements for the coach yards for storage and cleaning, etc. These are only incidental to the general scheme, as in most cases the layout and location depend entirely on local conditions.

The design and layout of a terminal passenger station of the through type is a very different subject to that of a dead-end terminal. The through terminal can be more economically and efficiently built and operated than a dead-end terminal, as the number of platforms required to handle a certain volume of business is less in a through terminal, because trains can be handled in and out very much more rapidly. There are practically two types of through terminals proper, namely, those with the station building to one side of the tracks, and those with the building built over, or above the level of the tracks.

A large terminal of the through type is the Columbus Union Station owned by the Pittsburg, Cincinnati, Chicago & St. Louis Railway, and by the Cleveland, Cincinnati, Chicago & St. Louis Railway jointly. There are in all six railway companies using this terminal. The general layout is shown in Fig. 6. There are four platforms, three 17 feet wide and one 11 feet wide. Two are 678 feet long and the other two have been extended to a length of 774 feet. These platforms are all 8 inches above the top of the rails. The tracks in pairs are spaced at 11 feet centres and the edge of the platform is placed 5 feet ¾ inch from the centre of the track. The tracks are all below the street level.

The front entrance and general waiting room are all on the street level. The passengers reach the platforms from the general waiting room by means of an overhead bridge extending across all the tracks, from which stairways lead down to the platforms. There are also stairways from the platforms down to a subway below the tracks which connects with the basement of the station. This subway is only used for rush business. The baggage and express rooms are on

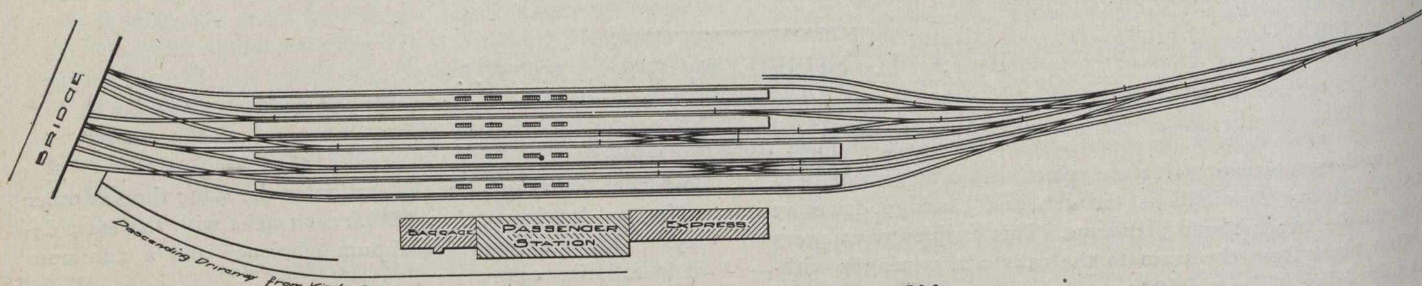


Fig. 6.—Union Station, Columbus, Ohio.

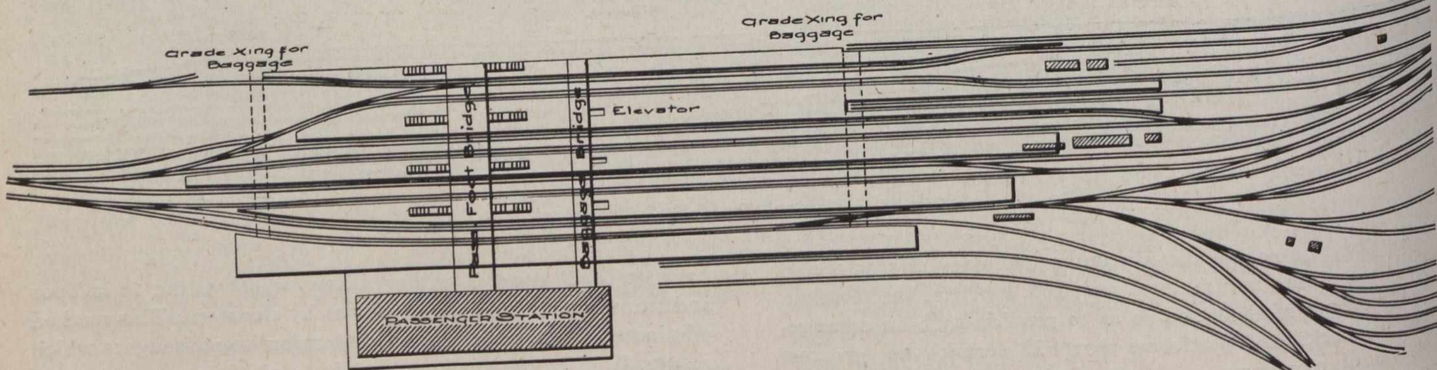


Fig. 7.—Harrisburg, Pa., Pennsylvania Railroad.

the basement floor, the baggage between the waiting room floor and the basement being handled by means of elevators.

There are 51 through trains, 34 originating and 35 terminating trains handled at this station per diem. The trains terminating are broken up with yard engines and each tenant company has its own engines which take its train to its own separate sorting and storage yard.

Another large through terminal is that of the Pennsylvania Railroad at Harrisburg, Pa. (Fig. 7). At this station there are 52 through trains, 47 originating and 45 terminating per day, and practically all of these are through main line trains, as there is very little suburban business. This station is a terminal of four divisions of the Pennsylvania Railroad and of the Cumberland Valley Railroad, the latter having independent stub tracks. Engines are changed on all through trains here; cars are frequently added to or taken from the trains. The switches are all operated by means of an interlocking plant.

There are four pairs of tracks placed at 12 feet 2½ inches centres, with platforms between each pair. Two of these platforms are 22 feet wide, and the remaining ones are 15.8 feet, 33.9 feet and 37 feet in width, with lengths of 765 feet to 850 feet. The platforms are reached by means of stairways and an overhead bridge at the waiting room level.

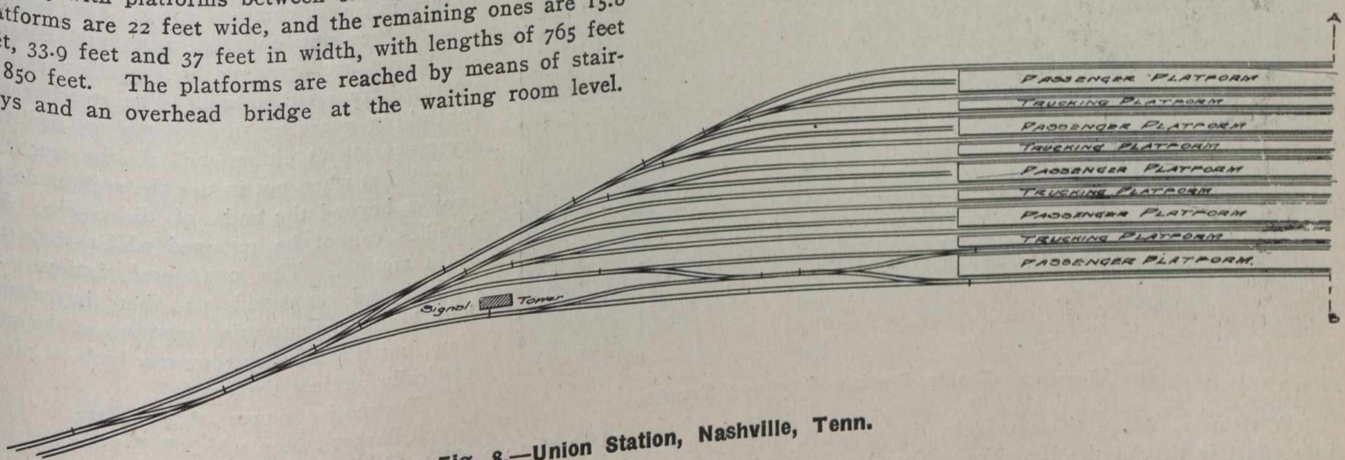
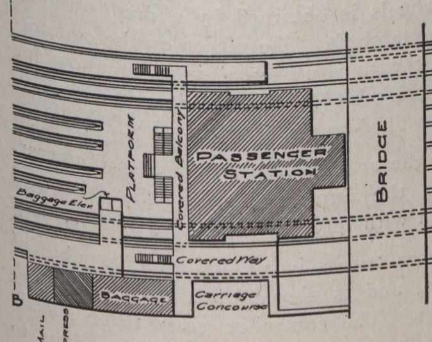


Fig. 8.—Union Station, Nashville, Tenn.



Another overhead bridge is provided for the baggage and express service, the trucks being lowered to the platforms by means of elevators.

The engine house at this terminal is about ¾ mile away from the station and the car storage yard is about 650 feet west of the station yard. The cars are handled between the engines and the storage yard by switching engine.

Another type of terminal commonly met with is the combined through and dead-end terminal, having a number of stub tracks and also a number of through tracks. A typical example of this kind is illustrated in Fig. 8, showing the layout of the Union Station at Nashville, Tenn., owned by the Louisville and Nashville Terminal Company and leased to the Louisville and Nashville Railway and the Nashville, Chattanooga & St. Louis Railway jointly.

There are 10 through and 26 originating and 26 terminating main line trains daily and no suburban trains. A certain amount of switching and making-up of the through trains is done, putting on and taking off Pullmans, etc.

There are six through tracks and four stub tracks in this terminal, spaced alternately 20 feet and 28 feet between centres, except where the train shed columns are situated on the platforms, where the spacing is 34 feet. The platforms are divided into passenger and trucking platforms, the former being 20 feet wide and the latter only 11 feet. They vary in length from 550 feet to 750 feet and are 9½ inches above the rails.

The engine house is over ½ mile away from the station and the car storage yards are over ¼ mile away. All the trains are handled and made up in the terminal and yards by switch engines.

The station building itself is placed at the end of the stub tracks and the through tracks pass to either side of the station, except one which passes through the lower part of the building.

The waiting rooms and general accommodation in the station is on the street level, above the tracks, and the passengers reach the platform from a balcony with stairways to the platforms and to a concourse at the end of the stub tracks.

These terminals described above will give a general idea of standard practices with regard to the different kind of passenger terminals, but at some of the more recent and larger terminals, such as the New York Central's Grand Central Station in New York, certain improvements have been introduced.

There are a number of problems, however, which the designer has to solve apart from difficulties due to the local conditions. For instance, he has to decide on the relative merits of handling baggage through subways and elevating to the platforms, or handling the trucks on special trucking platforms (as at the Nashville Union Station) reserved solely for this purpose, or as is more commonly done in the older terminals, to have the regular platforms wide enough to enable the baggage to be handled in the same platform as the passengers without causing inconvenience and delay either to the passengers or to the baggagemen.

The track layout at a terminal has been given much more serious consideration in recent years than formerly, with the result that the double ladder has been developed.

in order to bring the double track to each platform, so as to give great flexibility of movement and almost unlimited capacity for handling suburban traffic with electric trains.

Another phase of station design which is being brought into general use now is the elimination of stairways, and the substitution of inclined ramps between the different levels of the station, waiting rooms, platforms, subways, etc. In many cases, on account of limited space, the use of ramps becomes impossible, but where they have been put into service they have proved very satisfactory.

At the Grand Central Terminal, New York, while the alterations were being made experimental ramps at different grades were built in order to find out what grade the public preferred to take; it was found that the ramp with a grade of 8 per cent. was most popular. However, it is not always possible to use such a flat grade as this, but it should not be steeper than 10 per cent.

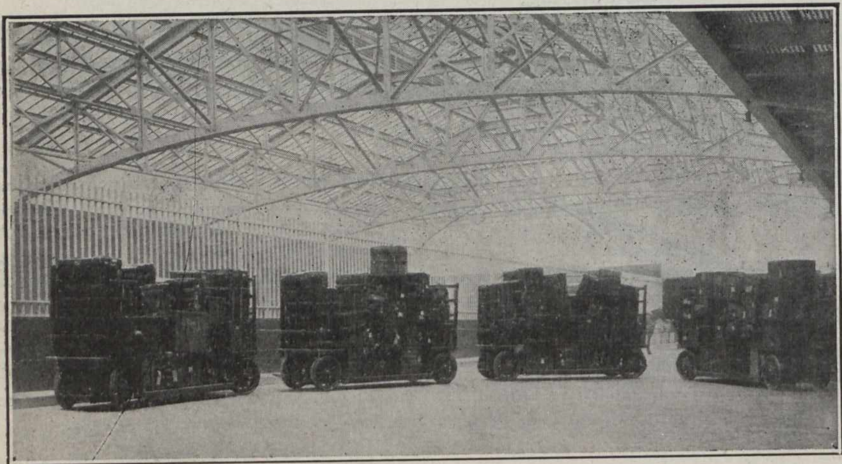


Fig. 10.—Drop Frame Electric Baggage Trucks.

A terminal where these modern ideas have been put into effect is that of the New York, New Haven & Hartford Railway, at Providence, R.I. The structure is substantial and pleasing to the eye, the driveway and approach is covered in. At the rear of the station building is the train shed with a concourse intervening. There are eight through

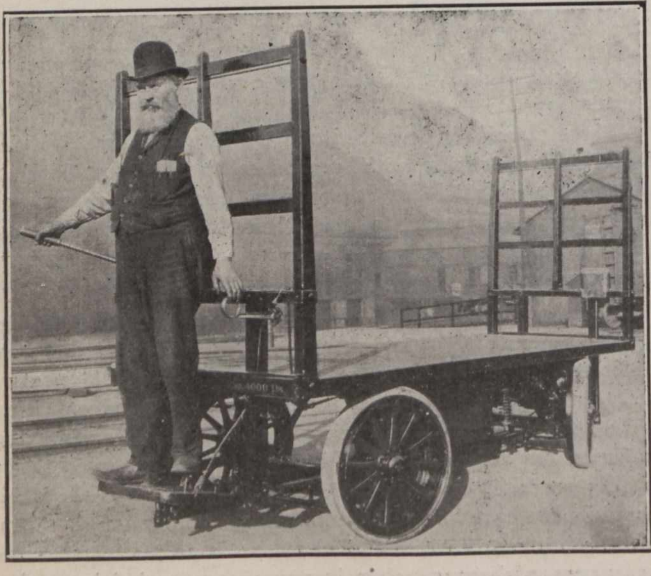


Fig. 9.—Pennsylvania Electric Baggage Truck.

tracks and the intermediate platforms are reached by subways and ramps. Another feature of this station worthy of special mention is the large and commodious toilet room accommodation which, unlike many stations, is provided with plenty of daylight and good ventilation.

The description of passenger terminals would be incomplete without a reference to the use of storage battery electric motor trucks for handling baggage and express. The Pennsylvania Railroad was one of the first to see the possibilities of this type of truck and commenced experimenting with them as early as 1904, but it was not until 1910 that they actually commenced to use them. It was also about this time that the New York Central Line commenced installing them.

Twelve trucks were first put into service by the Pennsylvania Railroad at their Jersey City terminal in 1910. These trucks were 12 feet long and 44 inches wide, with the platform 30 inches above the ground. This truck is illustrated in Fig. 9. The frames were of all steel construction, the ends were of pressed steel. Both pairs of wheels were mounted with knuckled axles and the steering gear so connected that all four wheels were utilized for steering, thus enabling the truck to turn in a very confined space. This feature, though, was not entirely necessary because the trucks are arranged so that they can be operated from either end. The steering and controlling gears are linked up to duplicate lever sockets at either end of the truck, so placed that when not in use the sockets do not project beyond the ends of the trucks. The handles cannot be removed whilst the truck is in motion. The operators' platforms are hinged and connected so that they cannot both be down in running position at the same time, but if necessary they can both be placed vertically against the ends.

The motive power of these trucks is an Elwell Parker motor, which is flexibly suspended so as to oscillate about the counter-shaft. The requisite speed of the driving wheels is obtained by a double reduction gear through a countershaft. The pinion on the countershaft is connected to it with a universal joint to allow for the turning of the driving wheels. This pinion drives on to an annular gear rigidly fixed to the driving wheel.

The wheels are of the artillery type, 27 inches diameter, one pair of wheels has the annular gear for the drive and the other pair are fitted with internal expansion brakes.

The battery on these trucks is of 12 cells, capable of giving 196 amp. hours, and is placed on a tray suspended on compression springs. The controller gives three speeds in both directions, the two running speeds giving four to five miles per hour and five to seven units per hour respectively. The weight of the truck is 2,390 lbs. and it has a capacity of 4,000 lbs.

The Elwell Parker Company, of Chicago, Ill., are now manufacturing two types of these baggage trucks, one is the straight frame type and is practically identical with the one originally built by the Pennsylvania and illustrated in Fig. 9. The other type they are now building is the drop frame type illustrated in Fig. 10. This truck has the centre part of the platform dropped down to within a few inches of the station platform. This truck was designed for especial use in terminals where the platforms are placed at the height of the car floors.

At one large terminal exhaustive tests were made with these trucks comparing them with hand trucks. For mail handling it was found that one electric truck operated by one man would equal the performance of 2½ hand trucks and five men, based on the full capacity of the trucks, viz., two tons for electric and one ton for the hand truck. For baggage handling, two hand trucks were equivalent to one electric. Actual figures with the hand truck as a basis were obtained as follows:—

	Electric Truck. Mail.	Electric Truck. Baggage.	Hand Truck. Mail or Baggage.
Fixed charges, interest, insurance, taxes	15.0	18.75	1
Depreciation: trucks, batteries, tires and switchboard apparatus	18.82	23.53	1
Maintenance: labor and material	4.2	5.25	1
Operation: labor and power	.21	.26	1
Total charges	.33	.42	1
Saving of electric over hand truck	67%	58%	

In Fig. 10 one truck is shown hauling three other loaded trucks.

A very complete installation of 16 electric baggage trucks of the drop frame type has been installed at the North Station, Boston. These trucks are similar in size and general design, control, etc., to those described above, and are used practically entirely for handling express. In these trucks there is rather a novel braking feature. The operators' platform is divided into two halves, the left half operating the brake. Normally the brake is on, and to release it the operator has to press down the left half of the platform. This has the advantage of almost instant stoppage if the operator steps off his platform.

The conditions met with at this terminal are particularly severe. There are 738 trains handled daily, on 23 parallel tracks, with intermediate and side platforms from 7 to 16 feet wide. At the station end of the platforms the trucks have to ascend and descend a 12 per cent. grade, and as there are passenger gates at the lower end this requires very efficient and quick-acting brakes. So far these trucks have been successfully operated without accident. Another saving has been found to be in decreased damage. Packages frequently dropped off the hand trucks, but it has been found that breakages from this cause with the electric trucks are practically nil, owing to the electric drive, rubber tires, flexible frames, etc.

With an equipment of this size it is necessary to have a complete set of operating rules to prevent confusion. In the operation of the trucks all are carefully examined before being placed into service and each truck is numbered with figures three inches high for reference. The trucks are started step by step similarly to a street car. Operators are not allowed to converse with any one while in charge of a truck, and are cautioned to use great care at gateways and passages. When operating on the main platform at the bumper ends of the train tracks the trucks take the middle of the course except that in passing others those operating on the main platform are given the right of way over those approaching from trains. Running backward in the station proper is also prohibited, and no trailers are permitted. Trucks proceeding in the same direction must keep 15 feet apart.

The Canadian Pacific Railway have installed two of these electric baggage trucks at the Windsor Street Station, Montreal, Que., and having found them satisfactory, are ordering a number of others for different points on their system.

EFFICIENCY IN THE PUMPING STATION.

By Seabury G. Pollard.*

The following extracts taken from an article by Seabury G. Pollard, in Municipal Engineering, will doubtless be found of interest to many who are directly or indirectly responsible for the efficient management of pumping stations:—

Efficiency may be defined as the ratio of actual performance to predetermined standard performance. It is the elimination of unnecessary waste.

Let us consider an ordinary every day pumping station, such as those in most of our medium sized cities and in many of our larger ones. The buildings are not always practical. The engine room is fairly well equipped, the bright work and the brass bands shine attractively, the floor is fairly clean, not much escaping steam is apparent, there are no cracked steam cylinders, the flywheel is all there, a few records are kept and the engineer is apparently well satisfied with himself and the world in general. The boiler room is usually unattractive. It may be gloomy, dirty and repulsive. Possibly there is an unsightly junk pile in one corner, a dilapidated work bench in another or some broken engine parts under the window. The sanitary arrangements consist of a greasy wash pail and a grimy cupboard. Such conditions are reflected in the employees. The fireman in a listless manner now and then fills the furnace up with coal. He occasionally cleans the fires and takes out the ashes. Possibly more or less steam is escaping through a blownout joint, the heater may be stopped up, the damper will not work, the coal goes on the fire and "the smoke goes up the chimney" just the same and nobody from the manager down considers for a minute that there exist numerous preventable losses all along the line, which in the aggregate may amount to thousands of dollars annually.

