PAGES

MISSING

Volume 21. Toronto, August 10, 1911

Contents of this issue on page 165

The Canadian Engineer

An Engineering Weekly.

THE SCIENTIFIC STUDY OF NAVAL ARCHITECTURE IN GERMANY.*

GEHEIMER REGIERUNGSRAT PROFESSOR FLAMM.

It may sound strange if, in the land of ships—the land that has probably done the most towards the practical and scientific development of the whole domain of shipbuilding—I take upon myself to describe the aims of scientific study in Germany, and the methods which it is now adopting. If, however, we reflect that, on account of the exceptionally rapid and accurate exchange of ideas which now take place between the civilized countries of the world, every successive generation, as it springs up, finds it easy to avail itself of the whole of the material which the past and present fellow-craftsmen of all countries have collected, we see that all nations are thereby enabled to attain a similar development from the same bases, and to make similar advances in the various domains of engineering.

Apart from small unimportant beginnings, the real nursery for scientific study in the various domains of naval architecture in Germany has been the institution now known as the Königliche Technische Hochschule zu Berlin, in Charlottenburg. Since 1904 the Königliche Technische Hochschule in Dantzic has likewise taken part in this work. The naval architectural departments of both these colleges have the same end in view—namely, the training of the young men who will later in life take a successful part in the building of the mercantile and naval fleets of Germany.

In view of the high degree of interest which the Charlottenburg technical college, as a whole, has often aroused abroad, and especially in England, it may not be out of place to give a brief account of the arrangement of the course of study in ship and marine-engine building in the institution in question. In accordance with the system adopted in all the technical colleges in Germany, it is a preliminary requirement for the admission of the students that they should have passed the matriculation examination of a gymnasium, real gymnasium, or oberrealschule (establishments with the classical, classico-modern, and modern tendencies respectively, met with in English secondary schools). Also these schools comprise nine forms, it follows that candidates for admission to technical colleges must be between eighteen and nineteen years of age. Since a further qualification is a practical training of one year at a shipyard of recognized standing, the age of the candidate is increased by six months, often by a whole year. To this must be added the period of military service, which is required of every physically and mentally sound German citizen, but which, in the case of an educated man who has obtained his volunteer certificate, is restricted to one year. For those who contemplate a career in the higher ranks of the Imperial naval construction department, the period of practical work and the year of service are spent in naval establishments—that is to say, in an Imperial dockyard and on board a naval training-ship respectively, before the course of study at the technical college is entered upon.

It may thus be said that the course of study begins when the student is twenty-one, and that it has been preceded by a certain period of preparation in the practical work of shipbuilding or marine-engine building. It is with young men thus prepared that the colleges at Charlottenburg and Dantzic have to reckon. The course of instruction is arranged in the following manner:—Within the department for naval architecture a distinction is made, in the first instance, between the professions of naval architect and marine engineer. The course of instruction itself in almost all the subjects comprises lectures and tutorials, or "practices," the object here kept in view being, that what is taught in the former is put into practical shape in the latter. It is a general principle in the German technical colleges that, as far as possible, no lectures are to be delivered without the accompanying tutorials. This principle extends, not only to the main professional subject in each case, but also to the subsidiary subjects, such as pure mathematics, mechanics, physics, descriptive geometry, political economy, law and administration, etc. It is to be observed that this principle has been productive of very good results, and that its extensive application has raised very considerably the standard of the education provided.

In all the departments devoted to different professional branches the course is a four-year one. At the conclusion of the second year, the preliminary examination for the degree or diploma is held, the final examination being taken at the close of the fourth year. The first two years are principally devoted to the more general studies in mathematics and natural science subjects, although a beginning is made with the introductory lectures and tutorials in the main subjects at the outset of the first term. But whereas the general subjects at first take up much more of the student's time than the special ones, this proportion gradually alters as the course proceeds till it finally becomes reversed. Another feature of the arrangement of the studies is that the lectures are, as far as possible, delivered during the earlier terms, while the drawing-office work gradually assumes greater importance as the course proceeds. This is intended to give the student in his last year as broad a base as possible for designing and applying what he has learned from the lectures.