Efficient Labor Required.—To avoid such losses it is necessary in the first place to employ only efficient and intelligent labor. In many municipal plants the executive is spared this trouble. The employees are selected for him, either arbitrarily because of their effectiveness in their respective wards and precincts, or through the medium of a civil service board. The first method is bad because the qualifications of the appointees are seldom taken into account. The second is often little better because the examining board is not acquainted with the character of work to be done and is therefore incompetent to judge of the fitness of the men. It does not eliminate political favoritism, and the best qualified men, having no difficulty in getting employment, pay no attention to the examinations. Pre-eminently the person best equipped to select the operating force is the engineering executive.

Operating Standards.—The next important problem before the waterworks operator is the fixing of operating standards. Duty trials of engines and efficiency tests of boilers are, or should be, made shortly after the installation of this equipment. If for any reason such efficiency trials have not been made, or if the results are not available, a competent engineer may be employed to study the conditions existing in the plant, to make such tests as may be necessary or desirable and to establish efficiency standards and proper methods of handling the plant.

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* Consulting Engineer, Cincinnati, Ohio, Member of Illinois Water Supply Association.

THE SUPPLEMENTARY ESTIMATES FOR THE CURRENT FISCAL YEAR.

Supplementary estimates for the current fiscal year totalling $23,470,316 were tabled in the Commons, Ottawa, on May 20th, by Finance Minister White.

The most important item in the supplementaries is an amount of $4,000,000 to provide for the construction, leasing or purchase of terminal elevators, as foreshadowed during the discussion of the amendments to the grain act in the Commons.

There is an amount of $1,500,000 for improvement to highways, distributed among the Provinces according to population. The same fate may meet this appropriation, however, as met a similar appropriation last year if the Government again fails to accept the Senate amendments to the highways improvement bill.

For harbors and rivers there is a total vote on capital account of $3,300,000, including half a million each for new Government drydocks at Esquimalt and Halifax naval bases; $200,000 additional for Port Arthur and Fort William harbors; $600,000 additional for Victoria, B.C., harbor, and half a million additional for each of the harbors of St. John, Vancouver and Toronto.

For harbors and rivers in Ontario the important items include the following:—

Armitage Landing, wharf, $8,700; Bowmanville, repairs to piers, $12,000; Bracebridge, wharf, extension and warehouse, $9,600; Burlington Channel, renewal of west part of south pier, $20,000; Burlington, revetment wall, $8,000.

Cobourg, repairs to east pier, $5,500; Cobourg, reconstruction of centre pier, $15,000; Fighting Island (Detroit River), improvement of channel, $57,000; Fitzroy Harbor, wharf, $5,500.

Gananoque wharf, $18,000; Goderich, harbor improvements, further amount required, $8,000; Kagawong, wharf, $5,600; Kenora, wharf, $10,000; Kensington, wharf, $6,000; Kincardine, breakwater, $25,000.

Little Castor River, improvements, $10,000; Meaford, extension and repairs to revetment wall, $33,000; Nation River, improvements, $10,000; Newcastle, repairs to eastern pier, $15,800.

Peterboro', drydock, $25,000; Port Dover, harbor improvements, $50,000.

Port Hope, harbor improvements, $30,000; Rainy River, survey and maintenance of gauges, $16,000; Richard's Landing, wharf and warehouse, $15,000; River St. Lawrence, improvements of Canadian channel between Kingston and Brockville, further amount required, $10,000; Sault Ste. Marie, wharf improvements, $34,500; Severn River at Washago, construction of dams and removal of rocks, $10,000.

Toronto, to pay over two accounts to R. Weddell & Company in connection with new entrance channel to harbor, $22,960; Vail's Point, wharf, $8,500; Victoria Harbor, wharf, $16,000; Wellington, wharf and harbor improvements, $20,000; Whitby, harbor improvements, further amount required, $20,000. Under the item of canals there is an amount of $250,000 additional for construction on the Trent Canal. It is understood that this is to begin the work of completing the northern outlet of the canal from Lake Simcoe. A contract amounting to $1,000,000 is to be let at once.

In addition to the expenditures provided for in the main and supplementary estimates it is to be noted that the Government has yet to bring down the railway subsidies, which will run up, it is expected, well into the millions. There is further expected legislation granting the Canadian Northern Railway, by way of subsidy and loan, of an amount something like $25,000,000.

The Intercolonial Railway calls for an additional expenditure of $756,000 on capital account.

The main items for new public buildings include: $100,000 for a new customs house at Halifax, $70,000 for a new post-office at St. John, $350,000 for a customs house examining warehouse at Montreal, $50,000 for a new public building at Brantford, $150,000 for enlargement of Hamilton post-office, $60,000 for a public building at Sudbury, $300,000 for barracks and drill hall at Winnipeg, $200,000 for Vancouver drill hall, and $100,000 for customs house at Edmonton. The expenditure for public buildings in the province of Ontario amounts to $1,277,655.

The expectation that the Government's supplementary programme for expenditures for this year would be on a lavish scale has been justified. The main estimate calls for an expenditure of $179,152,183, which, added to the supplementaries, makes the total authorized expenditure for the current year $202,622,500. This is an increase of $33,000,000 as compared with the estimates passed by the Government last session.

SIMPLE METHOD OF OBTAINING CORRECT MEAN LINE AND AZIMUTH.

By J. A. Macdonald.*

Necessity is the mother of invention, they say. The writer, being located at the present time (May) in Prince Edward Island, and being far from a town or railway station, and not being provided with the necessary paraphernalia to take direct astronomical observations, resorted to a very simple method, which not only gave at the moment correct meantime, but also azimuth, and both probably more accurate than by the usual methods of hour-angle of Polaris with a transit-theodolite. By the method hereunto described no instrument at all is required; no nautical almanac nor mathematical tables nor formula. There is, however, only one moment in the 24 hours when the trick can be done, and if the sky is hazy it may not be done at all. It requires a fairly clear sky, so that Polaris and another star may be seen in precise range.

The constellation in the northern heavens known as the Great Bear, the Plow, the Dipper or Charles' Wren, is doubtless familiar to all. Two of its five bright stars are known as the "pointers" from their pointing to the North Star or Polaris. The middle star in the tail or handle, as shown in the diagram, is the star which comes to the meridian at the same time as the North Star.

Another bright star comes to the meridian when Polaris is in the same vertical plane with the star Delta (δ) in the constellation Cassiopeia. When both stars are on the same vertical range with a plumb line it is very near the meridian.

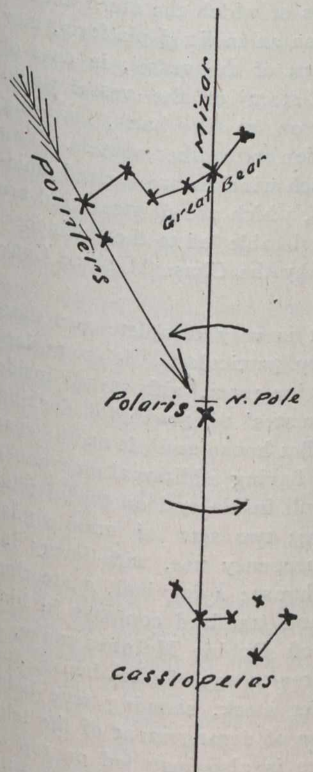
This method is practicable only when the star Delta is below the pole during the night. When it passes the meridian above the pole, it is too near the zenith to be of service, in which case the star Mizar, the last star but one in the tail of the Great Bear, may be used instead.

Delta, Cassiopeia is on the meridian below Polaris and the Pole at midnight on April 10th, and is, therefore, the proper star to use at that date and some two or three months before and after. Six months later the star, Mizer, (Zeta Urs. Maj.) in the tail of the Great Bear, will supply its place, and will be used precisely in the same manner. The method given in this article can not be used with advantage at places below 38° north latitude, neither can it, on account

* Hermanville, P.E.I.

of the haziness of the atmosphere near the horizon, on every night, for it requires a fairly clear atmosphere.

The diagram, drawn to scale, exhibits the principal stars of the constellations of Cassiopeia and Great Bear, with Delta (δ) Cassiopeia, Zeta (ζ) Ursae Majoris (also called Mizar), and Polaris on the meridian, represented by the straight line; Polaris being at lower culmination. This method is given in Lalande's Astronomy and was practised on the Ohio and Pennsylvania boundary with great precision.



Held perpendicular to the line of sight directed to the pole, with the right-band side of the page uppermost, will represent the configuration of the constellations with Polaris near eastern elongation at midnight about July 10; inverted (in natural position) it will show Mizar of the Great Bear and Polaris on the meridian (the former below and the latter above the Pole) at midnight about October 10; and held with the left-hand side uppermost the diagram will indicate relative situations for midnight about January 10, with Polaris near western elongation. Turned upside down it will show Delta Cassiopeia and Polaris in the meridian at midnight about April 10. The arrows indicate the direction of apparent motion, while the large arrow through the "pointers" indicates position of Polaris at any time.

Finding Correct Mean Time.—Table I.—Begin to watch plumb line for "A" to appear vertically below Polaris:

About—		On line
July 20	5 a.m.	5.30 a.m.
August 20	3 a.m.	3.28 a.m.
September 20 ...	1 a.m.	1.26 a.m.
October 20	11 p.m.	11.24 p.m.
November 20 ...	9 p.m.	9.22 p.m.
December 20 ...	7 p.m.	7.24 p.m.

Table II.—Begin to watch plumb line for "B" to appear vertically below Polaris:

About—		On line
January 20	5 a.m.	5.22 a.m.
February 20	3 a.m.	3.20 a.m.
March 20	1 a.m.	1.30 a.m.
April 20	11 p.m.	11.24 p.m.
May 20	9 p.m.	9.26 p.m.
June 20	7 p.m.	7.24 p.m.

When a plumb line matches "A" or "B" the Pole Star is approaching the meridian and the true local mean time then is the time in column "on line." Interpolate for intermediate days, subtracting four minutes for each day after or adding four minutes for each day before any given date.

Example.—July 25, begin to watch plumb line about 4.40 a.m., and Polaris will be exactly on line at 5.10 a.m. correct mean local time. The interval from July 20 to 25, 4 days multiplied by 4 is 20. This sum subtracted from 5.30, time on line July 20, is 5.10. To change this into local standard time add 4 minutes for each degree west of the time meridian and subtract same for stations east of the meridian. Thus at the point where I write, being 2°15′ west of the 60th standard meridian, 9 minutes must be added to the observed time for standard time. At Toronto add 17 minutes; at Ottawa add 3 minutes; at Winnipeg add 29 minutes; at Calgary add 35 minutes; at Vancouver add 15 minutes, and at Montreal subtract 6 minutes from the standard meridian times at those several places.

To Obtain Azimuth.—Azimuth, or the direction of the meridian can also be obtained directly at the same time and in the same manner.

When the Polaris and Mizar are in line with the observer this line is approximately on the meridian, but a little east of the true line. The North Star is exactly in the meridian 7.15 minutes after it has been in the same vertical plane with Mizar, and may be sighted to after that interval of time with perfect accuracy for 1913. The interval between the time when Mizar and Polaris are on the same vertical circle and the time when Polaris is on the vertical circle through the North Pole is increasing 0.33 minute a year, so that, in 1914 the interval will be 7.5 minutes.

The interval between the time when Delta Cassiopeia and Polaris are on the same vertical angle and the time when Polaris is on the vertical circle through the North Pole is 7.69 minutes for 1913 and is increasing 0.33 minute per year, so that in 1914 the interval will be 8.02 minutes.

A light placed back of the head will aid in seeing the plumb lines which may be hung in a convenient window and let the bob hang in a dish of water to prevent the wind from disturbing the line, or the observation may be made with closed window.

In marking out the meridian, use two plumb lines and connect them by a row of tacks, if the work is done indoors, driven in the porch floor in the range of a pillar, post or window casing.

VISIT OF A PRODUCTION ENGINEER.

Mr. Willis Bell Richards, of the firm of Gunn, Richards and Company, New York City, was a visitor at *The Canadian Engineer* office last week. Mr. Richards is well known in Canada as a production engineer, having been of valuable service upon many occasions to various departments of the Dominion government, as well as to many private corporations throughout the country.

The firm recently opened new offices in the Eastern Townships Building, Montreal, with Mr. H. Victor Brayley as manager for Canada. Mr. Brayley was formerly secretary of the Ottawa Branch of the Canadian Society of Civil Engineers, and held a government engineering position. Mr. James Newton Gunn, the president of the company, is one of the best known production engineers in the United States. He has been connected for many years as lecturer with New York University and the Massachusetts Institute of Technology. The firm employs over fifty trained engineers and also a number of expert accountants, who work in co-operation with the engineers in organizing the shops, offices, buying departments, etc., of industries of all types, in making appraisals and in scientifically analyzing production costs and power costs.

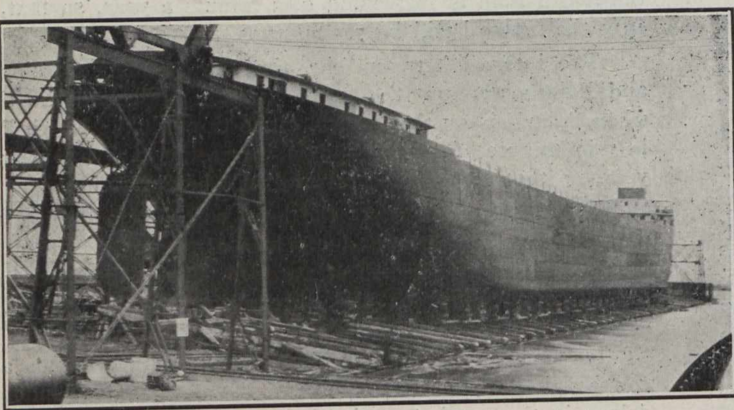
Mr. Richards was called to Canada by one of the leading Canadian capitalists to advise in regard to improving the organization, decreasing the running expenses and increasing the sales of two of the largest manufacturing concerns in the Dominion.

S.S. "JAMES CARRUTHERS."

The launching of the steamship "James Carruthers," which took place a couple of weeks ago at the yards of the Collingwood Shipbuilding Company, marked an epoch in the shipbuilding industry in Canada, in that the vessel is the largest bulk freighter ever built in the British Empire. Some idea of the magnitude of this vessel will be gathered from the photograph accompanying this article, and we are pleased to be able to give to our readers some information regarding the engineering features of this vessel.

The dimensions of the ship are as follows:—Length over all, 550 feet 3 inches; length on keel, 529 feet; beam moulded, 58 feet; depth moulded, 31 feet, with a carrying capacity of over 10,000 gross tons on 19 feet draft.

The arches and web frames are spaced 12 ft. centres, forming transverse girders, with channel bottom and side frames between, spaced 3 feet centres, plate floors in double bottom on alternate frames. The vessel is constructed with a complete double bottom, 5 feet deep and side tanks of same width, to height of main deck stringer, for water ballast, and forming a double skin over this portion of the ship to a point above the deep load line, the capacity of these tanks, including the peak tanks, engine-room tanks and deep tank forward being approximately 4,600 tons.



S.S. "James Carruthers" Just Before Launching.

The auxiliaries for handling and manoeuvring the ship are as follows: Steering gear—a 9-ft. by 9-in. quadrant geared steering engine, built by the American Engineering Company of Philadelphia, placed aft on main deck, direct connected by toothed quadrant to rudder stock and controlled from steering stands in the pilot house and on top of same by a hydraulic tele-motor. In addition to this there is an Aker's emergency steering gear, a complete and independent steam gear, placed also on main deck, on port side, direct connected to a toothed quadrant on rudder stock and controlled from steering stand on top of pilot house by jacks and pipe transmission. Steam is always turned on this gear. If any accident occurs to the regular gear, the Aker's gear may be thrown in, in three seconds, by means of a crank on steering stand controlled by the officer on the bridge which, at the same time, trips the regular gear, and throws it out of service for the time being, this gear being a valuable acquisition, where, in the event of a breakdown of the regular gear, in the rivers, without such a device collision or stranding is almost inevitable. Windlass—This is of the Emerson-Walker, quick-warping direct grip type, arranged to handle two four-ton Britannic stockless Bower anchors and 2¾-inch cables, this being the largest windlass of the type ever installed in a lake vessel. The anchors are arranged to stow in pockets entirely within the hull. The balance of deck machinery consists of four 8-inch by 10-inch single drum mooring winches, fore and aft on spar deck; one 8-inch by 10-inch single drum winch in windlass room, and one 8-inch by 10-inch double drum winch on spar deck aft, arranged to handle 3½-inch circumference wire mooring cables, manilla lines being dispensed with for this purpose. The second drum on the after winch is to take the kedge anchor warp, a 4½-inch circumference wire cable, and by means of which the stern anchor, weighing 4,000 lbs., and placed on an inclined platform, may be instantly let go over the stern of the vessel, in case of accident in the rivers, when the stern of the vessel would otherwise in the current swing on to the bank, involving serious risk of damage by collision with other vessels. Two 5-inch by 5-inch single drum hatch winches are located amidships to handle the hatch covers, which are of steel, and are opened and closed by a small steel cable led to these winches. All deck winches were supplied by the Chase Machine Company, of Cleveland.

The navigating outfit is very complete and thoroughly up-to-date in every particular. It comprises repeating telegraph to engine room, with stands inside pilot house and on top, mates' telegraph for docking purposes with stands in pilot house and aft on the spar deck, all with large dials, having additional emergency signals; engine whistle pull inside and on top of pilot house and on each bridge; two sets of main signal whistle pulls, one for emergency use, with levers inside and on top of pilot house; a fog bell, a steering compass in pilot house and standard compass in binnacle on top of house, of Dobbie McInnes make, a helm tell-tale, with indicator on top of pilot house, and direct connected to rudder stock, showing true helm angle at all times, in case of derangement of the telemotor apparatus. There is also installed on top of pilot house, a McNab engine dejection indicator, with direct connection to main engines, showing, by sight in daylight and by sound at night, every movement of the engines ahead or astern. This instrument is a splendid safeguard against the very costly accidents which occur frequently through a mistake in signals between the bridge and engine room. A Morrison trim gauge forms part of the equipment, and a draft gauge, by which the mates can read the exact draft of the ship in rough weather or at night, from an indicator and scale located on forecastle bulkhead forward and on deckhouse aft. A Thomson sounding machine is installed on the spar deck abaft the forecastle bulkhead, with a crane on the bulkhead to handle the sounding device when overboard.

Awnings are fitted over forecastle deck and pilot house, and the usual weather and dust cloths, etc.

There is a complete electrical installation, consisting of two 10-kw. generators with capacity for about 200 lights, being ample accommodation for hold and decks lights and running lights, arranged on separate circuits, and an electric tell-tale in pilot house to give indication of any arrangement of the running lights.

The propelling machinery consists of triple expansion engines with cylinders 24, 40 and 66 inches by 42-inch stroke, supplied with steam by three Scotch marine boilers 15 feet diameter and 11 feet long, 185 lbs. steam pressure and equipped with Howden system of forced draft, developing 2,400 indicated horse-power and designed to give the vessel a speed of 11 miles per hour, loaded, and 13 miles light.

The engines are located directly on the tank top, as far aft as possible, as usual in these vessels, with the boiler forward of this, located athwartships, three abreast on very heavy saddles and a cross coal bunker forward of fire hold, with capacity for about three hundred tons, and fuel hatch fitted in tank, above spar deck.

The engines are handled from a working platform, below main deck level, of convenient height to suit the levers, with dynamo room abaft this. Great care has been taken in laying out the engine room to ensure ample working space and at the same time studying the comfort of the engineers' crew.

The pumping equipment comprises one centrifugal and two duplex pumps located in the lower engine room to take care of water ballast, sanitary pump and deck pump, one duplex main feed, one duplex auxiliary feed and fire pump on upper engine room floor and air, bilge and cooler pumps direct connected to engine, also hand bilge and fire pumps forward and aft.

A refrigerating machine having capacity of three tons in 24 hours, by Kroeschell Bros., Chicago, is located in the upper engine room, and piped to refrigerator in the deck-house above, this being fitted with cooling coils and also an ice door, opening on spar deck, for use should a supply of natural ice at any time be required.

TRAFFIC THROUGH THE SAULT STE. MARIE CANAL.

The annual statistical report on lake commerce passing through the canals at Sault Ste. Marie, Mich., and Ontario during the season of 1912 has been issued by Lieut.-Col. Mason M. Patrick, of the U.S. Army Corps of Engineers. The total freight traffic through both the American and Canadian canals, of 72,472,676 short tons for the season of 1912, shows an increase of 36 per cent. over the previous year. All items of freight show an increase except coal, salt, copper and building stone. The season of navigation continued for a period of 7 months and 26 days. The traffic through the American canal was 45 per cent. of the total freight and 55 per cent. of the total net registered tonnage, while the traffic through the Canadian canal was 55 per cent. of the total freight and 45 per cent. of the registered tonnage.

Of the total traffic 55,377,687 short tons was eastbound, and 17,094,989 was westbound. The transportation charges, including loading and unloading, on freight passing through both canals were $40,578,225.40.

The total expenditures for operating and repairs on the American canal for the year 1912 are given in the report as follows: Operating, $71,135.66; repairs, $81,061.68; total, $152,197.34. The cost per freight ton was 4.64 mills.

MEDICINE HAT'S STREET RAILWAY.

Medicine Hat ratepayers have sanctioned a by-law giving an exclusive franchise to the Montreal Engineering Company to operate an electric street railway in the city. The franchise is for a period of 25 years. Work is to commence immediately on the construction of the plant.

The Montreal Engineering Company, which has secured the franchise represents Sir Max Aitken and his associates and is the company which built the Porto Rico railways, the Demerara Electric, the Camaguey Company and the Trinidad Electric. It numbers among its directors Messrs. R. O. Sweezey, A. R. Doble, F. P. Jones, Fred C. Clarke and Victor Drury.

PRESERVING FENCE POSTS FROM DECAY.

Wood-rot, in all its forms, is due to the action of fungi working under suitable air and moisture conditions. In fence posts these conditions are most favorable at or near the surface of the ground and hence it is there that decay first starts. Some woods, like the cedar and tamarack, are more resistant to fungus attack and may last, as fence posts, from eight to ten years. Unfortunately, however, the supply of these woods has grown very scarce, and one is faced with the alternative of importing durable material at a high price or of applying preservatives to the common non-durable woods which grow in his own wood lot. As the latter alternative is not only cheaper, but also much more effective, it is of considerable economic interest to know how these wood- preservatives are applied.

Creosote, a "dead" oil of coal tar, is perhaps the best preservative for this purpose, as it does not dissolve out of the treated wood, when in contact with moist earth. It costs from eight to fifteen cents per gallon.

There are two methods of applying the creosote, but before either method can be applied it is necessary to have the posts well seasoned if the best results are desired. This seasoning is best accomplished by peeling the bark from the posts and then stacking them in loose piles in the open air for several months, so the amount of water in the wood may be reduced to the smallest per cent. possible.

The brush method consists in applying the creosote like a coat of paint to the lower portion of the post, up to a point six inches above the ground line, the creosote being first heated to one hundred and eighty degrees Fahrenheit. Two or more coats may be applied, time being allowed between each application for the creosote to soak into the wood.

What is known as the open tank method, while more expensive, secures deeper penetration and gives better results, especially when the posts are split or checked. The creosote is heated to boiling point in a metal tank and if such is not available, a simple and effective apparatus can be made by boring two holes, about two feet apart, in the lower half of one of the staves of a watertight barrel and screwing into these holes two pieces of iron piping three to four feet long which are connected by a shorter vertical pipe with two elbow-joints, thus forming a complete circuit somewhat resembling the handle of a mug.

The barrell is then filled with enough creosote to cover both upper and lower pipe holes and a fire is kindled under the lower horizontal pipe which heats the creosote in the pipes and creates a circulation which continues until all the creosote within the barrel is at boiling point. The posts are then placed in this boiling liquid for about five hours, after which they are immediately transferred to another barrel of creosote, or else the fire is put out and they are allowed to remain in the tank until the creosote becomes thoroughly cooled.

In this process the preliminary heating drives some of the contained air out of each wood-pore, and when the posts are allowed to cool in the creosote, a partial vacuum is then created in each pore which draws the creosote into every fibre. Poplar posts, which ordinarily last but three to four years, after the above treatment will last twenty years, and the same applies to all other tree species in Canada. All that is essential is thorough seasoning before treatment. Further information on this subject can be obtained on application to the Forestry Branch, Ottawa.

RAILROAD TIMBER-TREATING PLANT.

By F. J. Angier.*

The Baltimore and Ohio Railroad has put into operation a new timber-treating plant, which has just been completed at Green Spring, W. Va. The new plant is one of the most complete and modern timber-treating plants in America. It covers sixty acres, and is situated close to large areas of timberland along the South Branch Valley of the Potomac River. The requirements of the Baltimore and Ohio system approximate 2,500,000 ties annually for renewals, and with the new plant in operation a large proportion of these ties will be treated by the company. Other timber for railroad use will also be treated at the plant.

The timber-treating plant is equipped with two treating cylinders, or retorts, as they are commonly called. These retorts are seven feet in diameter and 132 feet long, made of ¾-inch steel, and built for a working pressure of 175 pounds to the square inch. Each of the retorts rests on nine concrete piers, and is securely anchored to a centre pier with six 1¼-inch bolts. On the remaining eight piers the retort rests on cast-steel saddles, and placed between the saddles and an iron plate embedded in the concrete are nests of steel rollers, each nest being made of three rollers two inches in diameter and ten inches long.

At each end of the retort is a door which swings on steel rollers, and can be opened and closed easily by one man, notwithstanding the weight of 6,400 pounds each. The door consists of a steel frame with flanged steel dished head one inch thick. The retorts are equipped with heating coils, and also with perforated pipes. The pipes are used to obtain a more perfect distribution of steam when green timber is being artificially seasoned, as well as for the circulating device used in the card process.

The main building of the plant is of steel frame construction, with corrugated iron sides and concrete roof. The floors of the building are of cement, and a concrete basement so constructed that should any of the preservative be spilled it can be recovered. In the basement is a concrete sump equipped with an electric device which indicates to the engineer in charge that the sump is filled. The sump is emptied by means of an ejector, the liquid passing into a settling tank about 50 feet from the building. The settling tank is also of concrete construction, with dimensions of 20 feet in width, 50 feet in length, and approximately 10 feet in depth. The tank has four compartments, and after the drainings from the plant enter the first compartment the liquid is forced to travel through each of the other compartments in a circuitous path to the last compartment. By this time any creosote carried from the plant falls to the bottom, because of its greater specific gravity, and enters a well in the bottom of the last compartment of the settling tank. Here a bilge pump, operated by electricity, picks it up and carries it to an underground tank, and then by compressed air it is carried into the working tanks.

The boiler-room is situated adjacent to the main building, the dimensions of the room being 30 feet by 40 feet. The boiler-room contains two horizontal return tubular boilers of 150 horse-power each, built for 125 pounds working pressure per square inch. Space is provided in the room for a third boiler to be installed when the requirements of the railroad justify the enlargement of the plant. A boiler-feed heater, injector and feet water pump complete the equipment in the boiler-room.

The oil storage tank is 40 feet in diameter by 30 feet high, having a total capacity of 280,000 gallons. There is also a storage tank for a concentrated solution of zinc-chloride, the dimensions of which are 15 feet in diameter by 20 feet high, with a capacity of 25,000 gallons. The oil storage tank is equipped with a system of heating coils made in four sections, the combined heating surface of which is 500 square feet. An angle stem thermometer is placed in the side of this tank to enable the oil being kept at a constant temperature of about 120 degrees Fahrenheit.

Near the storage tank is an underground unloading tank, 6 feet in diameter by 60 feet long. The tank is enclosed in a concrete pit, which will prevent waste of the creosote in the event that leakage occurs. The tank will withstand an air pressure of 50 pounds per square inch, and creosote is forced from this tank into the storage, or working, tanks by air also. The working tanks and pressure tanks are all located inside the building, so that they can be kept warm and the temperature of the working solution retained at 190 degrees. The locating of these tanks inside the building also accomplished a further economy in the consumption of fuel, particularly in cold weather.

The working tanks are 24 feet in diameter by 20 feet high, each having a capacity of about 68,000 gallons. They rest on concrete foundations six feet above the floor line, being equipped with cast-iron radiators for heating the solution. Each tank has three sets of radiators, working independently of one another. The combined heating surface of the radiators is 441 square feet. Each tank is also equipped with air coils for agitating a mixed solution of creosote and zinc chloride. Air is admitted at 100 pounds pressure, and distributed in such manner as to completely mix the solution in from two to five minutes. The tanks are also equipped with mercury gauges, which show the true reading in tub feet and gallons, regardless of the temperature. This avoids the necessity of making correction for temperature readings with these gauges. Besides the mercury gauges, each tank has a syphon regulator, which regulates the steam supply to the radiators and automatically opens and closes the steam supply valve in maintaining the required temperature.

The pressure tanks are 8 feet in diameter and 14 feet high, made of ⅞-inch steel for a working pressure of 175 pounds. They are in reality a combination of pressure, measuring and drain tanks, and are located in such a way that they are readily filled while the treating cylinders are being filled preparatory to treating a charge of timber. Compressed air is then applied through the top of these pressure tanks, and the preservative is forced through a pipe in the bottom connected with the cylinders. Pressure is maintained until the required absorption is obtained in the timber, after which the valve is closed, and any preservative remaining in the tank can be returned to the working tank by means of the compressed air already in the pressure tank. There is also a sufficient amount of compressed air in this tank to force all of the solution in the treating cylinder back to the working tank. The tanks are also used for measuring purposes, being equipped with mercury indicators, which show the amount of solution, and thus informing the engineer as to the amount of solution going into the timber he is treating. They are also used as drain tanks to catch and measure the solution taken from the timber during the vacuum and draining process. The bottoms of the pressure tanks are only slightly lower than the treating cylinders; and, though all of the drainings from the charge would not flow into the pressure tank by gravity, this is easily and quickly accomplished by admitting atmospheric pressure to the treating cylinder while the pressure tank till maintains a vacuum. This combination of pressure-measuring-drain tank is entirely unique with the plant at Green Spring. It was worked out by the writer, assisted by Card and McArdle, who were the draftsmen in getting out the pipe plans. It eliminated entirely the dirty and ex-

* Superintendent of Timber Preservation, Baltimore and Ohio Railroad System.

pensive pressure pumps commonly in use in timber-treating plants

Recording gauges and recording thermometers are connected to the treating cylinders. This places the superintendent in complete touch with the treatment in all of its details, the charts indicating the temperature, pressure and vacuum recorded for every moment the plant is in operation.

The plant is heated throughout by steam, the vacuum system being used, all condensation being returned to the boiler-feed heater and thence to the boilers. A 50-kilowatt generator furnishes the light for the plant and the yard, there being three arc lamps and about 50 incandescent lamps in the system. The electric plant also furnishes current to operate two 10 horse-power centrifugal pumps and a single horse-power bilge pump. The centrifugal pumps are 8-inch ones, used to circulate the mixture of creosote and zinc-chloride in the retorts while using the Card process. The latter is in the settling tank and is used to pump creosote, that may have settled out from the drainings, into the underground unloading tank.

An experimental plant is situated adjacent to the main building. This plant consists of a complete physical and chemical laboratory. The experimental cylinder is 30 inches in diameter and 9½ feet long, or large enough to hold three or four ties. There are two working or pressure tanks, underground drain tank, pressure pumps and electric centrifugal pump. The tanks are equipped with the latest gauges and thermometers, and the entire plant is so designed that any process can be used, and pressure can be supplied as high as 300 pounds. The chemical laboratory adjoins the physical laboratory, and creosote distillations, zinc-chloride analyses, etc., will be made.

The office building is of concrete, and is fireproof in its entire construction. The same is true of the other buildings in the plant. The hose and engine-houses are of wood, but these are small and located some distance from the other buildings. A fire system has been installed as a protection against destruction in this way, and a fire department will be organized from among the employees, the organization of which will be similar to that at the large terminals, shops and other centres on the Baltimore and Ohio system. A 6-inch water main has been laid the entire length of the tie-yard, and every 300 feet there is a hydrant. The hose-house is near the office, and is equipped with a reel of 300 feet of hose. Water pressure for fire emergency is maintained by a high 50,000 gallon water tank, kept filled at all times.

At the present time the water used in the timber-treating plant is being pumped from the Potomac River, but this arrangement is but temporary until a permanent water system can be built for the joint use of the timber-treating plant and for supplying water to locomotives in train service. The permanent water plant plan calls for two pumps, located at the plant in a concrete well about 100 feet below the surface of the ground. The depression was deemed necessary on account of the lift from the river. Water will be pumped into the high storage tanks and fed by gravity throughout the plant and yard.

Practically all of the ties treated at the plant to date are oak, the number being approximately 200,000. The standard tie in use on the Baltimore and Ohio is 7 inches by 8 inches and 8½ feet long, containing 3⅓ cubic feet. These ties are unloaded and cribbed in piles of seven and one, and are handled by piece-work. It is the intention to air-season all ties. However, if they are not received in quantities sufficient to properly air-season, the plant is designed to take care of this by giving a preliminary steaming and vacuum before the injection of preservatives.

All storage yard tracks have three rails, the outside pair being of standard gauge and the inside rail fixing a 30-inch gauge for the tram cars. In loading for treatment the ties are classified as hard and soft woods and as No. 1 and No. 2. For this work the men are paid at a rate per tram instead of per tie, as is the case of unloading and cribbing for seasoning. Thus it makes no difference whether there are 30 or 40 ties on a tram; the cubical contents are practically the same, and the amount paid is the same. There are 130 tie-cars used to deliver the ties to and from the treating cylinders.

The location of the timber-treating plant is believed to be admirably suited for all purposes, being in near proximity to large timber areas. Green Spring is at the junction of the Romney branch with the main line of the Baltimore and Ohio system. The Romney branch, which extends 16 miles to Romney, W. Va., and the Hampshire Southern Railroad, extending 38 miles farther to Petersburg, tap a timber tract of several thousand acres, much of it being virgin timber. The outlet for all timber adjacent to the lines mentioned is by way of Green Spring, and in marking the timber it is in reality merely a question of stopping the timber at the plant to have it seasoned and treated.

THE R. M. S. "KYLE."

The R.M.S. "Kyle," which has been built and engined at the Neptune Works of Swan, Hunter and Wigham Richardson, Limited, to the order of the Reid Newfoundland Company, of St. John's, Newfoundland, went for a very successful trial trip on Monday, the 5th inst.

The steamer is a finely modelled screw vessel of 220 ft. in length by 32 ft. beam, exceptionally strongly constructed for running through ice which she will often meet on her mail and passenger service on the Newfoundland and Labrador coast.

The passenger accommodation is amidships for the first-class passengers. These are 68 in number, and have a large smoking room on the promenade deck, a dining saloon and music room on the upper deck, and state rooms, including a ladies' room on the main deck.

The second-class passengers are placed aft in two compartments on the main deck, one for men accommodating 102, and the other for women, with sleeping accommodation for 39.

The captain's house is on the promenade deck, the other officers and engineers are in rooms at the sides of the engine casing, and the seamen, firemen, and stewards are forward.

The steamer is provided with a complete installation of electric light, including a search light, an efficient arrangement of steam heating suitable for the climate, and wireless telegraphy.

The propelling machinery consists of a set of single screw triple expansion engines, supplied by steam from two large boilers working under Howden's forced draught, the whole having been constructed at the Neptune Works. On the trial trip they worked without the slightest hitch, giving satisfaction to all concerned, and driving the vessel at a speed of 13¾ knots per hour.

The owners were represented by Mr. R. G. Reid, one of their managing directors, and the builders by Mr. G. F. Tweedy, one of the managing directors of Swan, Hunter and Wigham Richardson, Limited.

DESIGN OF STRUCTURAL STEEL PLANT.

E. H. Darling, C.E., A. M. Can. Soc. C.E.*

General Conditions Controlling Design of a Plant of 10,000 Tons a Year Capacity.—A plant for the fabrication of structural steel for the Canadian market must be equipped for a wide range of work, for, while higher efficiency can usually be attained by specializing on one class, it is not always possible to do so for the following reasons:—

(1) Contracts of a uniform nature cannot always be obtained; and,

(2) Almost any contract has more or less variety of work involved in it.

Certain classes of work, such as building and highway bridge work, are required during the summer months only, while railway work can be done all the year round. By properly combining the two classes there will be less chance of slack seasons for the shop.

Location.—The location of a structural steel plant is subject to the same general principles that influence other manufacturing enterprises, and, while there may be many secondary conditions that will have more or less weight, the four main ones are: (1) The market; (2) the supply of the right class of labor; (3) access to raw material; and (4) the supply of power.

1. **Market.**—The market for structural steel depends on the class of work sought. Railway work is so widely distributed that good railway connections are of more importance, within reasonable limits, than location. Freight rates do not necessarily enter into the question, as the railways haul all such material and erection equipment, which is for use of their own roads, free of charge. For this reason, as well as others, connection with several railways is desirable. For mill building work, the greatest demand will be in industrial centres, although much of the same class is used in large public buildings, such as armories, churches, auditoriums, rinks, etc. For beam and general building

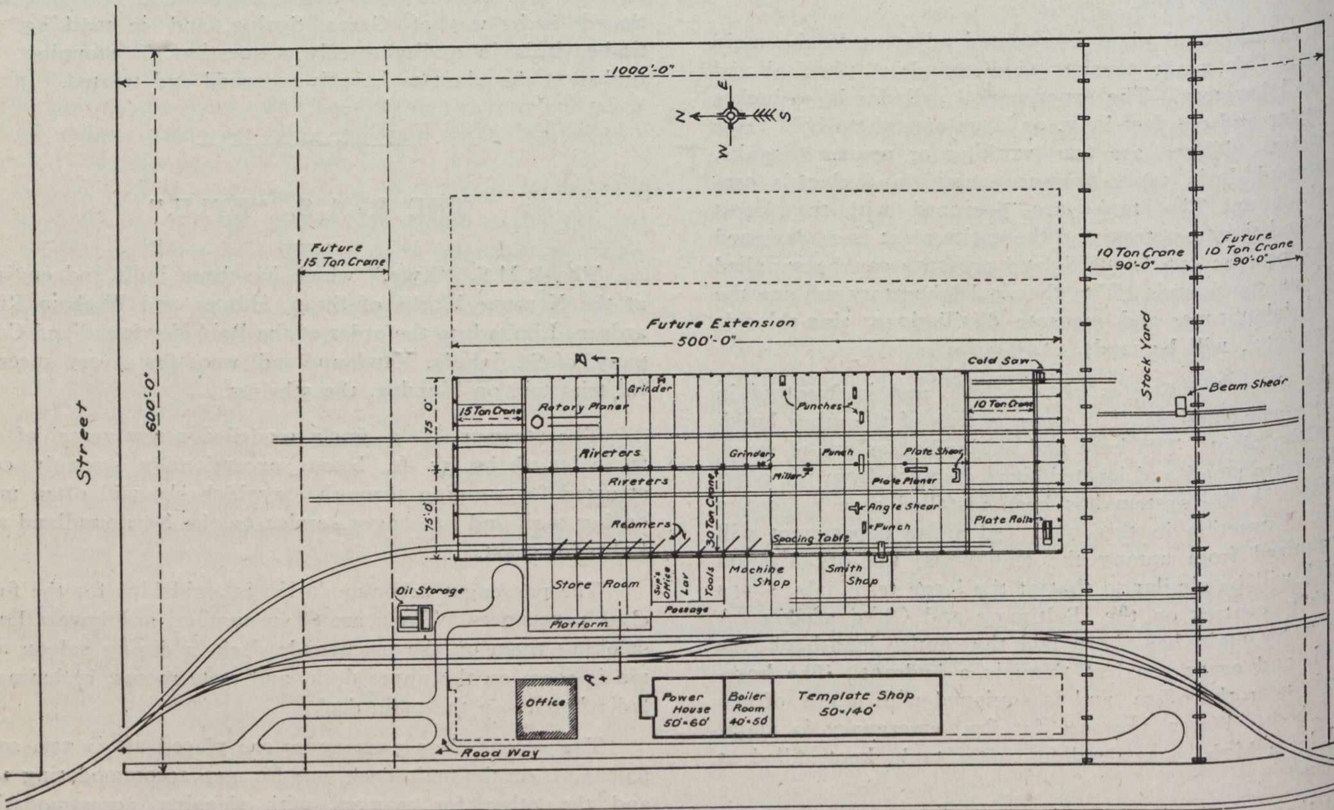


Fig. 1.—Showing Ideal Layout.

But apart from this, as the plant is a new one, whose market is not assured, it should be laid out with the idea of doing general work, and then, as the company finds its place in the business of the country, it may develop those lines which prove to be most profitable.

To secure this desirable flexibility of capacity in a plant having an output of 10,000 tons a year, it will be found advisable to have two main departments: first, a structural shop for all kinds of light truss and beam work, with facilities for handling pieces of five to ten-ton weight. Second, a girder shop where fifty-ton girders can be handled economically. A plant constructed on these lines, with all the necessary subsidiary departments, will be able to turn out any type of railway bridge up to 300 feet in span, and at the same time can be operated efficiently on any ordinary light work.

work, such as building contractors require, large commercial and business centres are the best markets. As most of such material has to be transported by team to the building site, good roads are necessary to handle this business. Steel highway bridges are required to replace old spans in the well-settled rural districts, or for new bridges in rapidly growing sections.

In finding the "centre of gravity" of a market, i.e., the point from which it will be possible to serve the largest number of customers, freight rates and cost of transportation should be considered rather than distances. For various causes, due to questions of competition and peculiar conditions existing in Canada, it will often be found that it costs more to make a shipment to a nearby place than to one at a greater distance. From a shipper's point of view, therefore, the latter place is nearer than the former.