In following out these ideas, the preliminary examination at the end of the fourth term is principally confined to the subject of mathematics, mechanics, physics, descriptive geometry, and chemistry, the special subjects being represented by the general details of marine engines and ships, while the results of the tutorials which, together with the mathematical proficiency shown, form the basis for the admission of the student to the oral examination, comprise a considerable number of constructive applications to details of vessels, such as double bottoms, after-bodies with rudders, etc., three sets of lines with the corresponding calcu-

*Paper read at the Jubilee meeting of the Institution of Naval Architects.

lations of displacement, several exercises in connection with the theory of shipbuilding, and, finally, the design and calculation of a number of parts of machinery.

The primary object of the course of instruction during the first two years is to give the student a general grounding on the broadest possible lines in mathematics and natural science subjects, and concurrently therewith to introduce him to the elements of his special subject, so that, after passing the preliminary examination, he may devote himself in a higher degree to the direct study of his profession during the last two years. In the course of these two years, then, the tutorials gradually take the place of the lectures, and the professional study proper is gone into in detail. The student of naval architecture is engaged in designing and working out the plans of merchant and war vessels, and in studying the arrangement and working of shipyards, while the marine engineering student is at work on marine boilers, reciprocating, turbine, and internal-combustion engines. In addition, auxiliary engines and propellers are thoroughly gone into. Students in each branch concern themselves with the other just so far that, in their respective parts of the work on one and the same vessel, they can completely understand one another, and give due consideration to each other's requirements. The domain of airship construction and aerial navigation, which is closely related to naval architecture, has been included in the province of the latter, and it may be of interest to mention that quite a number of the first designers and engineers who have specialized in airship construction were formerly students in the department of naval architecture.

A programme of the subjects taken during the two last years of the course is given in the syllabus of the final examination for the diploma. Among these are included:—

Shipbuilding.

(a) Mercantile Shipbuilding:—
- (i) Designing of ships' lines.
- (ii) Complete design for a merchant vessel.
- (iii) Outline plans for a merchant ship.

(b) Warship building:—
- (i) Design of a warship.
- (ii) Principal details in conection with the design.
- (iii) Design of a propeller with accompanying calculations.
- (iv) Questions relating to shipyard arrangements and work.

Marine Engineering.

- (i) Design for a marine reciprocating engine or for a steam-turbine, together with boiler installation for a merchant vessel or for a warship.
- (ii) Design for a marine gas-engine.
- (iii) Design for a ship's auxiliary engine.
- (iv) Outline plans for a merchant vessel.

The oral examination includes questions on:

Shipbuilding.

- (i) Theory of ship construction.
- (ii) Design and construction of ships.
- (iii) Lay out and working of shipyards.
- (iv) Construction and arrangement of warships.
- (v) Marine engine construction.
- (vi) Fundamental principles of law and administration.

Marine Engineering.

- (i) Power plants, machine-tools and machine construction.
- (ii) Marine engine construction (reciprocating, turbines, internal-combustion).
- (iii) Boiler construction, auxiliary engines and accessories.
- (iv) Shipbuilding (merchant vessels and warships).
- (v) Electricity as applied to ships.
- (vi) Administration and management of naval and private establishments.

One of the important aims of science as applied to naval architecture is directed to the keeping of the rules of the classification societies in general accordance with the latest advances in knowledge. This refers chiefly to the arrangement, scantlings, and riveting together of the structural parts of the hulls of vessels, and to the application of the laws of mechanics, statics and dynamics. A second aim is that the rules of these societies, which are gradually gaining in authority, shall be prevented from developing into crystallized and inelastic ordinances, which interfere with the scientific development of ship design. We should insist, in this as in every other branch of engineering, that each new structure shall be looked upon much more as a concrete entity than has hitherto been the case, and that any new ship's design shall be worked out in this spirit.