The value of a market, however, depends largely upon the amount of competition that will have to be met; so in finding the centre of gravity it will be necessary to assign

* McPhie, Kelly & Darling, architects and engineers, Hamilton, Ont.

"weights" to various cities or districts according to how well they are served by existing companies.

2. **Labor.**—The cost of labor in the manufacture of structural steel is such a large percentage of the total cost that the question of obtaining a sufficient supply of the right kind deserves careful consideration. It will be necessary, in the first place, to secure experienced foremen and leaders, and these can only be obtained from other plants. With these as a nucleus it will be possible to train up intelligent laborers to do a great deal of the work, but, owing to the changes that are constantly taking place in a large organization, there will always be a need for men who have had some experience in a structural shop. Such workmen can more readily be obtained at some point near or in easy reach of other structural plants, while at other points it will be necessary to have a well-organized employment department to look after this. As many as two hundred men will be required to operate the plant, who, with their families, may mean that one thousand persons will be supported by it.

Raw Material.—Apart from a small amount of machine shop supplies, such as any manufacturing concern uses, "raw material" means only one thing in the structural steel business, and that is the rolled steel plates, beams, angles, etc., used in fabricating. There were over 600,000 tons of steel imported into Canada last year and by far the larger part of this quantity was in the form of structural material. Most of this comes from the United States, with Pittsburg as a centre. European manufacturers are at a great disadvantage in competing for this trade, because ocean transportation means more handling and serious limitations to the size and length that can be shipped.

It is of great convenience to a structural steel company to be as near as possible to its source of supply. Not only will it mean a big saving in freight rates at times, but what is often of more importance, it will save delay in getting material, and when mistakes are made in shipments they are more easily remedied.

The further removed a plant is from its source of supply the more necessary it is that a stock of material be carried. This requires a lot of capital, but, as a rule, it will be found very profitable, as well as a great convenience.

Power.—Compared with many other lines of manufacture, a structural steel plant does not need as much power in proportion to its output, and in this case not more than two hundred and fifty horse-power will be required. The most convenient form for it, as will be shown below, will be in electrical energy, and it is usually easy to obtain it in manufacturing centres. But it may happen that an otherwise desirable location does not offer this advantage, and then a power plant will have to be installed. This will mean the investment of extra capital and an increase in operating expenses, which must be taken into consideration.

There are a great many secondary conditions that influence a choice of location, such as climate, special inducements from municipalities, personal preference, etc., which will all deserve careful consideration, but it must be remembered that a mistake made at this stage will handicap the industry for all time.

Choice of Site.—An ideal site for a structural steel plant is not readily obtainable. A large area is essential, even for a comparatively small plant, while ample provision should be made for growth. Judgment must be used in this particular. Too much land might be a burden to a new company, or, on the other hand, a valuable investment. It should be level and have a water supply and good drainage. It must have at least one railway connection, and more if possible. For immediate neighbors it is convenient to have other iron industries, for these not only supply the smaller items of raw material, but tend to create a larger labor market. The site should be convenient to the homes of the working men, for, apart from the question of wages, no one thing has a greater influence on the problem of building up a permanent and efficient organization than this.

It is not necessary to discuss all the possible variations that may occur and yet give a satisfactory site, for such things as the shape of the lot, the location and number of railway connections, position of streets, etc., make each site a special study. The necessary, or, at least, very desirable features are:—

(1) Sufficient room to arrange the switches and buildings conveniently, leaving ample room for extensions.

(2) A storage yard at one end of the plant where cars may be unloaded and material stored.

(3) A corresponding area at the other end, smaller in extent, to serve as a storage yard for finished work, with facilities for loading it for shipment.

An Ideal Layout.—Fig. 1 shows an ideal arrangement for a structural shop on a lot of fourteen or fifteen acres, six hundred feet wide and one thousand feet long, lying north and south. A railway, from which switches can be made, is assumed to run along the west side, and a public street at the north end. The outstanding features of this plan are as follows:—

The buildings are placed approximately near the centre of the lot, leaving the ends clear for stock and shipping yards. The office, power-house and template shop, which will have to be of a permanent type of construction, are placed along one side of the lot, where they will not interfere with future extensions of the plant. The storerooms and the smaller departments are arranged along the permanent side of the main building for the same reason. The east side is left clear for additions.

The service tracks are brought in between the buildings so that supplies and materials may be readily unloaded just where required. It will be of great convenience to have two connections with the railway as shown. A double track permits the passage of cars, and gives as well more storage room for them. A cross-over between the tracks will be of great service. One track should be run into the shop under the travelling cranes, so that long and heavy pieces may be loaded directly on the cars. It is very necessary to have easy curves on this, for long girders, loaded on several cars, will be brought out over this track. For this reason, and because heavy locomotives cannot take sharp curves, the degree of curvature should be kept as low as possible. The curves shown have a maximum of 20°, which should be considered the limit. At some future time another track may be put along the west boundary, where cars of the erection department may be stored when not in use.

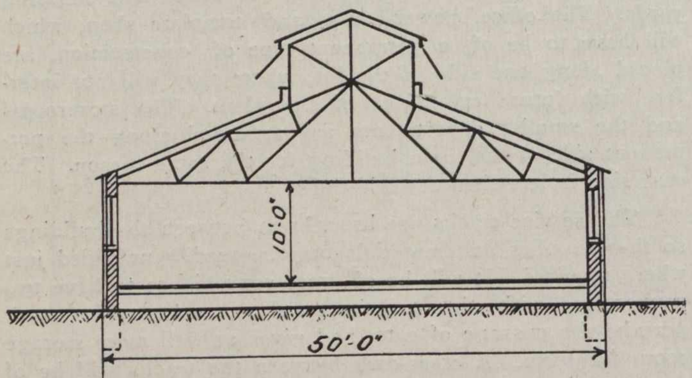
Regarding the arrangement of the various buildings and departments, it will be noted that the office is placed so as to be the first building approached on entering the plant. Room is left for building on a new front when larger and more elaborate offices are required. The power-house boiler-room and template shop can conveniently be placed in one building, divided by fire-walls, or in a series of buildings. The south end of the template shop may have a temporary end, which will allow it to be extended if necessary, but the power-house and boiler-room should be made of good proportions, as it will not be possible to enlarge these buildings conveniently.

This arrangement places the power-house near one boundary of the site, so that high voltage power lines may be brought into it in such a way that all danger of accident from contact is eliminated. At the same time it is at a central point from which it is convenient to distribute the power to all parts of plant. A small tower at the north end of the power-house forms the transformer room, and the main switchboard may be placed along the wall between this tower and the engine-room.

As the plant will probably be run by electrical power purchased from a power company and not generated at the plant, the boiler equipment will be largely used for heating purposes only. The buildings requiring heat will be the office, power-house, template shop and machine shop, and these are grouped around the boiler-room so as to make the distribution system very simple.

Templates.—The product of the template shop is used altogether at the south end of the main shop, where the "markers" do the laying out. It will be desirable, therefore, to have the template shop as convenient to the markers as possible, as shown on the plan. It will also be in easy reach of the drawing office, which is over the business office.

On the other side of the tracks, convenient for receiving and shipping (and also at the permanent side of the plant), are placed the storerooms, machine shop, rivet and bolt shops, and the blacksmith shop. These departments are relatively small compared with the rest of the plant, and the space allotted should be quite ample for all requirements. Extensions, however, may be added at either end, and the partitions between these departments may be made of temporary construction so as to be easily re-arranged should it be found desirable to make any changes in the future.



Template Shop

The position of the storeroom, with its platform along the tracks and road in from the street, permits supplies to be readily handled. Its proximity to the machine shop, rivet shop and blacksmith shops will save time in transporting materials to and from these departments. As far as the main shop is concerned, the largest item drawn from the storeroom will be rivets and bolts and those are used entirely by the assemblers and riveters at the north end of the building. The storeroom is made of good size as by far the larger part of the room will be taken up by bulky equipment for the erection department.

The main shop consists of two seventy-five-foot aisles, one for heavy girders and the other for general structural work. As it will be the structural department that will require to be extended in the future, the girder shop is placed next the storeroom and the way is left open for adding two more aisles to the structural shop. Putting the girder shop in this position makes it possible to bring the railroad track into it.

Buildings.—The office building, power house and template shop should be substantially constructed so as to be warm, dry, and fire-proof. The office will be two stories high, the second story being occupied by the engineering staff. The power house and template shop will be a one-story brick building having a monitor, as shown on the cross section, Fig. 2. The roof is of 2-inch concrete carried on steel purlins and trusses. The windows which take up a large part of the wall space, will have steel sash. The monitor windows will be on hinges so they can be opened, and sections of the other windows will also be made to open. The floor of the power house will be concrete. The template shop floor will be raised eighteen inches or so above the ground level and be of 4-inch mill construction with an upper floor of inch white pine. This makes a good floor for laying down work upon.

The type of construction to be followed in the main building is shown on the cross section. A large percentage of the exterior walls as well as the monitors will consist of windows which will insure good illumination throughout. The balance of the wall area will be corrugated iron, with the exception of the eight feet below the first row of windows. This will be made a 9-inch brick wall on the north, west and south sides of the building with a concrete window sill to finish it off. This brick wall will make the building much more comfortable, both winter and summer.

For the roofs of such buildings as are subject to considerable deflection as well as vibration, and shock, it is preferable to use 2-inch matched wood sheeting rather than concrete. As the roof is flat, the covering may be 4-ply felt with tar and gravel.

The frame work will be steel throughout and entirely self-supporting. Steel sash will be used for the windows, as it is only by its use that the large windows can be had.

In dimensions the main building is two hundred feet wide and five hundred feet long. It consists of one fifty-foot and two seventy-five-foot aisles with a sixty-foot transverse aisle at each end. An economical length of bay will be twenty feet. The clearance between the bottom chord of the truss and the floor in the seventy-five-foot aisles should be twenty-one feet to allow for air hoists, etc. In the transverse aisles and the girder shop additional head room will have to be provided to allow for travelling cranes. By making the roof at these points as high as the roof on the monitors a good appearance will be obtained. In the machine shop aisle, fifteen feet will be sufficient clearance. Too much height here means a more difficult building to heat, and longer belts for belt-driven machinery.

All trusses whose bottom chords are at the fifteen and twenty-one-foot level should be designed to carry two five-ton trolleys without danger. Use a factor of safety of five for one trolley and of three for two trolleys. For the roof live load at least fifty pounds per square foot should be provided for and, for certain localities where the snow fall is unusually heavy, the live load should be increased. Where there is any possibility that a column will have to carry a jib crane, provision should be made for it in the original design. This refers to the columns in the girder shop where those along the west wall will have to take radical reamers, while five-ton travelling jib cranes for riveting machines have to be supported by the east side. Particular care should be taken with the design of the bracing for the building, and the bottom chord system should be especially heavy to tie the whole structure together rigidly.

To facilitate the transfer of material from one aisle to another the interior columns in the structural shop should be so arranged that the bottom chords of the trusses form one continuous trolley runway from one aisle to another. This is done by spacing the columns forty feet centres and placing them in the middle of a bay, carrying the roof trusses on longitudinal trusses between these columns. The east wall is filled in with temporary columns to carry the girts and siding. These can be moved further east when another aisle is added.

It will be necessary in order to attain economy in shop work, to floor the main building. All things being considered, it will be found that a wood floor will be comfortable for the workmen, reasonably durable, easily repaired, and as cheap as any in first cost. On account of the enormous loads the floor will have to sustain and the rough usage it will receive, it should be made of 3-inch red or white pine. Nailing pieces or stringers of 4 x 4 timber should be bedded in cinders thoroughly rammed and smoothed flush. These pieces should be spaced from three to four feet apart. Every precaution should be taken to keep the sub-floor perfectly dry and if there is any possibility of the wood getting damp, it should be treated with some kind of preservative before laying.

Machinery Equipment.—The machinery equipment of the plant is probably the most important question to be considered. Not only does the output of the plant depend on it, but a large proportion of the capital of the company may be invested in equipment and, unless every department is nicely balanced, more or less of it may be unproductive much of the time.

The manufacture of structural steel work requires in its operations the straightening, cutting, shearing, punching, assembling, reaming, riveting, milling and general finishing of a large number of different steel sections.

It would, therefore, be necessary to provide at least machinery for these operations. But the capital invested in a manufacturing plant is subscribed with the expectation of it being able to turn out a certain amount of work which will net a certain percentage of profit. So it will be necessary to have enough machines of each kind to make the capacity of the plant what is desired. For reasons mentioned above, the proportion of each class of work varies widely with different contracts. It therefore becomes a matter of experience and judgment to fix on the amount of equipment to install, as the most careful figuring is at best very approximate. The first item which it is well to fix is the number of riveting machines required. From this the number of punches may be decided upon, and the rest of the equipment proportioned accordingly.

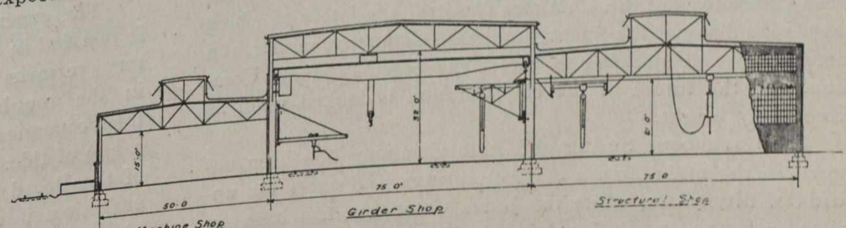
In purchasing machinery certain general rules should be observed. It will be found advantageous in the long run to buy machines having a rated capacity well above the average demand that will be made upon them. Besides the fact that the heavier machine will be more durable, it will in some cases give the plant equipment for a wider range of work at comparatively little extra cost. At the very least it will provide for an emergency which otherwise might prove very expensive.

If the demand for a certain machine product varies widely it will some times be found economical (when the cost of operating a large machine is high) to have two smaller machines instead of a single large one, the first with sufficient capacity for the average requirements and the second capable of taking care of the extraordinary demands. As the plant spreads out, duplicate machines may be required at different locations, it being cheaper to operate two machines than to transport material long distances to have work done upon it.

While complicated machines are to be avoided, it will save capital at the start to buy machines that may be changed over for different classes of work, provided they are not in constant use. For example, the plate rolls should be made a combination of bending and straightening types. The punches should be made so that either cross-cutting or splitting shear blades may be put on to replace the punch and die. The light riveting machine should have one or more extra interchangeable stakes to be used for column or other special work. In this way, at the cost of the extra parts and the time it takes to make the change, work could be done that would otherwise require two separate machines, one of which would probably be idle most of the time.

The matter of punches, shears, reamers, riveting machines and other machines might be taken up at this stage. Their capacities, accessories and other outstanding features are in line for careful attention, but the discussion of these items is a little removed from the province of this preliminary investigation of the general lay-out itself, and will not be discussed.

Arrangement of Machinery and Routes for Material.—The arrangement of the machinery and the establishing of the routes for the material to pass through the shop is one of the most difficult and perplexing problems in connection with the design of a structural steel plant. In theory the material should enter one end of the shop and pass through it from one department to another, emerging at the other end as finished product, without having once been turned around or carried back over any part of its route. In practice, however, there is such a variation in the order in which the work has to be performed—due to details of design and special requirements—that no fixed route can be maintained. At best a material route can be laid out only in a general way, observing the following principles:—



Section on AB (see Drawing 1)

Arrange the plant for that class of work which promises to be the most plentiful. If it is necessary that some material be re-handled, let it be the shorter and lighter pieces rather than the long heavy ones.

Sufficient space, sixty-five to seventy feet in the longitudinal direction of the shop, should be left between machines so that, under ordinary circumstances, there will be no crowding or interference. Material over seventy feet in length may be considered very unusual and when, on rare occasions, it becomes necessary to take care of it, more or less difficulty and interference may be permitted. To design the whole plant for it would add very materially to the cost of buildings, while the increase in the distances that the shorter material would have to be transferred would add to the cost of operation of the plant on regular work.

The material will be sorted out in the stock yard and any with kinks or sharp bends in it will be taken directly to the straightener or plate rolls as the case may be. It will then be put on the trucks, taken into the shop and piled on the markers' skids. From here it will be taken to the various cutting machines, and then on to the punches. As it is punched it will be stacked up until required for assembling, when the various pieces are bolted tightly together, taken to the riveters and riveted up. Reamed work will, of course, be reamed before riveting. The work may now be finished up, cleaned and painted, and as soon as the paint is dry it is ready to ship.

A study of Fig. 1 will show that the machines and department are arranged approximately in the order mentioned above, starting at the south end of the plant. Variations from this rule are due to physical limitations, or are the result of experience.

(To be continued.)

NEW STEEL PRODUCTS COMPANY

Several Canadian steel industries are to be merged as the Steel Products of Canada, Limited. The participating firms are the Gananoque Spring and Axle Company, Limited; the D. F. Jones Manufacturing Company, Limited, of Gananoque, and the Dowsley Spring and Axle Company, of Chatham, Ont.

The capitalization of the new company is as follows:—

Six per cent. bonds	$600,000
Preferred stock, 7 per cent.	750,000
Common stock	750,000
	$2,100,000

Seventy-five per cent. of the securities in the new company has been taken in lieu of cash by the holders of stock in the amalgamated companies, and that the rest will shortly be offered to the public for subscription, by Messrs. Richardson and Company, of Montreal.

Mr. W. T. Sampson, for many years manager of the Gananoque Spring and Axle Company, will act as managing director of the new company. His long association with the Jones Company and the Chatham concern, the latter of which was a subsidiary of the Spring and Axle Company, render him particularly well qualified to direct the Steel Products Company, and the future of the consolidation is looked upon as exceedingly bright.

The Gananoque Spring and Axle Company has been engaged in the manufacture of steel springs and axles for upwards of fifty years, while the Jones Company has been in existence for an equally long time, and is among the foremost concerns of the Dominion manufacturing shovels and other steel specialties. The Chatham company is a comparatively recent organization.

RUBBER FROM COKE-OVEN GAS.

A recent issue of the "Bulletin" of the French Society of Civil Engineers contained a paper on "Coke-Oven Gases and Their Utilization," by M. Gouvy, in the course of which he refers to a new application of coke-oven gas, viz., the manufacture of artificial rubber. M. Gouvy points out that after prolonged investigations conducted by various chemists, with the object of finding a substitute for india-rubber, it was produced synthetically by the processes patented by Bayer & Company, of Elberfeld, which were based upon the manufacture of butadeine. More recent researches, however, have shown that rubber consists mainly of a hydrogen carbide, most complex in composition, viz., isoprene, the simplest form of which is butadeine. This having been shown to exist in small quantities in the crude gases of coke ovens, the above-named company based their process upon its polymerization into isoprene, i.e., rubber. The raw material is really extracted from coke ovens by a special treatment of benzol, which distills below 25 deg. C. The manufacture of artificial rubber by this process is still in the experimental stage, and the cost price must be very high, but M. Gouvy thinks it may be reduced.

TIDAL WATERS AS A SOURCE OF POWER.

By C. A. Battiscombe.

At a meeting of the Society of Engineers (Incorporated), held on Monday, May 5th, a paper on "Tidal Waters as a Source of Power" was read by Mr. C. A. Battiscombe, the object of the paper being to draw attention generally to the commercial possibilities of hydro-electric installations in the British Isles, more particularly with regard to the use of the tides. After some introductory remarks in reference to tidal intervals and the range of neap tides, the author points out that in this connection the head of water available for actuating turbines cannot exceed one-third of the range of minimum tides. The form of installation required for a continuous output of power is then discussed, the chief objections to twin installations, so placed that the tidal interval at the one will not synchronize with the tidal interval at the other, being pointed out. An outline is given of the arrangements proposed for the constant maintenance of a working head, by means of a chamber for the turbines, connected by valves to the tidal way and to three reservoirs in which the tidal water may be impounded, and to this is added a description of the proposal of sequence of flow between the tidal way and the reservoirs.

It is claimed that the utilization of the tides for power purposes presents few engineering difficulties as far as principles are concerned, but that the real difficulty lies in the question of cost, and therefore in the choice of the site and in the design of the structural details.

The expenditure on commercial works that an engineer is justified in recommending is suggested, and some explanatory remarks are offered in respect to various items given in the rough estimate and to the principles governing the economical capacity of a proposed installation for any range of tide. The rough estimate follows next and the cost of the Board of Trade unit, obtained from the proposed installation, is then considered from the point of view of supply and demand, both from a commercial and a municipal standpoint, on the basis of annual expenditure over a period of fifty years. The paper concludes by insisting on the importance of regarding the supply of fuel as a matter that concerns the whole nation; that the demand for combustible fuel is continually increasing, and that coal being practically the only fuel found in England, it would be mere folly to neglect any other available source of energy whereby the present rate of consumption of coal may be sensibly reduced. It is submitted that not only can the tides be utilized as a constant source of power, but that, taken in conjunction with the power that could be derived from fresh-water rivers, their utilization would be a great gain to the commercial and industrial interests of the United Kingdom.

MOOSE JAW ELECTRIC RAILWAY COMPANY.

The gross receipts of the Moose Jaw Electric Railway Company amounted to $77,996 for the past year; 1,607,770 passengers were carried. The assets of the Moose Jaw Electric Railway are placed at $573,367, of which $570,128 is in plant, property and equipment, and the balance of $2,239 is in accounts receivable. The liabilities are: capital stock (paid up), $480,271; bills payable, $15,359; accounts payable, $22,581; and a profit and loss surplus of $15,359. The company's officers and directors are: president, Mr. A. A. Dion; vice-president, Mr. Newton J. Kerr; secretary-treasurer, Mr. D. R. Street, and Messrs. E. J. Daly, E. O'Connor, T. Frank Ahearn, P. B. Mellon, A. H. Dion and Charles E. Armstrong.

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FACTORS IN PLANT DESIGN.

As one of the earliest factors of industrial economy, as applied to factory construction and operation, there is no more important phase open for thorough consideration than a complete summary of the many demands which will be made upon the building after erection. A careful routing of work from its raw state until it reaches the siding, both these initial stages being included in the study, means much toward low operating cost throughout the years during which the plant will be in service. Such items as location, market, cost of labor, power, arrangement of buildings and machinery, and future extensions, if given most careful study in the early stages of design, frequently minimize operating expenses to such a degree that if computed over a number of years, would vindicate a thorough initial investigation running into a considerable sum.

In his article dealing with a design of a structural steel plant, Mr. Darling gives adequate attention to this phase of engineering design, and clearly cites the advantages to be derived from ample provision for conditions bearing upon the efficient housing of an industry.

THE MASS CURVE IN DETERMINING STREAM FLOW YIELD.

It is only very recently that the mass curve has been used to determine the yield of a watershed. The maximum quantity of water which can be obtained daily throughout the driest cycle of years covered by the records is exceedingly difficult to obtain if it is attempted to secure the information by numerical means. The mass curve furnishes a ready and convenient method of analyzing the flow of a stream, and it is rather surprising that it has not been more widely used. This curve or diagram is used for computing the yield of a watershed from a continuous series of gaugings, and at the same time for determining the volume of reservoir capacity required to store the flood waters for use in season of drought so as to maintain a specified constant rate of flow. The method was first described by Mr. John R. Freeman in his report on New York's water supply.

Briefly, the method consists in adding up the totals of the daily or monthly yield from month to month for the whole period of gaugings under consideration, then plotting the successive steps of accretion of the mass as an irregular line or mass curve. Any desired rate of draft may then be assumed, and its successive sums plotted to the same scale, and of a uniform rate. This draft curve forms a straight, inclined line, and if it is made to start coincident with some point or summit on the mass curve, the divergence of the two curves at successive points serves to show the volume of storage that would have been required on this date to have maintained the required rate of flow up to that time.

A very interesting paper in which this mass curve method was used extensively is one read recently before the Western Society of Engineers by George L. Thow and L. R. Howson. In this paper the various steps in the computation of yield on the Hickman Creek watershed, run-off records of which are available for a period of twenty-six years, are analyzed. This discussion will well repay careful study by the hydraulic engineer interested in the study of stream flow. The increase in acreage of drained agricultural lands will steadily increase the run-off and continue to lower the level of the ground water. With the exhaustion or full development of ground water supplies, the impounding of rainfall in reservoirs will be necessary.

One of the most significant conclusions drawn from the above paper is the vital importance to be placed on the length of the run-off record. This is well shown by a few figures from the paper. With an available storage equal to 12 inches on the watershed a daily yield of 3,600,000 gallons per day could be obtained. Let us suppose the record ended with 1902, covering a period of eighteen years from 1885 to 1902, inclusive. During this period the driest cycle of years occurs from 1889 to 1902. Assuming the same amount of reservoir capacity available as above, we find a daily yield of 4,300,000 gallons per day could thus be obtained.

Selecting the period from 1888 to 1898 from the record, we have eleven years during which time, even in the driest years, 1894-95, a daily yield of at least 5,800,000 gallons per day could be obtained, based on 12 inches of storage available.

These facts show very conclusively that by using a record of short duration some very erroneous conclusions as to the least yield might result. The following tabulation, taken from the paper, shows clearly the value of the length of a run-off record in the computation of yield:—

Length of record.	Least yield during driest cycle.	Per cent. based on 26-year record.
Twenty-six years	3.6 M.G.D.	100 %
Eighteen years	4.3 M.G.D.	120 %
Fifteen years	4.5 M.G.D.	125 %
Eleven years	5.8 M.G.D.	160 %

Even with a record with 26 years of run-off data available, it cannot be safely assumed that a drier period has not existed previous to those records, or may not again occur at some future time.

THE INTERNATIONAL JOINT COMMISSION.

In *The Canadian Engineer* for May 1st and 8th we commented editorially upon the Livingstone Channel in the Detroit River, since the opening of which, last October, the town of Amherstburg, Ontario, had raised strong objection to the proposal to construct a dam at Bois Blanc, the purpose of which was to maintain the normal depth of water in the river above the channel. The objection brought forward by Amherstburg was that the proposed dam would divert a large body of water into the narrow channel between the town of Amherstburg and Bois Blanc Island, increasing the current to such an extent as to render the harbor practically useless. It was further predicted that the ice brought down by this increased flow would destroy docks and personal properties along the water front. There was also the danger to health from Detroit City sewage, which would be diverted in proximity to the shore at Amherstburg.

The commission handled most admirably the test consigned to it. In conclusion, it deemed necessary the erection of a dyke for the improvement and safety of navigation, but that such, if built on the west side of the river instead of adjacent to Amherstburg, would reduce the velocity of flow to the desired degree, at the same time not affecting the flow in the Amherstburg channel. Its recommendation to the Governments of both countries was that a dyke be built upon this location; and further, that considerable excavation work be executed on the west side of the Livingstone Channel, and that the shoals on the east side be also dredged.

A SEWER DISCHARGE DIAGRAM.

By J. M. M. Greig, A.M.I.C.E.*

[Thinking that many of our readers who are interested in sewer design and construction might care for an extra copy of the diagram accompanying this article, we have had a few extra copies struck off on coated stock, on the back of which is given the formula to be used in connection with it. Engineers who would care to receive a copy of this diagram may do so by asking for it—*Editor*.]

The author compiled the accompanying diagram to assist in arriving at the best form of sewer for each particular case, or rather to give a choice of several sizes of sewers with equal discharging capacities.

The diagram is arranged to show the discharge in cubic feet per second of circular brick sewers, egg shaped brick sewers, concrete culvert shaped sewers of the type illustrated, and vitrified pipes when running full at any gradient. It also gives an indication of the velocity of flow in the concrete culvert types, but these velocity curves do not hold for the brick sewers.

The formula used was:—

Discharge in cu. ft. sec.—$A\,C\,\sqrt{R}\,\sqrt{S}$

Where A = Sectional area.

C = Kutter's coefficient for different values of $\sqrt{R}$ and N (taken from Wollheim's sewerage note book).

R = Area divided by wetted perimeter.

S = Slope.

N = Coefficient of friction—.015 for brickwork and .013 for concrete.

The value $AC\sqrt{R}\sqrt{S}$ was obtained for each cross section of sewer for a gradient of 1. in 100 and having got together these amounts the diagram was constructed as follows:—

The slopes whose square roots equalled 0.001, 0.002, etc., up to 0.1 were marked down at equal distances along a horizontal line from the origin towards the right and a vertical line was erected at 0.1, that is, at the 1 in 100 slope. On this vertical line a scale of discharges was marked off. Then the value of $AC\sqrt{R}\sqrt{S}$ previously obtained for each particular size of sewer was noted on the discharge scale and lines were drawn from the origin through these points and on these lines produced the dimensions of these sewers were written above a short length of line. The radial lines drawn on the diagram are through every 50 cub. ft. sec. at 1 in 100 and are merely guides to the eye but by fixing a thread to the origin a convenient straight edge is formed which can be used in finding the following:—

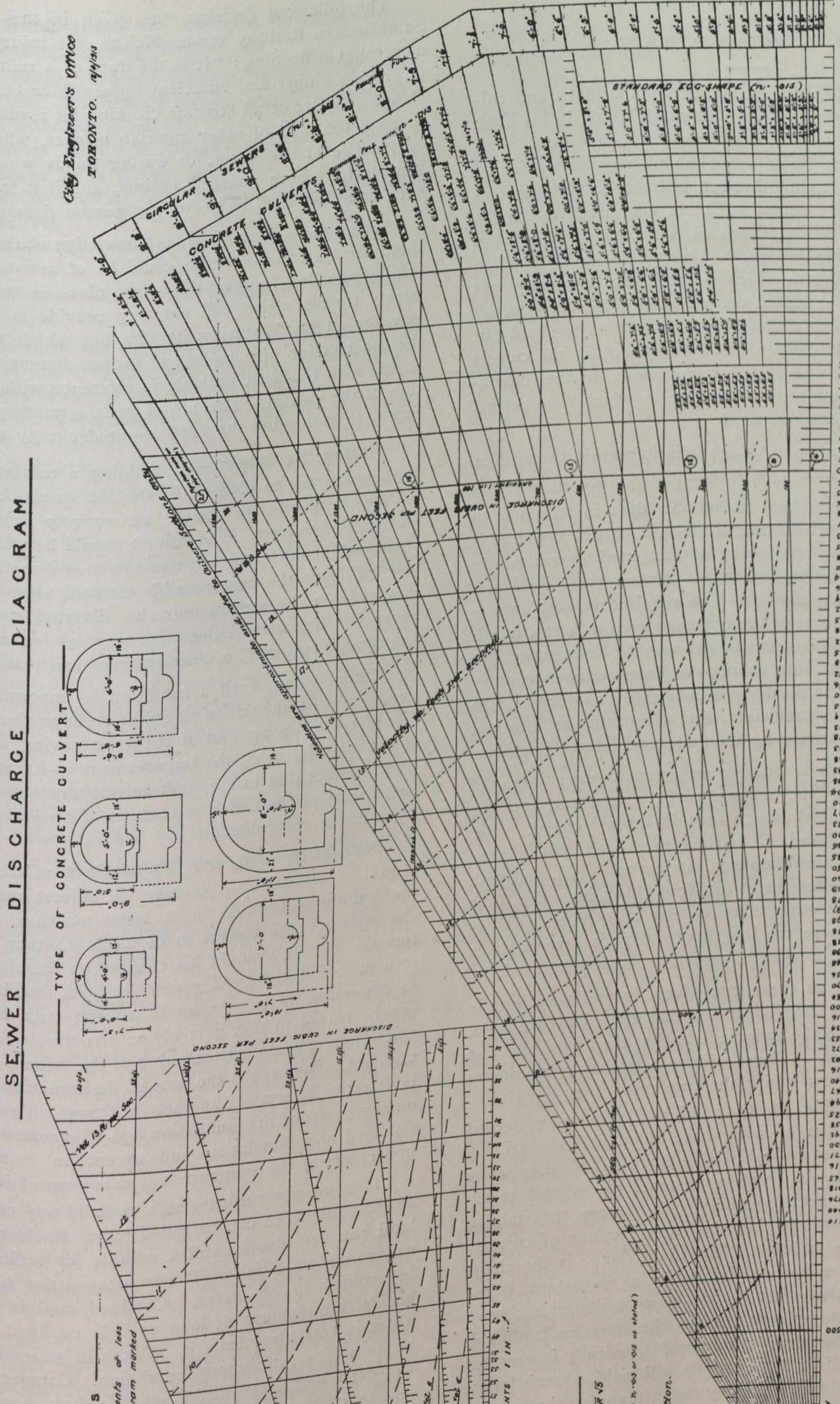
The various sizes of sewers which will give the required discharge at a certain gradient, the discharge any sewer gives at any gradient, or the gradient required to give a certain discharge with a particular size.

If size is required stretch the thread over the intersection of the gradient and discharge lines and the dimensions can be read above the thread on the right of the diagram as, for instance, at 1 in 400, 300 c.f.s. may be got through concrete culvert of 5′ 6″ x 8′ 9″ or 6′ 6″ x 7′ 3″ or a 7′ 3″ diameter brick sewer.

If discharge is required stretch the thread along the line of the particular size of sewer chosen and read the discharge where the thread cuts the gradient line.

If gradient is wanted stretch the thread along the line of the sewer and read off gradient where the thread cuts the discharge line. The discharge scale on the larger diagram for the pipe sewers shown thus: (12) is 100 times that for the larger sewers, that is the figure 1,000 on the 1 in 100 line for an 18″ diameter pipe must be reduced to 10. c.f.s.

*City Engineer's Department, Toronto.


SEWER DISCHARGE DIAGRAM
TYPE OF CONCRETE CULVERT
City Engineer's Office
TORONTO.
CIRCULAR SEWERS
CONCRETE CULVERTS
STANDARD EGG-SHAPE
DISCHARGE IN CUBIC FEET PER SECOND
PIPE SEWERS
GRADIENTS 1 IN
FORMULA
A = sectional area
S = slope
n = coefficient of friction.
GRADIENT 1 IN

CONCRETE CULVERTS.

By F. H. McKechnie, B.A.Sc.

Introduction.—The distinction between bridges and culverts is not a hard and fast one, although Webb, in his book on railroad construction, attempts to define the term "culvert" as follows: "The term culvert may be applied to all water channels passing through railroad or highway embankments, which are not of sufficient magnitude to require a special structural design, such as is necessary for a large masonry arch or truss bridge." This seems to be rather a mistaken idea of culverts which is much too frequently met with, that, given a standard design or two for culverts, all that is necessary is to choose which design to use and put the culvert in place. Such a method of choosing the culvert should only be used where all the conditions for the foundations are perfect, such as rock bottom, in which case perfect stability of foundation is assured.

There are a number of things it is important to consider before deciding on size, style or shape of culvert to be used.

Waterway Area.—Where no reliable data in reference to the volume of water flowing through a culvert opening is obtainable, the culvert area may be computed approximately by a number of empirical formulae. Among these is Myer's formula, which is as follows: The required culvert area is equal to the square root of the drainage area in acres, multiplied by F, where F is a coefficient varying from unity, for flat country, to four, for rolling or mountainous country from which rainfall is discharged at a greater velocity. The proper value for the coefficient, for any particular location, must be selected entirely by the judgment of the engineer.

Talbot's formula is another in common use: Area of waterway in square feet is equal to C, a constant, into the fourth root of (the drainage area in acres)^3 cubed. For steep and rocky ground C varies from two-thirds to one. "For rolling agricultural country, subject to floods, and with the length of the valley three or four times its width, C is about one-third. In other districts, not affected by accumulated snow, and where the length of valley is several times the width, one-fifth, one-sixth, or even less may be used."

Formulae such as these two given depend very largely upon the choice of coefficient so that they are valuable, chiefly as a guide to the judgment, rather than hard and fast rules to be followed. They indicate a probable maximum and minimum between which the true result may lie.

On the legal side of the subject Engineering Record says in part: Although courts have ruled that the railway companies are not to be held liable for insufficient capacity for extraordinary floods, there is too much guess work in determining sizes of such openings. It is easy to establish better procedure for selecting the cross sections of culverts than exist in some railways. The main factor is the shape of the drainage area and another, quite as important, is the topography, also the effect on the flow of the character of the soil. This factor rarely receives the attention it should. A naturally impervious soil is rendered practically impervious by a rainfall of half an hour and so will yield a much larger run-off toward the end of a heavy storm than one that is very sandy. A very wet marsh will also yield an extraordinary run-off in a heavy storm. There are good formulae, but one suitable for prairie is not suitable for hilly country. While a railway may be exempt from damages, due to extraordinary freshets, the courts will hold it strictly to account where the channels are inadequate to carry off the water that may be reasonably expected.

The following decision was given in the case of the Southwestern Railway versus McKay, for injury to property on account of flooding: "It is the duty of a railroad company to provide proper and sufficient openings or culverts for the escape of water of all streams crossing its roadbed, so as not to flood the land of other riparian owners, whether at ordinary stage of the water, or during floods which could reasonably have been guarded against, and if it fails to provide such openings it is liable to any person damaged thereby."

Where there is no previous knowledge of the country and there are no records which could be of assistance in determining the flow, one of the safest plans is to build a temporary trestle, which will not only provide an ample waterway for all floods during its life, but which will permit of the construction of a culvert of proper dimensions under the trestle with the least possible interference with the construction of the culvert. The life of such a trestle would be sufficient to determine the area required closely enough.

Placing the Culvert.—In building a culvert it is not always necessary to place it in the old stream bed, in fact it is often very wise to choose an entirely new spot for the stream and culvert. The culvert should be placed in such a position that the water will come to it as directly as possible, and will have the best possible channel away from it. For this purpose the stream may be diverted and cleaned out above and below the culvert opening, giving all the advantage for the culvert of a clear entrance and exit for the water.

Except where such a condition is impossible of realization, a culvert should be placed at right angles to the centre line of track, on account of the great saving in the quantity of the material used, the improvement in its appearance and from the fact that in the skew culvert new stresses may arise on account of the different position of the structure with respect to the embankment.

Foundation Bed and Foundations.—Careful soundings should be taken before locating the culvert and the result of the soundings should, in a large measure, determine the character of the culvert to be used, whether plain or reinforced. Patton says, in his treatise on foundations: "When structures fail, it may in general be said, that it is impossible to determine the cause, but in a large majority of cases, it can be traced to that part of the structure under ground or under water, and ultimately due to the failure of the foundation bed. For even if the part of the structure under ground is defective in some of its parts, it throws an excessive weight on some part of the foundation bed. Be sure of your foundation bed and foundation and except in extreme cases the upper part of the structure will take care of itself."

It is usually perfectly safe to build any culvert required on material which can be called rock. Boulders or gravel or hard pan can also be called reliable for ordinary structures under good conditions. The scouring action of water should be avoided in all cases. Confined sand is safe to bear a load of any amount as long as it is confined and running water is kept away from it. Taken in general though, sand is not a very satisfactory foundation. Compact and dry clay will carry very large loads, but it is very soon rendered useless by contact with water, as it is then a pasty material and gives away by flowing and bulging up around the structure.

Trautwine says, that on good compact gravel sand or loam, at a depth below atmospheric influences, two to three tons per square foot are safe. Pure clay, especially if damp, should not be trusted with more than one to two and a half tons, according to the case. Examples will be given, in a later part of this paper, showing effect of different conditions of foundations, on actual culverts in the field.

Typical Specifications for Concrete Structures.—From Ontario Government Highway Report, 1911:

(1) The general type of highway bridge shall preferably be as follows, but limiting lengths are not absolute and may be varied as occasion permits.

(a A concrete arch, or concrete abutments with slab covering for spans up to sixteen feet.

(b) A concrete arch or concrete beam bridge for spans sixteen to forty feet.

(c) A concrete arch for spans exceeding forty feet in length.

(d) All concrete structures will preferably be reinforced, using medium steel.

(2) All parts of the concrete shall be proportioned so as not to exceed the following unit stresses, in pounds per square inch for stone or gravel concrete:

Extreme fibres of beams and slabs, for bending	650
Shearing stress in concrete	60
Bond between plain steel and concrete	60
Bond between deformed steel and concrete	160
Tension in soft steel	14,000
Tension in medium steel	16,000
High steel, one-half the elastic limit, but not exceeding	20,000

(3) Reinforced concrete beams and slabs will be designed on the assumption that compressive stresses may vary directly as the distance from the neutral axis. No allowance will be made for concrete in tension. Ratio of moduli of elasticity of steel and concrete will be assumed as fifteen. All calculations will be based on concrete having a crushing strength of two thousand pounds per sqvare inch in twenty-eight days.

(4) The bearing power of soils under foundations shall, if possible, be based on actual test, but where this is impracticable, the following shall be used:

	Tons per sq. ft.
Rock in thick beds	25
Strong gravel and coarse sand, dry	8
Compact sand or firm clay, dry	4
Clay, moderately dry	2
Clean, dry sand, not cemented	2
Wet clay	1
Quicksand and wet, yielding soils	0 to ½

(5) The safe bearing power of wooden piling, determined by the following: $P = \frac{62wh}{s-1}$

Where P = Safe load in pounds.
W = Weight of hammer in pounds.
H = Fall of hammer, in feet.
S = Penetration of last blow, in inches.

(6) Each structure shall be designed to carry the following loads:

(a) A dead load consisting of the total weight of concrete steel and other material therein, including the weight of earth or other superimposed filling; the weight of the concrete to be assumed at one hundred and fifty pounds per cubic foot, and earth fill at one hundred pounds per cubic foot.

(b) A uniform load, expressed in pounds per square foot of floor surface, covering the whole or any part of the bridge.

(c) A concentrated live load expressed in tons, passing over any portion of the bridge, on two axles at ten-foot centres and six-foot gauge, two thirds of the load to be carried on the rear axles.

(d) For floor slabs, a concentrated load expressed in pounds midway between stringers or beams and resting on a base one foot wide.