There is one other point to which I must here draw attention. Both for instructional purposes and for scientific research work, suitable laboratories are nowadays of the very greatest value. In all branches of engineering there are many questions the solution of which by pure analytical methods is impossible, and which therefore can only be dealt with by practical experiment. To what excellent use in this way have not the existing testing laboratories in almost all countries been put. At the Technical College in Charlottenburg the Mechanical Engineering Section in particular has established numerous laboratories, and they have been of the utmost value both from the educational and from the industrial point of view. The distribution of these laboratories among the different sections of the college is as follows:—

Section for	Architecture	1
"	Civil Engineering	1
"	Mechanical Engineering	9
"	Shipbuilding and Marine Engineering	—
"	Chemistry and Metallurgy	8
"	General Science	1

It will thus be seen that the Technical College at Charlottenburg now possesses twenty laboratories, which serve the purposes of the research work of the professors as well as those of instruction. A short time ago a project for the installation of a second laboratory for the civil engineering section for the investigation of hydraulic questions was unfortunately rejected by the Prussian House of Representatives. It is a remarkable circumstance that in the entire establishment the section for shipbuilding and engineering should be the only one which has no laboratory. It must be admitted that this is very much to be deplored, and that the course of instruction as well as the solution of engineering problems is immensely impeded thereby.

The Lake Shore & Michigan Southern Railway has just adopted the design of the Strauss Bascule Bridge Co., for a 125-foot single leaf double-track span bascule over Buffalo Creek.

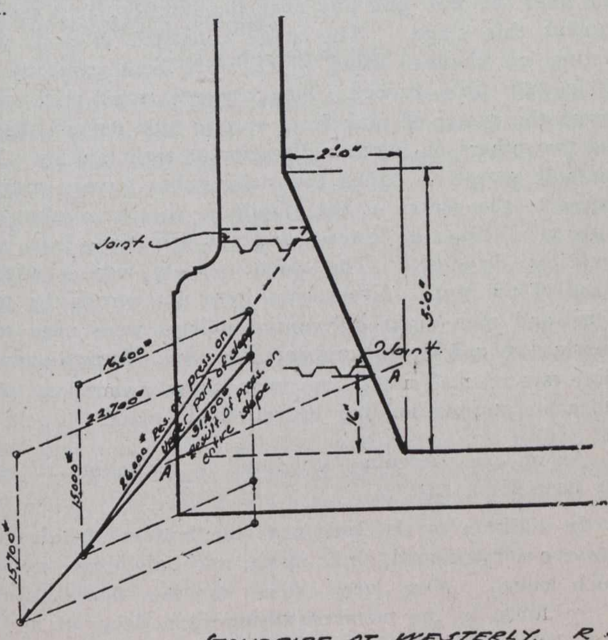
REINFORCED CONCRETE STANDPIPES.*

L. C. Wason.

When a discussion of standpipes was first mentioned to me I asked the American Society of Civil Engineers to compile a list of all the reinforced concrete standpipes built in this country and abroad as found in print. I have received that list—which, by the way, was imperfect, as nine of the New England standpipes, and one in New South Wales, were omitted from it. It is interesting to know that the first one erected in this country was that at Little Falls, N.J., in 1899, athough it is concealed from view inside the filter plant which it serves; and to date there have been 52 built in this country and abroad.

There are 13 New England tanks in this list, and no tank has been built outside of New England with a capacity larger than one-half million gallons; while inside there have been six of larger capacity, of which there are over one million gallons. This would indicate that local engineers and water companies have more faith in this type of construction than those in any other part of the world.

The company with which I am associated has built two large standpipes, and a tank, the smaller 40 ft. in diameter and 70 ft. high at Westerly, R.I., and the larger at Attleboro, Mass., 50 ft. in diameter and 100 ft. high to water level.



STANDPIPE AT WESTERLY. R.I.