Materials.—Cement must be of a known brand of Portland cement, approved by the engineer in charge of the work, and complying with the requirements and tests of the Canadian Society of Civil Engineers, for cement.

Fine aggregate shall consist of sand, crushed gravel or stone screenings, passing when dry a screen of one-quarter inch mesh; and not more than six per cent. passing, when dry, a screen having one hundred meshes to the linear inch. The material shall be clean, sharp, siliceous and of varying sized grain. Gravel, if used in its natural state in making "fine" concrete, shall be of uniform character and varying grain, making a dense and compact mass, such that the smaller particles will fill the voids between the larger, the largest stones therein to be such as will flow readily around the reinforcement but will not separate from the mortar in laying. Gravel shall be free from earthy mould or organic matter. Should there be insufficient fine material to properly fill the voids and make a compact mass, the deficiency shall be corrected by the addition and mixing of such quantity of sand, and in such manner as may be required by the engineer or inspector in charge of the work. Should the gravel to be used contain an excessive amount of sand, loam, large stones or other objectionable material, it shall be screened through a mesh of proper size. Where the sand and fine stuff is thus removed the resulting mass of pebbles shall be treated as broken stone and sand shall be mixed therewith in the manner herein described for broken stone concrete. Where large stones only are removed the material shall be treated in the ordinary manner for gravel concrete.

The steel used for reinforcement shall have an ultimate strength of not less than fifty-five thousand pounds per square inch and must bend cold one hundred and eighty degrees to a diameter of the thickness of the piece tested, without fracture.

The water used is to be clean, and the mixture must be wet enough to flow into the forms and around the reinforcement without permitting the separation of the coarser aggregates from the mixture in conveying from the mixer to the forms. The weight of Portland cement shall be assumed to be one hundred pounds per cubic foot.

Proportioning Materials.—The proportions of materials to be used in mixing fine concrete shall be by measure, loose and unless otherwise directed by the engineer, shall be as follows:—

Gravel Concrete.

(a) Abutments, piers and wing walls: One part of cement to seven parts of gravel.

(b) Arches from the springing line, floor slabs, beams and parapet walls: One part of cement to five parts of gravel.

Broken Stone Concrete.

(c) Abutments, piers and wing walls: One part of cement, three parts of sand, and six parts of broken stone.

(d) Arches from springing line, floor slabs, beams, and parapet walls: One part of cement, two parts of sand and four parts of broken stone.

The specifications given above, while incomplete, cover pretty well the usual specifications required in the building of concrete culverts.

Types of Concrete Culverts in Common Use.

Concrete pipe culverts—plain and reinforced.
Old rail culverts.
I-beam culverts, and box culverts.
Arch culverts—plain and reinforced.

These types of culverts will be discussed in the following pages, with examples of each.

Concrete Pipe Culverts.—Tests of plain and reinforced culvert pipes.*

The tests were intended to throw light on the strength of pipes placed in railroad embankments, and are valuable on account of the practical conditions under which the tests were carried on. The main tests were made with a specially prepared testing apparatus, which included a box of strong, stiff construction, and the pipes were embedded in sand and

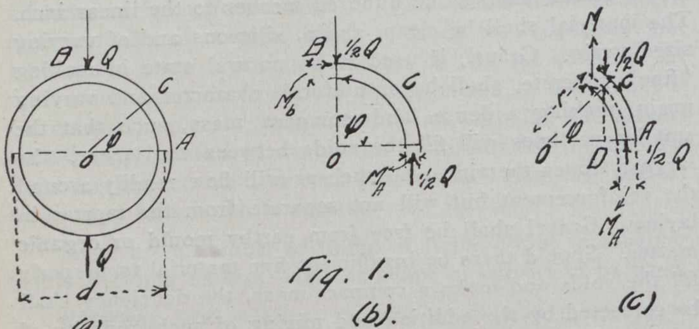


Fig. 1.

the load applied through a saddle, resting on a sand cushion. Short rings of concrete and reinforced concrete were tested, both under concentrated load and under distributed load.

Mechanics of pipes and rings subject to external pressure.

Bending moments and conditions of loading: The stresses developed in rings subject to external earth pressure, as in railroad culvert pipes, are dependent upon the bending moments developed, and, as the exact load coming upon the ring and its distribution over the surface are difficult to determine, the bending moment is in general quite uncertain. The amount of the load and its distribution, and therefore the bending moments on different parts of the ring, depend upon a number of conditions, some of them being: the nature of the earth used in filling; the method of bedding the pipe; the way of tamping the earth at the sides; the amount of the lateral restraint or pressure of the earth horizontally; the method of filling and tamping the earth above; the condition of moisture in the earth, etc.

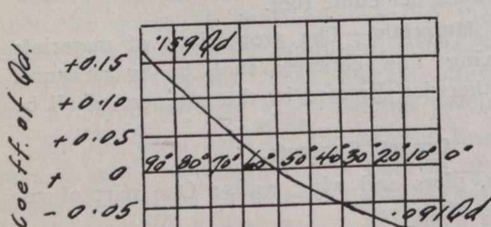


Fig. 2.

Evidentally in such earth as quicksand, the conditions may approach those of external hydrostatic pressure, and on the other hand, in the deep sewer trenches the earth filling may act so that its weight is carried against the sides of the trench. In discussing the stresses in rings, it is well, first, to find the bending moment for certain assumed conditions of loading, then to make tests under varying conditions of loading, and finally to compare these results with a view to determining the probable range of bending moments under the actual conditions of construction. The assumed loadings include:—

(1) A concentrated load at the crown of the ring.

(2) A vertical load distributed uniformly over the horizontal section.

(3) A distributed vertical load together with a horizontal load, distributed perpendicularly over the sides of the ring.

(4) An oblique loading.

On account of the uncertainty in these calculations, the difference of the intensity of the load at the crown and at the extremities of the horizontal diameter, due to the different depths of earth, need not be considered. In general, the pressures on the lower half of the ring will be considered to be the same as on the upper half. As refinements are not essential, and approximations are permissible, the equations will be based on a thin ring of homogeneous material, having a constant modulus of elasticity, and it will also be assumed that the changes from a circular form have little effect on the dimensions of the ring.

For a load concentrated as shown in Fig. 1 a, the quadrant shown in Fig. 1 b will be in equilibrium under the load ½Q at B, a thrust ½Q at A, a moment 0.091Wd at A, and a moment 0.159Wd at B.

At B, M is 0.159Wd. (1)

For a point C at an angle ϕ above the horizontal diameter (Fig. 1 c) the equation for the bending moment is (2)

$M = Qd\ (0.159 - \frac{1}{4}\cos\phi)$

Fig. 2 shows the changes in bending moment between the haunches and the crown. The point of zero bending moment is $\phi = 50^\circ\ 30'$. At this point the sign of the bending moment changes from negative to positive.

The expression for the deflection of the pipe under concentrated load or for the change in vertical diameter is $0.0186Qd^3$ and for the change in horizontal diameter is

————

EI

$0.171Qd^3$.

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EI

Distributed Vertical Load.—For a vertical load, distributed uniformly over the horizontal section, as shown in

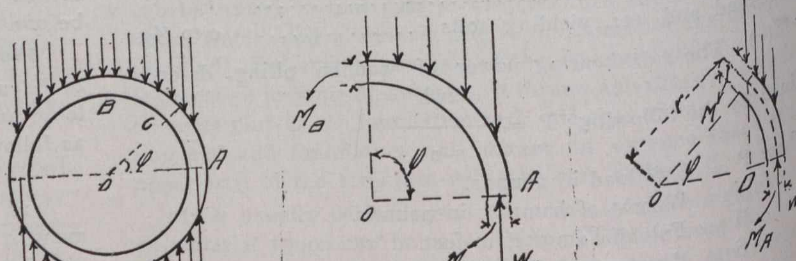


Fig. 3.

Fig. 3 a, the quadrant shown in Fig. 3 b will be in equilibrium under the load, a thrust at A, a moment at A, and a moment at B.

Calling the load on the ring W, and the mean diameter of the ring d, the moments at A and B, which are equal, are given by the expression M = 1/16Wd. (3)

For a point C at an angle ϕ above the horizontal diameter (Fig. 3 c) the equation for the bending moment is (4)

$M = 1/16Wd\ (1 - 2\cos^2\phi)$

In Fig. 4 is shown the change in bending moment between the haunches and the crown. The point of zero bending is ϕ—45°. At this point the sign of the bending moment changes from negative to positive.

* Tests of cast iron and reinforced concrete culvert pipe, by A. N. Talbot, in University of Illinois Bulletin.

The expression for the deflection of the pipe, or for the change in vertical diameter, is $1/96 \frac{Wd^3}{EI}$, and the change in horizontal diameter is the same.

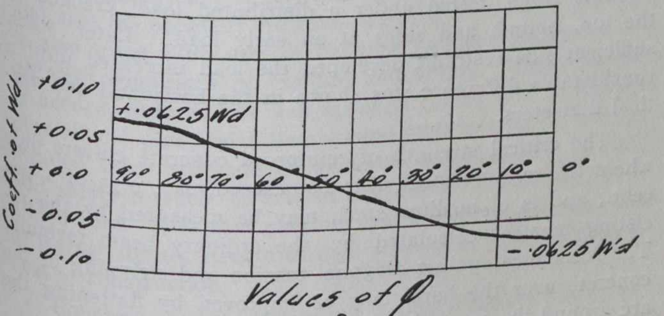


Fig. A.

Distributed Vertical and Horizontal Load.—If it be considered that the vertical load is uniformly distributed over the horizontal section of the pipe as before, and that there is also a horizontal pressure uniformly distributed against the pipe, the loading will be as represented in Fig. 5 a.

If the ratio of the horizontal pressure to the vertical pressure is denoted by q, the moments at A and B will be given by the equation, $M = 1/16(1-q)Wd$ (5)

For a point C at an angle ϕ above the horizontal diameter (Fig. 5 b) the equation for the equation for the bending moment is $M = 1/16Wd(1 + q - 2\cos^2\phi - 2q\sin^2\phi)$ (6)

The bending moment becomes zero at $\phi = 45°$, as in the other case. If the intensity of the horizontal pressure is the same as that of the vertical pressure, $q = 1$ and M becomes zero at all points. This corresponds to uniform external pressure, and equal pressure is produced in all parts of the ring.

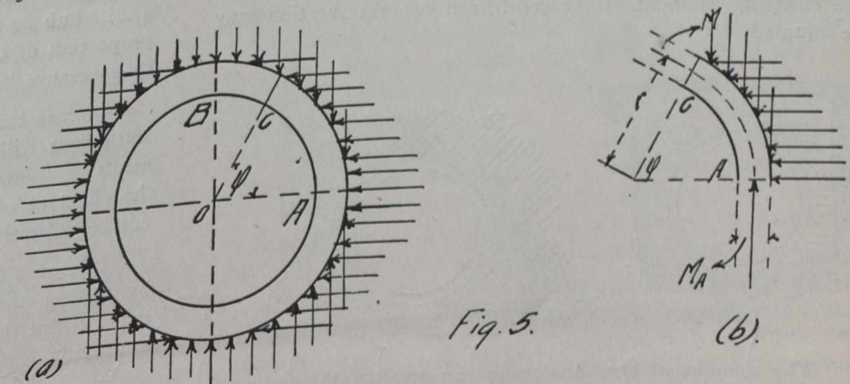


Fig. 5. (b).

Oblique Load.—In the case of the concentrated load and the distributed load it is seen that the bending moments at A and B are large, and that the moment decreases to zero amount at some point between A and B. If it was certain that this loading was present, no provision against bending need be made at the points of zero bending moment, and but little for points close on either side. However, it must be borne in mind that if there is a change from the specified loading, the conditions of the bending moment are likewise changed. If, for example, the method of filling over the pipe should be such as to make the pressure come obliquely, as shown in Fig. 6 a, the maximum moment would be at the 45° points and the maximum moments at the ends of the horizontal and vertical diameters.

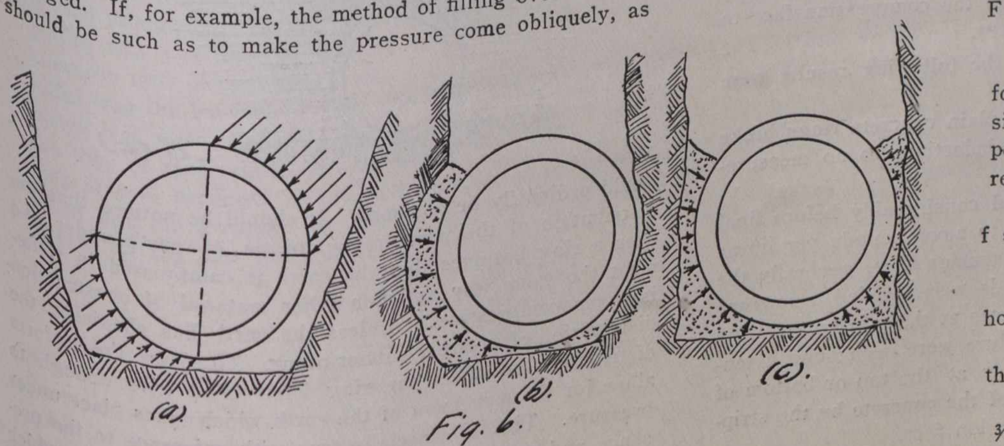


Fig. 6.

Similarly, if in a trench a slip of earth caused the pressure to come against the pipe, as shown in Fig. 6 b, the the distribution and amount of the bending moment would be very different from that of the usual vertical loading. While an accurate measurement of the bending moments in such cases is impossible, yet in any case it is possible to judge the amount and location of the bending moments, within reasonable limits, and to provide strength in the section of the pipe to take the consequent stresses.

Resisting Moments and Stresses.—With rings whose thickness is small in comparison with the diameter, the difference between the length of the inner and outer fibre is small, and the expression for the resisting moment used for ordinary straight beams may be applied without much error. The length of ring (width of beam) will be considered unity. Call t the thickness of the ring.

For the rectanglar section of the ring the resisting moment will then be $1/6ft^2$ where f is the unit stress at the remotest fibre. In sections where there is no thrust, the maximum stress at the remotest fibre may be found by equating the expression for bending moment and the expression for the resulting moment and substituting the numerical values at the section considered. If a thrust exists at the given section, this thrust may be considered to be uniformly distributed over the section and the stress will be equal to the sum or difference of the resisting moment stress and the thrust stress.

For a concentrated load at the crown (Fig. 1) the stress at B, since there is no thrust, may be determined from the formula $1/6 \text{ ft.}^2 = 0.159Qd$ (7)

At A, the same form of expression may be used for the resisting moment, but this must be combined with the stress due to the vertical thrust. Considering this to be uniformly distributed, the stress in the remotest fibres will be

$$F = \frac{Q}{t} + \text{ or } - \frac{0.091}{1/6t^2} \quad (8)$$

The minus sign will be used for the outer fibre and the plus sign for the inner fibre. At any point C (Fig. 1 c) the stress at the remotest fibre may be shown to be

$$f = \frac{1/2 Q\cos\phi}{t} + \text{ or } - \frac{M}{1/6t^2} \quad (9)$$

For a uniformly distributed horizontal load the stress at the crown B will be $f = \frac{1/16\ Wd}{1/6t^2}$ (10)

and at A, $f = 1/2 + \text{ or } - \frac{3/8 Wd}{t^2}$ (11)

and at any point C, (Fig. 3 c) $f = \frac{Wr\cos^2\phi}{t} + \frac{M}{\frac{1}{6}t^2}$ (12)

For a distributed vertical and horizontal load (Fig. 5) there will be a thrust both at A and B. The stresses at the crown B, will be given by the equation

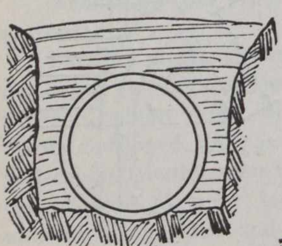
$$f = \frac{QW}{t} + \text{or} - \frac{MB}{\frac{1}{6}t^2} \qquad (13)$$

At A, the extremity of the horizontal diameter

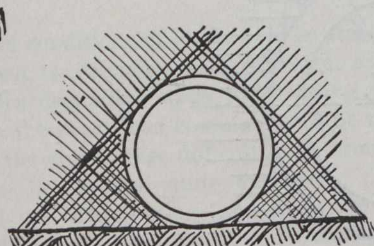
$$f = \frac{W}{t} + \text{or} - \frac{MA}{\frac{1}{6}t^2} \qquad (14)$$

At any point C, (Fig. 5 b) the expression for the stresses may be written $f = \frac{W\cos^2\phi}{t} - \frac{qW\sin^2\phi}{t} + \text{or} - \frac{M}{\frac{1}{2}t^2}$ (15)

These formulae may be applied without any great error to plain concrete rings at the breaking loads, if the modulus of the materials for rupture, obtained under the same conditions of thickness and loading, be substituted for the maximum tensile stress f. For a reinforced concrete ring the conditions are somewhat different from the above. For ordinary cases the bending moment, determined as above, and the resisting moment of the reinforced concrete section may be equated.



8(a).



8(b).

The amount of the tension in the steel at the point A, may be calculated by the formula $f^1 = \frac{f - \frac{1}{2}nT}{t(1 + np)}$ (16)

The formula is applicable for both concentrated and distributed loads. In this formula f is the tensile stress in the steel due to the bending moment, p is the ratio of the area of reinforcement for a unit width of beam to the distance between the centre of the steel and the compression face of the concrete. T is the thrust or pressure against the face of the section, and n is the ratio of the moduli of elasticity of steel and concrete, and equal to fifteen for the experiment. t is the distance from the compression face to the centre of the steel reinforcement.

In the actual tests on pipes the following results were obtained:—

Concentrated load tests: The plain concrete rings broke before there was an appreciable deflection, so no measurements of deflections were made.

The reinforced rings deflected considerably before final failure. At a load of from 1,000 to 2,000 pounds per linear foot fine cracks appeared on the tension face, generally the top or bottom. When higher loads were applied, numerous cracks appeared on the tension faces at the top, bottom, and sides. Two forms of critical failure were seen; one a tension failure of the reinforcing bar at the top or bottom of the ring, and the other a failure of the concrete by the stripping of the concrete from the tension face.

Distributed load tests of reinforced concrete rings: In the reinforced concrete rings cracks appeared early in the test on the tension side at the top and bottom, but the load continued to increase to a load of 15,000 pounds per linear foot. The reinforced concrete rings were much stiffer than the plain concrete rings.

Distributed load tests of plain concrete rings: The plain concrete rings, tested under a distributed load, cracked at the top, bottom and sides at an early load. Later when sufficient side restraint developed the load increased until a considerable difference was shown in the horizontal and vertical diameters.

The critical strength of reinforced concrete culvert pipe where the reinforcement does not exceed, say, 0.75 of 1 per cent., and is of medium steel, may be measured by the resisting moment calculated by the ordinary beam formula. The resistance against diagonal tension and stripping of the concrete over the bars, may be improved by flattening the arc around the top and bottom.

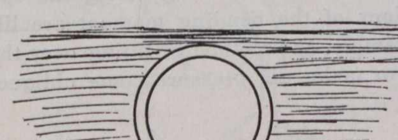
Bedding and loading of pipes: If the layer of earth immediately under the pipe is hard or uneven, or if the bedding of the pipe at either side is soft material or not well tamped, the main bearing of the pipe may be along an element at the bottom and the result is in effect, concentrated loading. This condition may be aggravated in the case of a pipe with a stiff hub or a bell where settlement may bring an unusual proportion of the bearing at the bell and the distribution of the pressure be far from the assumed condition.

In case the pipe is bedded in loose material the effect of settlement will be to compress the earth immediately beneath the bottom of the pipe more completely than will be the effect at one side, with the result that the pressure will not be uniformly distributed horizontally.

In case a culvert pipe is laid in an ordinary embankment by cutting down the sides slopingly, as shown in Fig. 8 a, it is evident that the load which comes upon the pipe will be materially less than the earth weight immediately above it.

In a case where a culvert pipe replaces a trestle and the filling is allowed to run down the slope, as shown in Fig. 8 b, the direction and amount of the pressure against the pipe will differ considerably from that which obtains in a trench or in a case of level filling, shown in Fig. 8 c.

It is possible in this case that the smaller amount of settlement of the earth directly over the culvert pipe, due to the greater depth of earth on adjacent sections, may allow a greater proportion of the load to rest on the culvert pipe than



8 (c).

would ordinarily be assumed. It should be noticed that the distribution of the pressure by means of earth under and over a ring assumes that the earth is compressed in somewhat the same way as when other material of construction is given compression. Unless the earth has elasticity, the uniform distribution of pressure cannot occur. To secure the uniform distribution assumed, the ring itself must give enough to allow for the movement of the earth which takes place under pressure. This is especially true with reference to the presence and utilization of lateral restraint, and a ring which does not give laterally, as for example, a plain concrete ring will not develop lateral pressure in the adjoining earth under ordinary conditions of moisture and filling, to any great extent. As the conditions of earth and moisture produce mobility and approach hydrostatic conditions, the necessity for this elasticity and movement do not exist, but here the lateral pressure approaches the vertical pressure in amount and the bending moments become relatively smaller.