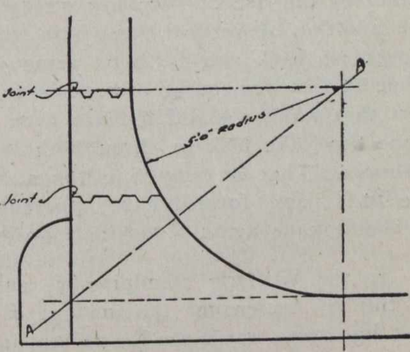
The Attleboro standpipe was designed on the basis that the hoops take the entire load with a unit stress in the steel of 13,500 lb. per sq. in. In order not to have the bars too close together, 1½-in. diameter bars were used in two rows from the bottom of the standpipe to a height of 61 ft. From 61 ft. to 81 ft. a single row of 1½-in. diameter bars used. From 81 ft. to 100 ft. the bars were 1⅛-in. diameter. In the upper 15 ft. of the height the section of steel was kept a constant, although the hoop stresses from the water were constantly diminishing to the top. This was done to provide for possible stresses caused by the formation of ice in the standpipe. In actual practice it was found that, owing to the frequent fluctuation of the surface of the water, ice did not form solidly over the whole water surface of the tank, so that pressure on walls never really occurred.

The walls of the standpipe started with a thickness of 18 in. at the bottom, and tapered to a thickness of 8 in. at the top.

In order to space the reinforcing bars the exact distance apart, 4-in. channels with a ⅜-in. hole through both flanges were used. The holes in these channels were punched so as to give the exact spacing required for the hoops. The channels were set upright at intervals of about 15 ft. centre to centre, a ¼-in. rod was passed through the holes, and the hoops were rested directly on the ends of these ¼-in. rods, which were then bent up to secure the hoop firmly. From the height of 61 ft. to the top of the standpipe where there was but a single row of hoops, 3-in. channels were used for spacers instead of the 4 in. The floor of the standpipe was 12 in. thick and met the wall with a curve whose radius was 5 ft.

The top surface of the floor was reinforced with ¼ in. square twisted bars 6 in. on centre each way. These bars were carried well up the curved corner, and into the wall of the standpipe; ⅝ in. square twisted bars were also placed radially at intervals of about 3 ft. around the circumference of the standpipe, their ends projecting up into the wall for a height of 10 ft.

The foundation consisted of a slab about 18 in. thick. Immediately under the walls of the standpipe, however, the depth of this slab was increased to 4 ft. for a width of 5 ft. A concrete curb 3 ft. high and 12 in. thick with a curved top



STANDPIPE AT ATTLEBORO, MASS.

was built around the outside of the standpipe at the bottom, but was not monolithic with it.

On one side a gate-house was erected enclosing the various valves and giving access through a passage covered by a balanced manhole cover to the interior of the standpipe.

The roof was a Gustavino tile dome in which were suitable means of ventilation.

At the high-water line a series of rectangular slots were left in the walls whose total area was greater than the area of the inlet pipe. These holes effectually prevented the water reaching a higher level than the one for which the standpipe was designed.

The method used in splicing the ends of the bars together may be of interest. These bars were obtained long enough so that three would reach entirely around the circumference with a lap of 40 diameters at each joint. Two

* Discussion before Boston Soc. of Civil Engineers.

wire rope clips were then used at each splice to insure the bars being held firmly together. It was found by actual test at the Watertown Arsenal that these clips alone were sufficient to secure the full working stress of the bare bars, so that any additional bonding strength from the concrete was added to the factor of safety. These splices were staggered so that one in eleven loops came in the same vertical plane.

From the experience with this standpipe, and with that at Westerly later I believe that the addition of considerable vertical reinforcement in the lower 8 or 10 ft. of the standpipe wall, the ends of which are turned out and bonded well into the floor, would assist very materially, and perhaps entirely obviate the formation of a horizontal crack in the lower few feet of a standpipe. It is obvious that under water pressure the walls, owing to the deformation of the steel, must increase in circumference, and the entire tank increase in diameter in proportion. At the bottom of the standpipe, however, owing to the rigid connection of the wall with the floor, this increase in diameter can not take place. This rigidity extends a short distance upward to the point where compression on floor changes to tension in wall. At the finish of a day's work near bottom of tank at or quite close **to the plane of weakness** above indicated there may be a direct movement outward of the wall above, relatively to that below, the joint when under pressure. When the pressure is relieved the elasticity of the hoops would tend to draw the wall back to its original position.

It is apparent then that unless precautions are taken, either by the use of very low stresses in the hoops, or by the addition of vertical steel bars, there may be a distinct movement back and forth on some joint in the standpipe That this movement at present is further indicated by the fact that when a standpipe has been kept full of water for some time, the leakage through these joints almost entirely disappears, but on emptying the standpipe and refilling it the little dams formed have apparently been broken down, as the leakage again occurs as vigorously as at first.

In the Westerly standpipe we endeavored to take care of this by increasing the amount of steel. At the lowest foot the stress was 6,000 lb. per sq. in. This stress was increased 1,000 lb. for each foot in height until we reached a maximum stress of about 12,500 lb. per sq. in. No vertical steel, however, was used, and on filling the standpipe we found with the maximum head of water that a small line of dampness occurred in a horizontal joint about 3½ ft. above the floor of the tank. This damp place was nearly 30 ft. long.

By reference to the cut showing the section of the base in these two standpipes will be seen the position of what I call the critical joint. On the section of the Westerly standpipe a diagram is shown indicating the forces existing from the weight of the wall and the outward pressure of water on the sloping corner. The resultant of these two forces is shown. Projecting this resultant backward to the inside face of the wall the point is found where compression probably changes to tension. This is the critical point. It also comes very close to the joint where the second day's work left off. This is the joint that leaks. After the tank had been filled three weeks the leakage was just sufficient to dampen the surface but did not run down. If this point in a standpipe can be taken care of it is my belief that a standpipe can be made bottle tight.

In these two standpipes quite different methods were used in erection. At Attleboro a large tower (see cut) consisting of 8 in. by 8 in. hard pine timbers properly braced was erected. On the top of this tower were placed two bull-wheel derricks. Concrete was handled in a bottom dump bucket swung to the position desired by the derricks, dumped in boxes and shovelled into the wall. The forms were of wood in sections about 7 ft. high of such sizes that they could be handled easily by the derricks, or if necessary by the unaided power of the men.

At the Westerly standpipe (see cut) the plant consisted of a simple concrete mixer fed by wheelbarrows. The mixed concrete was delivered to an ordinary elevator, hoisted to a hopper erected on the elevator tower where it was dumped, from which it was fed into wheelbarrows and shovelled into place. The forms were made from ⅛ in. steel plates riveted to 2½ in. by 2½ in. angle irons which were bent to the proper curve. These forms were made up by a boiler maker. They were about 3 ft. high and two sets were used, so that the bottom one could be taken off and re-erected, enabling us to pour 3 ft. of concrete a day. The lump sum price of $1,000 was paid for these steel forms. The saving in labor from their use was sufficient to more than pay for the cost of the forms themselves over what was estimated for the use of wooden forms. They gave a very satisfactory finish to the wall, as the cut of the finished standpipe will indicate. No pointing was done.

A very light platform was used for a working stage in the interior of the standpipe. This is shown in the accompanying cut. Wooden posts 3 in. by 4 in. were carried up, one near the wall and one near the interior, at 8 points to support this stage. The stage consisted of 2-in. planks resting on channel irons which were bent carefully to a circle and cross braced. Two channel irons were carried across the center of tank from side to side on one diameter and two others on another diameter at right angles. These not only served to stiffen the staging but gave a means of access to the center of the standpipe so that a plumb bob could at all times be lowered and any deviations from a true circle be detected. The wooden posts were carried up ahead of the work. Cross bars were put across the top of them, and then eight differential pulleys were used to lift the staging quickly to any point desired. Immediately this point was reached cross bars were nailed from post to post under the staging holding it securely in place.

As on the preceding standpipe, a Gustavino tile dome was used for a roof.

In addition to the leak near the bottom of this standpipe above mentioned, three spots, and only three, appeared which leaked. One very close to the floor caused by a breakdown in the mixer resulting in a delay of an hour or so between batches of concrete, thus breaking the bond and destroying the monolithicity of the floor. There was another one about 23 ft. up, and one about 40 ft. These were grouted under high pressure and stopped. The worst of the three leaks before they were grouted dripped one drop in six seconds. Very great caution was exercised in finishing the joint between the day's work. Two men were kept on into the night after concrete was placed to scrub the top surface of concrete very carefully with brushes and water to get the laitance off, and also to wash the surface of all stone showing on top as clean as it was before being mixed, because cement bonds very well to clean aggregates; but it does not bond well to old cement. Roughing strips were put in the wall to form a groove. These were also removed by the men in the evening. Before concrete was placed the following day the surface was thoroughly washed with water, then coated with neat cement, which was rubbed in with a brush, and the grooves formed by the roughing strips were filled with neat cement.