The importance of care in bedding culvert pipes is shown and also the necessity for care in filling over them and there is also great difference of bending moment developed with different conditions of bedding and filling. Where strength is needed, time will be well spent in taking care in the bedding of the pipe and filling around and over it. A little additional labor will add considerable stability, life, strength and safety to such structures, far out of proportion to the added cost. It is also possible that under careful conditions of laying, lighter structures may be used with a saving in the cost of construction

Concrete culvert pipe in use on the Chicago and Illinois Western Railway: The pipes were built for use in low embankments where the top would be eighteen inches below the bottom of the ties and give satisfaction under heavy freight traffic.

The pipes were made in the shape of hollow cylinders with square ends, and they were four feet in length. They were molded with an interior of four feet with six-inch shells giving an outside diameter of five feet. The pipes were laid end to end in trenches cut as near to the shape of the pipes as possible and were covered with earth thoroughly tamped around the top and sides.

The concrete used in manufacturing these pipes was composed of American Portland cement, limestone screenings and crushed limestone that has passed through a ¾ inch diameter screen after everything that would pass through a ½ inch screen had been removed. The concrete was mixed in the proportions of one part cement to three and a half parts each of screenings and crushed stone. All except form work was done by common laborers. The pipes were left in the forms till the morning of the day after molding, the average time being sixteen hours.

(To be continued.)

ACCIDENTS IN AMERICAN COLLIERIES.

The United States Bureau of Mines has compiled statistics which show that during the calendar year 1912, 2,360 men were killed in and about the coal mines of the United States. Based on an output of 550,000,000 tons of coal produced by 750,000 men, the death-rate per 1,000 employed was 3.15 and the number of men killed for every 1,000,000 tons of coal mined was 4.29. The number of men killed was the least since 1900, the death-rate per 1,000 employed was the smallest since 1899, the death-rate per 1,000,000 tons of coal mined was the lowest, and the number of tons of coal produced in proportion to the number of men killed was the greatest on record. The following are the figures for the past few years:—

Years.	Number Killed. Total.	Per 1,000 employed.	Per 1,000,000 short tons mined.	Production per death, short tons.
1907.........	3,197	4.88	6.93	144,000
1908.........	2,449	3.64	6.05	165,000
1909.........	2,668	4.00	5.79	173,000
1910.........	2,840	3.92	5.66	177,000
1911.........	2,719	3.73	5.48	183,000
1912.........	2,360	3.15	4.29	233,000

SEWAGE DISPOSAL BY DILUTION.

By Horace S. Griswold.*

The general principles of sewage disposal and information as to the various methods used have been discussed in *The Canadian Engineer* several times over, but the following extracts from a paper by Horace S. Griswold, of the University of California, on "Sewage Disposal by Dilution" with special reference to inland streams, will no doubt be of interest to all readers connected with work of that character. The general outline followed comprises seven heads:

1. Sources and Composition of Sewage.
2. Decomposition of Sewage.
3. Present Status of Sewage Disposal.
4. Sewage Disposal by Dilution.
5. Clarification of Sewage by Screening.
6. Sewage Effluent and the Diluting Stream.
7. Conclusions Based on California Conditions.

He goes on to say:—

Sewage is the used water supply of a community; composed ordinarily of the drainage from sinks, the discharge from water closets and baths of hotels, apartments and residences; the wastes from bakeries, laundries, stables, saloons, butcher shops; together with rain water from roofs and washings from streets. In general appearance sewage resembles soapy, dirty, wash-bowl water, but with the addition of various floating matters such as pieces of paper, rags, matches, bits of vegetables, fecal matters and other waste materials.

The refuse from slaughter houses, discharges from hospitals and sanitariums, the wastes from breweries, tanneries or canning establishments may be added to the residential wastes. Sewage, then, contains all excreta of human life and excreta of industrial life of various forms.

In spite of the variety of objectionable materials of different sorts conveyed by water carriage, fresh sewage is comparatively inoffensive to sight and has only a slight odor. This is due to the extreme dilution in which these matters are carried. According to Messrs. Kinnicutt, Winslow and Pratt, the sewage from an average residential American city will contain only from two hundred to eight hundred parts of solid matters out of one million parts of sewage (0.2 to 0.8 of a gram per litre), or less than one-tenth of one per cent. This solid matter is half mineral and half organic, with about seventy five per cent. of the mineral and sixty per cent. of the animal and vegetable matters in solution.

Residential sewage is influenced in its character by the relative content of the bodily wastes. The character and composition of the bodily wastes depends upon the type of food the body is receiving as its fuel.

The body uses as its material for developing energy and repairing wastes a rather restricted list of substances known as food stuffs. These ordinarily include:

1 Water,
2 Inorganic salts,
3 Proteids and albuminoids,
4 Carbohydrates,
5 Fats.

Water and the inorganic salts are of no particular significance in the present discussion.

The proteid and albuminoid bodies, found in such foods as meats, cheese, eggs, gelatin, containing C, O, H and N as the basic elements, are extremely complex in character, but are rather readily broken down into simpler compounds.

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The carbohydrates are familiar in every day life in the various starches and sugars, and are relatively simple in structure. The fats, butter as an example, are among the less complex organic compounds, but are more stable, relatively, than either the nitrogenous or the carbohydrate group.

These substances are taken into the body, utilized by it through the processes of digestion and nutrition; and the waste products are given off in the sweat, the breath, the sputum, the urine and in the feces.

The feces are of importance as one of the main constituents of sewage and are composed primarily of:

1. Various indigestible materials, ligaments of meat and cellulose from vegetables.
2. Portions of various undigested materials, fragments of meats, fats, vegetables.
3. Certain products of intestinal secretions.
4. Products of intestinal bacterial decomposition.
5. Inorganic salts of various sorts.
6. Bacteria, harmless or pathogenic, in vast numbers.

The bacterial content per day in the feces of the normal adult has been determined as about thirty million million, and constitutes some thirty per cent. of the total weight in the dry solid matter of the feces.

When it is remembered that typhoid and dysentery are all too common; that the bowel discharges of a person suffering from these or other intestinal diseases may contain the specific germ in vast numbers, then the danger of sewage to the health of the community begins to be manifest.

Sewage, after being deposited in a sewer, does not long remain in its original condition; natural processes occur which completely transform its character. The process of change is commonly spoken of as decomposition.

2. Decomposition of Sewage.—In what follows, the term fermentation will be defined as "the action of micro-organisms upon carbohydrates." The term putrefaction will be defined as "the action of micro-organisms upon nitrogenous substances," i.e., proteids and albuminoids. Both fermentation and putrefaction are brought about by enzyme action. Decomposition will be defined as "the action of micro-organisms upon organic substances." Thus decomposition may mean fermentative action, or putrefactive action or both.

After many years of observation and study, it has been determined that the animal and vegetable constituents of sewage decompose from their original complex, unstable, organic form to a simple mineralized form. The final mineralized form closely resembles ordinary humus in appearance and composition. The change from the complex to the simple is brought about by a process of fermentation and putrefaction occurring in two related phases. The first phase is accomplished by the enzyme action of those sewage bacteria that live and multiply without air. The second phase is affected by sewage bacteria requiring oxygen. The two phases are not entirely separate and distinct; under certain conditions it is possible to have both anaerobic and aerobic decomposition occurring simultaneously.

The process of decomposition consists of the hydrolyzing and liquifaction of some of the simple compounds; a breaking down in structure of the more complex ones to those of less complexity, and finally, the complete oxidation and nitrification of these relatively simple substances. Gases of a more or less objectionable character, CO_2, CH_4, H, N, NH_3, H_2S, are liable to be among the products of these decomposition steps.

3. Present Status of Sewage Disposal.—Since the very earliest times it has been the effort of man to rid himself of the waste products of his life with the least trouble and danger. The method has progressed and developed from its original simple personal state, through the various processes of disposal by means of trench, midden heap, privy and dry earth closet, to the present almost universal system of water carriage. This system is used by the community, for the benefit of the community and is under community control. The water conveying and disposal of the wastes of life has been found so convenient and simple that for years, with no thought of danger, communities discharged their crude sewage into the nearest watercourse. Conditions of positive physical nuisance, brought about by an overloading of the streams, finally forced a restriction on and a governing of the method.

For many years the opinion was held that sewage, in almost any quantity, might be safely placed in a stream, as the flowing water would purify itself. To-day, however, it is known that flowing water is dangerous in so far as it rapidly conveys polution from distributor to consumer. The greater the lapse of time between the deposit of pollution in a water supply and the drinking of that water, the better for the consumer.

In spite of the fact that there is a self purification of water through natural agencies, sanitarians of to-day discountenance the unfiltered use of an inland stream for water supply purposes.

The self purification of a stream may be satisfactory as regards the removal of nuisance, but there is no surety as to the bacterial purification at all times. There are many natural probable sources of pollution of these waters, so that sewage clarification to the extent of preventing nuisances should ordinarily be sufficient for sewage effluents entering most inland streams.

The placing of crude or clarified sewage in any body of water as a method of disposal, is spoken of as disposal by dilution.

4. Sewage Disposal by Dilution.—There are three general conditions governing the disposal of sewage by dilution:

1. Disposal by dilution in inland streams.
2. Disposal by dilution in lakes.
3. Disposal by dilution in tidal waters.

When disposing of sewage by dilution in inland streams, particular care must be observed with regard to the following:

1. The diluting body should show no floating matters which are offensive or which might strand on the banks of the stream.

2. A sufficient portion of the settling matters of the sewage should be removed to prevent the formation of mud banks; care should be taken to insure a proper relationship between the velocity of the stream and the size of the materials admitted to it.

3. The relation between the volumes of sewage and the diluting water should be such as to insure an aerobic decomposition of the sewage. It is also desirable to insure a residual oxygen content in the stream sufficient to maintain the major forms of fish life.

4. The question of a sewage containing a large amount of trade wastes will require a particular study for each case.

The removal of floating bodies which are objectionable or which might strand is very readily accomplished in any of the clarification processes:

1. Screening.
2. Sedimentation.
3. Chemical precipitation.
4. Septic tank process, either of the Cameron or the Imhoff type.
5. Single contact beds.

It should be distinctly noted that these processes are simply methods of clarification, the sewage effluent from them is highly organic and unstable and must acquire from some outside source sufficient oxygen to complete the process of decomposition to a condition of stability.

Of the clarification processes noted, perhaps the most simple under favorable conditions is that of screening.

5. Clarification of Sewage by Screening.—The use of screens for the removal of settling and suspended matters has been extensively followed in Europe for some years and to-day we are employing them more and more, as the opportunity offers, as a method of clarification. Screens may be classed as coarse or fine. The first type consists of gratings or bars; the second are generally constructed as a net mesh.

Coarse screens are used to remove all gross refuse matter which might be objectionable. When sewage is pumped, screens are installed to protect the pumps. Such screens are generally limited to minimum clear openings of about one-half inch. In design they may be either of the fixed or movable type. The fixed screen may be of bars, iron or wood, set upright or horizontally. The fixed grillage is hand cleaned with a rake whose teeth fit the clear spaces. The upright screens are best set at a slight inclination, generally with the direction of flow. The movable grating may consist of:

1. Fixed rods with movable scrapers.
2. Movable rods with fixed scrapers.
3. Movable screens with fixed scrapers.
4. Movable screens with movable scrapers.

Screening devices require constant attention to prevent severe clogging and resultant backing up of the sewage, and should in general be installed in duplicate to admit of continuous operation.

The amount of screenings removed per million gallons of sewage clarified will vary greatly, depending entirely upon local conditions. So also will the cost of removing the screenings. Foreign practice appears to allow from ten to thirty square feet of screen per million gallons of sewage treated per day.

Fine screens or sieves deal primarily with the settling and the suspended organic matters. These screens are either fixed or movable and, to operate successfully, care must be taken:

1. That the screenings do not disintegrate on the screen.
2. That no deposits are formed in the screen channel by the blocking of the screen and the backing up of the sewage.
3. That the screens be easily adapted to variations in flow.
4. That continuous operation be insured by easy interchange of screens or duplication of installation.

Various endless belts with different kinds of scrapers have been developed and have filled the particular needs in a satisfactory manner. These fine screens have a minimum mesh clearance of about one-thirteenth of an inch. General practice allows from ten to fifty square feet of screen per million gallons of flow.

Perhaps the most well-known fine screen developed in the country is the Weand Segregator. The original unit is installed at Reading, Pa., and has a capacity of eight million gallons' flow per day. This rotating screen consists of an iron and steel horizontal cylindrical frame, six feet in diameter and twelve feet long, upon which is placed forty mesh Monell metal wire cloth, protected by a five-eighths inch mesh copper screen.

The sewage enters at one end of the cylinder on a line with the horizontal axis, flows over a spreading plate and drops upon the screen. The water of the sewage passes through the cloth, while the solids are carried upward by the rotating screen till opposite a series of oscillating jets outside of the cylinder, which force them from the cloth. The screenings fall to the bottom of the cylinder and are carried by a worm conveyor to a point of storage.

This screen removes from thirty to thirty-five cubic feet of wet matter per million gallons of sewage screened. The screenings contain about ninety per cent. of moisture.

A screening installation of any type must accomplish certain definite results. The particular governing conditions will depend largely upon the relation between the sewage flow and the diluting stream.

6. Sewage Effluent and Diluting Stream.—All surface waters in their unpolluted state contain atmospheric oxygen to a greater or less extent, depending on such factors as temperature, atmospheric pressure, kind and quantity of aquatic life. When clarified sewage effluents are placed in these waters, this dissolved oxygen is utilized by the organic matters of the effluent to complete the process of decomposition. The relation between the volumes of effluent and diluting water should be such as to supply all the oxygen needed by the suspended and dissolved organic matters of the sewage. In addition thereto there should be unconsumed a residual oxygen content of from thirty to fifty per cent. of complete saturation, at the particular temperature and pressure.

When either crude or clarified sewage is placed in a stream in such quantity that it completely exhausts the oxygen content of the water, then the normal aerobic decomposition ceases. The unobjectionable process becomes a most obnoxious anaërobic one, with no final condition of stability.

This has been the experience of many cities in this country and of the larger cities of Europe which continued to discharge sewage into a stream without regard to the capacity of that stream to decompose sewage. The changing of the Thames into an immense cesspool was experienced by London during the summers of 1858-59, and has been most vividly described by Budd in his monograph on typhoid fever. "Stench so foul, we may well believe, had never before ascended to pollute this lower air. Never before, at least, had a stink risen to the height of an historic event. Even ancient fable failed to furnish figures adequate to convey a conception of this thrice Augean foulness. For many weeks the atmosphere of Parliamentary Committee Rooms was only rendered barely tolerable by the suspension before every window of blinds saturated with chloride of lime, and by the lavish use of this and other disinfectants. More than once, in spite of similar precautions, the law courts were suddenly broken up by an insupportable invasion of the noxious vapor. The river steamers lost their accustomed traffic, and travellers, pressed for time, often made a circuit of many miles rather than cross one of the city bridges."

The experience in the past of many American cities has led to the conclusion that a minimum flow of from 4 to 7 cubic feet per second per 1,000 of population sewering into a stream is necessary to prevent the formation of a nuisance; providing the stream has sufficient velocity to prevent the formation of sewage mud banks. Roughly, it has been found that a stream will purify one-fiftieth of its volume of sewage but not one-twentieth.

It is not possible to set definite limits as to the amount of sewage containing trade wastes, that may be cared for by a stream. Biological and chemical factors have to be very carefully considered. Wastes containing objectionable foreign particles, acids, or alkali, or other materials poisonous to the life in a stream create entirely different conditions from those obtaining when domestic sewage alone is discharged into a stream.

7. Summary and Conclusions.—Sewage is a mixture of highly complex organic substances and, under certain conditions, will form offensive decomposition products. Sewage may contain pathogenic organisms in large numbers.

A satisfactory disposal by dilution, whether preceded or not by a clarification process, is only to be had in streams possessing a satisfactory diluting volume. Streams having a large variation between maximum and minimum flow conditions, are particularly liable to give rise to nuisances.

Satisfactory disposal by dilution implies the avoidance of physical nuisance; it does not imply a satisfactory bacterial removal.

The streams of California, with the possible exception of the Sacramento and the San Joaquin, do not exhibit sufficient dry weather flow to receive the clarified sewage of communities, and so dilute it as to avoid nuisance.

All questions of legality waived, it would seem that natural stream conditions in California preclude the consideration of sewage disposal without purification.

This conclusion is based on the impossibility of avoidance of stream nuisance.

HYDRAULIC DREDGE "PORT NELSON."

The 24-inch hydraulic dredge "Port Nelson," built by the Polson Iron Works Toronto, for the Department of Railways and Canals, was successfully launched on Saturday, May 31st, five weeks after the material was ordered, which constitutes a record in the history of Canadian shipbuilding. It was christened by Mrs. Hearst, wife of Hon. W. H. Hearst, Minister of Lands, Forests and Mines in Ontario. The contract for the dredge, which amounted to $270,000, was placed by the government in the beginning of April and the company expect to deliver the dredge in Montreal before the expiry of the contract time. It was designed by Wm. Newman, M.I.N.A., and following is a description of the dredge: The dimensions of the hull are as follows:—

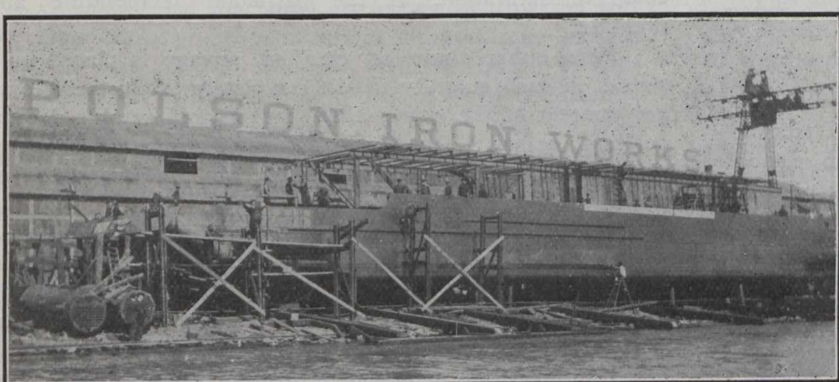


Fig. 1.—Showing the "Port Nelson" on the Ways.

Length	180 ft.
Beam over all	44 ft.
Depth at side	11 ft.
Draft, about	6 ft.

The dredge is to be of scow model with a spoon bow, as shown on drawings, and is to have circular bilges with 18-inch radius. All material and scantlings are designed up to, and in most cases above, Lloyds' requirements.

As the dredge will be towed around the Labrador coast to her destination, which is Port Nelson, and for which the government are now calling for tenders, her design and structure throughout are being made amply strong to enable her to take this trip with safety, the shell plates being ½ inch throughout, and keel plates ⅝ inch. The sheer plate extends 3 feet above the main deck and is surmounted by heavy steel bulwark rails, these lending additional longitudinal strength to the structure.

The deck stringers are ⅝ inch thick, and the deck itself is ¼ inch chequered plate. The deck housing is of steel structure of ¼ inch plate, and will be divided into three parts by two longitudinal watertight bulkheads. The framing is exceptionally heavy, with 10-inch channel floors weighing about 25 pounds to the foot, and located 20 inches apart. The side frames and deck beams are all 6-inch 15-pound shipbuilding sections. The longitudinal girders used are of 15-inch channel, 35 pounds to the foot, and the longitudinal truss frames are of 12-inch 25-pound channels.

There are two 26-foot metallic life boats and two life rafts.

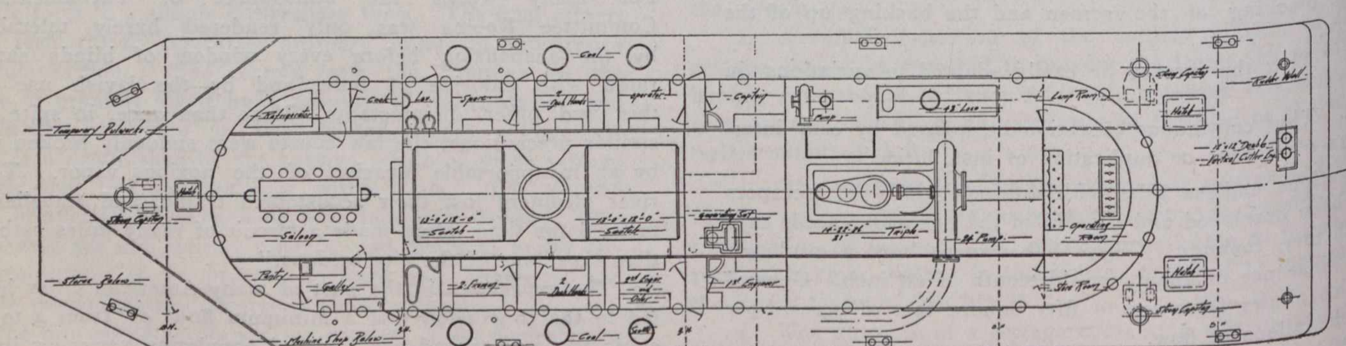


Fig. 2.—Showing Plan of the "Port Nelson."