CROSS-TIES PURCHASED 1910.

The Forestry Branch of the Department of the Interior has collected statistics with regard to the cross-tie consumption in Canada for 1910.

There were 9,213,962 cross-ties purchased in 1910 by the steam and electric roads of Canada at a cost of $3,535,-228. This is a decrease of 35 per cent. from the number purchased in 1909. The average cost of these ties at the point of purchase was 38 cents per tie. Three kinds of wood, cedar, jack pine and hemlock furnished 77 per cent. of all the ties purchased. Cedar itself supplied 40 per cent. of the total consumption and its use is increasing yearly in proportion to other species. Oak, which makes an expensive tie, costing 74 cents each, was used principally by a United States company having mileage in Canada. Of the total number of ties purchased, 70 per cent. were hewn ties. The only important species which has a majority of sawn ties, was oak. Sawn ties cost on an average 36 cents per tie and hewn ties cost 3 cents more. The steam railways used 95 per cent. of all the ties and these ties cost them on an average 38 cents. The electric railways used 302,540 ties—an increase of 183 per cent. over 1909. They paid for their ties 41 cents each. Although on the average they use smaller ties, this excess of 3 cents in the cost is due not only to the disadvantages incident to contracts for smaller quantities of materials but also to the fact that the electric roads are more likely to purchase ties at points where the price includes transportation charges.

The existence of salt lakes and deserts in Britain in pre-glacial times was stated by W. W. Watts, professor of geology in the Imperial College of Science, at the Royal Institution, to be shown by the peculiar geological features of Charnwood Forest, Leicestershire. It was by far the oldest landscape known in Britain. To-day where the marl had been swept away by denuding agents the rocks protruded in peaks, and in some cases the rocks were harder than steel. The resemblance of the scenery to deserts in Arabia and Arizona, he said, went to show that in the pre-glacial periods there must have been deserts in Britain occupied by salt seas. As a further proof of the existence of deserts ages ago he indicated by means of slides the smoothness of a number of the rocks in Charnwood Forest. Their polish, he said, could only have been produced by the action of the wind drifting sand against them. From vastly ancient days the marl had preserved the original rocky landscape.—Dundee Advertiser.

There is probably no more active period in Western Canada for the railroads than during the next three or four months. For some time past preparations have been going on for sufficient equipment to handle the enormous crop that is now assured, and by the time the wheat starts to move the railroads will be ready to handle it.

Outside of arrangements for handling the crop railroad work is going forward rapidly in the West generally, and particularly in Winnipeg. The Canadian Pacific is about to make big additions to its terminals here and will add to its station; will build a subway to connect with a new four-storey building north of the tracks; will build a first-class waiting-room for travellers in the Royal Alexandra Hotel annex, and will nearly double the size of the hotel itself by making it a 700-room house.

The Canadian Northern Railway Company's new station will be completed and opened at Brandon for traffic on August 1st. The outside work of the new Canadian Northern hotel, which is being erected in connection with the Canadian Northern station, is completed, and the work of the interior has commenced. The hotel expects to be opened for business on January 1st.

EARTH DAMS.*

A. M. McPherson.

Preliminary to the construction of a dam of any type, a study of the water supply to the reservoir to be formed by the dam in contemplation, should be made. The most satisfactory method for determining the run-off of any area is to secure records of the gauging of the stream, or streams, which it is intended shall supply the water to the reservoir. For this purpose, weather bureau reports, showing the annual fall for a period of years in the locality in question, can generally be secured.

If we supplement our weather bureau reports with the two rules given below we can arrive at a fairly accurate estimate of the run-off from any given area.

The first rule is one that has been deduced by the Director of the U. S. G.S. and is: That for each 100 feet increase in elevation the rainfall will increase six-tenths of an inch. This rule has been quite generally substantiated by the reports of the Weather Bureau.