The dredge will be equipped with a complete electric light outfit and search lights. A complete machine shop outfit consisting of air compressor, planer, lathe, drills, etc., will be installed so that the dredge will contain the necessary outfit for effecting any repairs required from time to time.

It will have a discharge pipe of 24 inches in diameter, and the hull will be divided into six water compartments by five transverse bulkheads.

The main engine for driving the pump is of the marine triple expansion type; cylinders 14 inches and 22 inches and 36 inches in diameter by 21-inch stroke. There are two Scotch boilers 13 feet in diameter by 12 feet long. In addition to these there is an auxiliary boiler of the locomotive marine type situated on deck, being 48 inches in diameter by 14 feet long, and alongside of this is an 8-inch wrecking pump.

The dredge will be equipped throughout for salt water service, with surface condenser and copper piping. The circulating water will be supplied by an 8-inch centrifugal pump driven by a 6 x 7-inch vertical engine. The air pump is of the vertical simplex beam type. It will also be equipped with feed and bilge pumps. For the purpose of raising and lowering the suction pipe, a 12-inch by 12-inch, two-cylinder double-acting engine will be provided on the main deck forward. There will also be three capstans provided, operated by 6-inch by 8-inch double-acting engines. The boom for raising and lowering the suction pipe is located at the suction end of the dredge, is 64 feet in length, and is built up of steel shapes and plates throughout.

The cutter engine consists of 12 x 12-inch two-cylinder doublt-acting horizontal engine. The cutter head is 5 feet in diameter, with a spare cutter head 4 feet in diameter.

A general fire service pump, hand deck pump, and necessary hose to reach all over the ship will be furnished with the dredge.

The gallery, dining room, cabin and crew's quarters will be fitted up and furnished complete. The dredge will also be supplied with 3,000 feet of piping and pontoon for the discharge. It will commence operations at Port Nelson this summer, where a harbor thirty feet deep at low tide will be dredged, thus giving Canada her first ocean port of any importance on Hudson Bay. Some $4,000,000 has been appropriated by the government for this year's work, which will be supervised by Mr. H. T. Hazen, engineer for the Department of Public Works.

STANDARD OF ABRASION FOR PAVING BRICK.

The organizations of city officials interested in standardizing paving specifications adopted a standard rattler for making abrasion tests and standard methods of making the tests but did not see fit to specify the maximum allowable amount of abrasion until a year or so ago. After two or three trials the specification has been set at 22 per cent. with proviso in the specifications of the American Society of Municipal Improvements that "where medium or light traffic or other conditions exist which, in the opinion of the engineer, do not require a brick capable of giving an abrasion loss of only 22 per cent., brick of a quality which will give a loss of 25 per cent. or even 28 per cent. may be used.

SPECIAL LIBRARIES' ASSOCIATION.

The fifth annual meeting of the association will be held at the Hotel Kaaterskill, Catskill Mountains, New York, June 24th to 26th, 1913.

Information regarding hotel arrangements can be had from Harrison S. Downs, 19 to 21 West 44th Street, New York City. Travel information can be had from F. W. Faxon, chairman, Travel Committee, 83 Francis Street, Boston. An attractive post conference trip will be arranged by the travel committee in the Lake Champlain district.

COAST TO COAST.

Vancouver, B.C.—Timber as an asset of provincial wealth is daily becoming of greater value. With the opening of the Panama Canal and the free entrance of lumber into the United States, British Columbia timber will, it is predicted, be more sought after than ever. "The day of $2 timber is long past," was the answer of Mr. R. C. Bidlake, of the Snowdon-Bidlake Logging Company, of this city, when asked concerning the value of standing timber. "Values are advancing rapidly, and it is impossible to-day to buy at anything like the figures of a year or two ago. For good timber that can be taken out at a reasonable cost, say, on Crown grants, it is very doubtful if anything can be bought under $2.50 a thousand feet, taking the general run of the cruise, and figures over that are happening every day. Only a week or so ago a tract of one hundred million feet on Menzies Bay, Vancouver Island, was sold for $3 per thousand feet, and another recent purchase of a tract a little smaller also went at $3. Then there was the purchase on the Lower Lillooet a few weeks ago, also quoted at $3. Crown-granted timber is in strong demand, and very few small tracts can be had for less than $3. That it is being paid shows that the timber is worth it. Besides, at that figure buys are good, since values are advancing. A factor in determining values also is whether the logs have to be towed down the coast, for losses are bound to occur."

Edmonton, Alta.—The city council has authorized the commissioners to spend $125,000 upon further provision for the sedimentation and filtration of water at the present pumping station. This sum is to be used in the construction of a 5,000,000 gallon sedimentation basin and filter units with a total capacity of not less than 4,000,000 gallons, together with a clear water basin to take care of the same. In this connection the commissioners reported as follows: "We feel that this is not making too great a provision to take care of the water in the interval between now and the time that the new waterworks scheme might be ready for operation. If this amount is authorized, work can be proceeded with very shortly with the construction of a sedimentation basin, and tenders received for the construction of the filters and the clear water basins. We estimate that the sedimentation basin will cost in the neighborhood of $50,000; filters and clear water basin, $64,000, the housing, pipes and incidentals to make up the balance. Judging from the increase of population during the past year, and taking the same percentage of increase for another four years, our population will then be in the neighborhood of 120,000, and the provisions made are not too ample to take care of, and give satisfactory service for, the intervening years." A motion was made and adopted that the report be accepted, that the commissioners be instructed to proceed with the work specified this year in order that the filters may be in operation by next spring, and that the city solicitor bring down the necessary by-law covering the expenditure. If good progress is made upon the work there should be no more muddy water at the time of the spring freshets, which will become forever a matter of painful memory—the muddy water, not the freshets.

Montreal, Que.—Mr. Norman M. McLeod, contractor in charge of Montreal's big filtration plant, to cost about three million dollars, has sent a notarial protest to the city, saying that the structural design is unfitted for the bearing power of the soil, as proved by the subsidence of certain work. He says that he will do the repairing to the cement work damaged by frost, but he wishes to be relieved of all responsibility for the failure. The protest recites the history of the contract and the notice received on April 3 to make good damage to cement, which was attributed to frost. Mr. McLeod says also that on May 12, the city protested to him to go on with and make good the work said to have been damaged by frost, and repudiating his charges of defective foundations. The following serious errors in the design of the structure are named by Mr. McLeod: 1. In regard to the original irregularity of the surface of the ground, which necessitated lowering high places and filling in low ones, thus offering unequal bearing capacity for the foundations, the structure should have been designed to provide for footings of proportionate bearing capacity to prevent unequal settlement. 2. That the structural features of the building should have been designed to be separate and distinct from those features dictated particularly by the object for which the building is to be used, the footings and piers being carried down to a firm foundation separate or otherwise, supported with due regard to the nature of the material on which the structure is to be founded and independent of the floor. 3. The construction and design of the arch system is such as to have aggravated any damage or disturbance beyond what would ordinarily occur. 4. The floors and walls should have been designed to be absolutely watertight in view of the fact that even so small an amount of leakage as that allowed by the specifications into soil of the nature in question will undoubtedly cause settlement or subsidence, which must result in the cracking of the floor walls and the certain failure of the structure.

Ottawa, Ont.—At the sittings of the Board of Railway Commissioners to be held in Ottawa on Tuesday, June 17th next, the board will take into consideration the proposition that, by limiting the height of freight cars operated on railways subject to its jurisdiction to 13 feet 6 inches from the top of rail to the running board, trainmen would be safeguarded, and grade separation facilitated; also of the proposals submitted by the Canadian Freight Association in conformity with the suggestion that this object would be promoted by basing the minimum weights of the Canadian freight classification for light and bulky articles on the cubical capacity of box cars, instead of on their length, as at present.

Ottawa, Ont.—The Government has decided to institute a new departure in connection with the forestry branch which will undertake the work of investigating the possibilities of conserving our forests by reducing waste in manufacture, by prolonging the life of forest products used in construction, and developing uses for products now wasted for the lack of knowledge as to how they may be employed. To take charge of this work Hon. W. J. Roche, Minister of Interior, has selected A. G. MacIntyre, at present editor of the "Pulp and Paper Magazine," and acting secretary of the Pulp and Paper Association. Mr. MacIntyre is a graduate of Acadia University, and he also graduated from McGill University in chemical engineering. He was chemical engineer of the Jonquiere Pulp Company, where he had charge of the water power, water discharge measurements, etc., and he put in a bleaching system of his own design, saving in the value of the paper. He was also engineer in charge of construction for Price Bros. at Kenagami, Que., and did the investigation for the new sulphite mill. His special qualifications should assure the successful carrying out of the project. The work will be carried on at present in co-operation with McGill University. The various classes of investigation to be carried out will be as follows: Wood tests, timber physics, wood preservation, wood distillation, and wood pulp. This is an advanced step on the part of the Department of the Interior The forestry branch is one in which Dr. Roche has been particularly interested, and this new step is along the lines of modern scientific forestry work in Germany and other European countries. To fulfil the prime object of forestry, which is to preserve and conserve our forests, it is felt this line of development must be undertaken.

Calgary, Alta.—That it will be inadvisable to establish a filtration plant on a large scale until Calgary definitely settles the question of source of water supply is the emphatic statement of Waterworks Engineer A. Ellison Fawkes. Mr. Fawkes discussed the situation at some length after having consulted Saturday with T. Aird Murray, of Toronto, one of the recognized authorities on water supply in America. At the present time Mr Fawkes is having erected a temporary chemical purification plant which will be part of the pumping station supplying water from the Bow River as a standby to the Elbow River gravity system. This pump will afford a 20,000,000 gallon supply daily from the Bow River, and the water will be treated with hypochloride and sulphate of aluminum. At the present time, the water taken from the Bow is treated only with hypochloride, which effectually kills all germicidal life. The addition of aluminum sulphate to the water, however, will also remove suspended matter and the chemical precipitates, giving a clarity of about 75 per cent. The hypochloride makes the water practically pure so far as typhoid and the like are concerned, having an efficiency of about 98 per cent. The by-law carried an appropriation for $50,000 for the establishment of a turbidity filtration system in connection with the Bow pumping station, but Mr. Fawkes decided that it would be impossible to erect a proper filtration system at this point under a cost of $400,000. To spend such a sum on a filtration plant when the city is as yet undecided whether the supply shall ultimately be obtained by gravity from mountain streams or lake in the Rocky Mountains, the waterworks engineer considers foolish. He discussed these points with Mr. Murray when that expert looked over the water situation here, and Mr. Murray agreed that the temporary chemical treatment of the water is the best solution of the problem at present. It costs less than $500 to install the chemical treating apparatus at the Bow River station, and it will soon be in working order. According to Mr. Fawkes, the aluminum sulphate not only removes suspended particles from the water, but also removes the chemicals after their work is done. When added to the water, the aluminum sulphate spreads out in a glutinous form and collects the infinitesimal particles of suspended matter, the dead germicidal matter which has been killed by the hypo-sulphide, and also the precipitate formed by the hydro-sulphide after the chemical reaction takes the addition of the aluminum sulphate and is then strained out through a series of screens. The water comes out 98 per cent. pure, so far as germ life is concerned, and 75 per cent. clear of suspended matter as silt, clay and the like.

Port Coquitlam, B.C.—Engineers for the cities and municipalities on the route of the proposed highway to Port Coquitlam have begun preliminary surveys of the grades with a view of estimating the cost. It is probable that a new road will be built between the North road and Port Moody on an easier grade than that of the present highway. The engineers forming the party were: City Engineer Fellowes, Vancouver; Engineer McPherson, Burnaby; Col. Davis, Port Moody; Engineer Kilmer, Port Coquitlam. In addition to the new road from the North road to Port Moody, City Engineer Fellowes believes that there ought to be a new route from the Vancouver city boundary to Barnet to eliminate some of the heavy grades on Hastings Street. He also advocates that Pender Street be made the main route out of the city because of Hastings Street being a car line thoroughfare. Profiles will be drawn of the various sections and another meeting will be held later. The plan will then be laid before the Provincial Government with a request for financial assistance.

Vancouver, B.C.—Encouraging reports of the manner in which the interior of the province in the Hope district is filling with ranchers are brought back to the city by Mr. George D. McKay, provincial timber inspector, who returned to this city recently after a visit of inspection of the forest fire protection service. "It is four years since my last visit to the district, and I was amazed at the great alteration," said Mr. McKay. "All along the route of the new Pacific Highway the land is occupied with ranches, and the country looks prosperous. The Pacific Highway is going to be a wonderful thing to enable our residents to see the scenic beauties of the province, and will attract thousands of wealthy automobilists here, too," said Mr. McKay. "The roadway is being cut through a hundred-mile stretch of the most wonderful scenery imaginable. It is twenty-four feet wide all the way, and will start from Chilliwack and run clear through to Hope, and thence on to Silver Creek and the summit of the Cascades, striking the old Dewdney and Similkameen trails to Nicola and the Boundary country. There are wonderful views of mountain and valley scenery, nearly the whole way. It will be one of the great resorts for automobilists who want to see Nature at her grandest." Superintendent Sutherland and his staff of 100 men have already got sixteen miles of road in the Yale district completed, and are following up the work as fast as the snow disappears in their path. Mr. McKay does not anticipate any danger from floods in the Chilliwack district unless the thaw from the mountains should be delayed, and a heavy drainage comes down toward the middle of June, when a high tide is due. The tide from the ocean backs up the waters of the Fraser River as far as Sumas, and the danger to be feared is that the high tide should come at a time when the river is swollen with the mountain thaws.

PERSONAL.

MR. DOUGLAS SPENCER, of London, England, arrived in Toronto this week. Mr. Spencer's visit is a strictly business one. While here he is making his headquarters with the Canadian Boving Company of this city.

MR. GEORGE IRVINE has been appointed Canadian manager for the National Meter Company, of New York. Mr. Irvine will make his headquarters at 229 Spence Street, Winnipeg. He is a Canadian by birth and fully familiar with conditions existing in Canada. He has been in the employ of the National Meter Company for nearly twenty years, and has had long practical experience in connection with waterworks matters.

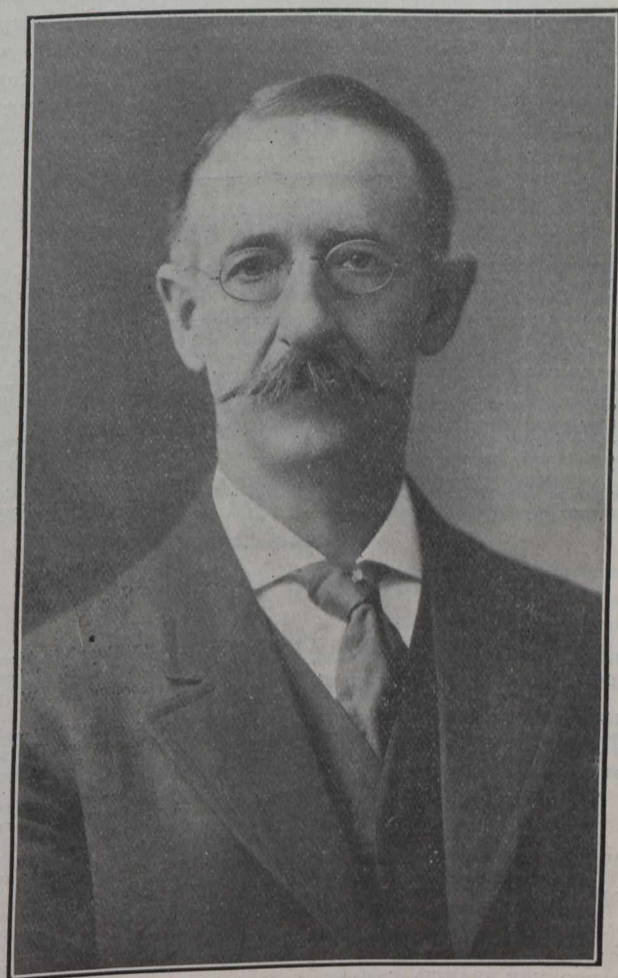
MR. SAMUEL HILL, president of the American Road Builders' Association, at the invitation of President George McAneny, of the Borough of Manhattan, and President Cyrus C. Miller, of the Borough of the Bronx, New York City, on May 26th delivered an illustrated address on the subject "The Highways of the Northwest" at the residence of President McAneny, before an assemblage of over fifty municipal engineers who are in charge of the highways of Greater New York.

OBITUARY.

MR. J. K. McLEAN, Dominion Land Surveyor at the Sarcee Reserve, near Calgary, died on May 23. Deceased was the eldest son of the late Donald McLean, formerly collector of inland revenue in Guelph. He was a resident of Ottawa.

THE PRESIDENT OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

It gives us great pleasure this week to be able to present to the readers of *The Canadian Engineer*, a portrait, together with some facts relating to the career of Professor George F. Swain, President of the American Society of Civil Engineers, which society is to hold its summer meeting in the city of Ottawa this month. Owing to the fact that many of our readers are members of both the Canadian and American societies, we feel they will be interested in learning something about the career of Professor Swain.



Prof. Geo. F. Swain.

George Filmore Swain was born 2nd of March, 1857 in San Francisco. His father was a prominent citizen of that city and a leading merchant. It was while he served as president of the Chamber of Commerce, that he was appointed superintendent of the branch mint during the Presidency of Abraham Lincoln. Swain, Jr., received his preparation for college at a military school. When sixteen years of age he became a student at the Massachusetts Institute of Technology. His teacher in civil engineering was Professor John B. Henck. In 1871 Mr. Swain received the degree of Bachelor of Science. This was followed by courses of study in Berlin, Germany, where he specialized in bridges, railroads and hydraulics. He returned to the United States in 1880, and shortly after was appointed instructor in civil engineering at the Massachusetts Institute of Technology. He was soon promoted to the position of assistant professor, and a few years later, in 1881, became full professor in charge of the department of civil engineering. In 1909 Professor Swain was offered and accepted the Gordon McKay professorship of civil engineering in the graduate school of applied science, Harvard University. In 1893 upon the organization of the Society for Promotion of Engineering Education, he was appointed the second president of that society. His publications include Notes on Hydraulics and also on Structures, for the use of his classes. In 1887 he contributed a paper to the American Society of Civil Engineers on the "Calculation of Stresses in Bridges for Concentrated Loads," which paper has had a very marked effect upon present practice so far as structural computations and investigations are concerned. Professor Swain has served on a number of different commissions, among them being the Boston Transit Commission organized for the construction of the Boston Subways; the commission appointed to fix the method of eliminating grade crossings in various parts of New England, and has in very many cases been called as an expert in court cases, not only in Massachusetts but elsewhere.

COMING MEETINGS.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, C. E. Bawden, Birkbeck Bld., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE CANADIAN FORESTRY ASSOCIATION.—National Convention will be held in Winnipeg, Man., July 7-9. James Lawler, Secretary, Canadian Forestry Association, Canadian Building, Ottawa.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memorial Museum, Ottawa.

NATIONAL ASSOCIATION OF CEMENT USERS.—Tenth Annual Convention to be held at Chicago, Ill., Feb. 16-20, 1914. Secretary, E. E. Kraus, Harrison Bld., Philadelphia, Pa.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—176 Mansfield Avenue, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, A. B. Lambe, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Decary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

CALGARY BRANCH—Chairman, H. B. Mucklestone; Secretary-Treasurer, P. M. Sauder.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson, Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290. Meets 2nd Thursday in each month at Club Rooms, 534 Broughton Street.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSIOCATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ALBERTA ASSOCIATION OF LAND SURVEYORS.—President, L. C. Charlesworth, Edmonton; Secretary and Registrar, R. W. Cautley, Edmonton.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, A. C. Garner, Regina; Secretary-Treasurer, H. G. Phillips, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, The Thor Iron Works, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, C. E. Bawden, Birkbeck Bld., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary. James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary. H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, James Coleman; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, F. C. Mechin; Corresponding Secretary, A. W. Sime.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Edmund Burke; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Bedford McNeill; Secretary, C. McDermid, London, England, Canadian members of Council:—Prof. H. W. Claudet, J. B. Porter, H. E. T. Haultain and W. N. Miller and Messrs. S. S. Fowler, R. W. Leonard and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, J. L. Doupe; Secretary-Treasurer, W. B. Young, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary. H. E. Moore, 195 Bioor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.—Kingston, Ont. President, W. Dalziel; Secretary. J. C. Cameron.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman. Alfred Burton, Toronto, Secretary.

TECHNOLOGY CLUB OF LOWER CANADA.—President, F. E. Came; Secretary-Treasurer, E. B. Evans. Meets twice yearly.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.