The second is one formulated by Mr. Grunskey of the U. S. G. S. after a careful study of the precipitation and run-off records of the Pacific coast. It is as follows: The run-off may be expressed in identical percentages of the precipitation expressed in inches.

These two rules and their application can best be illustrated by taking some concrete example. We will suppose that we have the weather bureau reports from some station within the area or of some station near at hand. The elevation of this station is 3,000 feet above sea level. The area of our water shed is 100 square miles. The maximum elevation of our water shed is 7,000 feet, but our average elevation is only 5,000 feet. Now if the precipitation at our station is 10 inches per annum, our average rainfall, over the whole area, by the first rule would be 10 inches plus six-tenths times 20 inches or 22 inches. Now by Grunskey's formula 22 per cent. of the 22 inches can be expected to appear in the streams as run-off, equal to 4.84 inches or .403 feet equal to 25.792 acre feet per year.

In determining the capacity of the reservoir, it is generally considered best to make a topographic survey of the basin and determine the capacity by means of the areas of the different contours.

A quick rough way to estimate the capacity of a reservoir in acre feet is to multiply the area of the flow line in acres by one-third the height of the dam.

A very important feature in determining the site of a dam, providing there is more than one site, as is very often the case, is the ratio of the cost of the dam to the number of acre feet stored in the reservoir, or the cost per acre foot of water stored.

It will be necessary to explore the site to determine the depth to bed rock or some suitable foundation material, and to secure data in regard to the character of the materials lying above it. This may be done in several ways: A water jet may be used to bring up samples of the materials. A steam well drill may be used to determine the depth to bed rock. A diamond drill may be used to determine the character and thickness of the bed rock, or open test pits may be sunk. But whatever method is employed it should always be supplemented by sinking a number of test pits. Nothing gives such intimate knowledge of the underlying strata and the character of the foundation as an open test pit.

* A paper read before the Idaho Society of Engineers.

Probably the best material for construction is a mixture of gravel, sand and clay, the mixture containing enough sand to fill the voids in the gravel and enough clay to fill the voids in the sand. Such a mixture has great specific gravity. It will stand on a much steeper angle than ordinary earth, and is practically impervious to water. Pure clay should never be used, as it shrinks and cracks upon drying and swells when wet. It is also very susceptible to slides, and its angle of repose, when wet, is very slight.

However, it is not often that ideal mixtures of gravel, sand and clay exist in the vicinity of the dam site, and it is necessary to make tests on the materials at hand to determine their suitability and also to determine the proper cross section of a dam built of them.

In making these tests it is desired to observe the general behaviour of the materials in question when subject to water and to determine more particularly the angle of repose, and the angle of saturation. The angle of repose, here, is the maximum angle at which the material will stand when subject to the action of water. The angle of saturation is the angle the water makes in passing through the dam. It depends directly upon the frictional resistance offered by the materials of the dam to the passage of the molecules of water. The frictional resistance again depends upon the compactness of the material, so if we had our materials compact enough and could keep them in that condition our angle of saturation would be vertical.

It is a common error to think that if a dam is built with a core wall of some impervious material that there will be no water passing through the core wall into the lower half of the dam. But numerous boards of experts have examined many dams and have found that in every case water had passed through the supposedly impervious core wall and had saturated the lower half of the dam to a greater or less extent.

A uniform sample of the material to be used in the construction of the dam should be taken. It should be thoroughly mixed so as to resemble as near as possible the material as it would be placed in the dam. This material should then be placed in a tank which has been constructed for the purpose. A tank 4 feet wide, 4 feet deep, and 22 feet long is large enough to give satisfactory results. A miniature dam is then constructed upon the profile which has been tentatively decided upon, say 3-1 on the inside or water face, and 2-1 on the dry face. The earth should be tamped in, moistened slightly, and made as compact as possible. Pieces of gas pipe with holes bored along their sides and covered with pieces of wire netting, should be sunk at intervals of about a foot, beginning at the axis of the dam and extending on through the dry surface. Water is then admitted on the 3-1 side to a level proportionate to the heighth of the dam, and is kept at this mark until the water remains at a constant level in the pipes sunk in the lower side of the dam. This will probably cover a period of several weeks. The depth of the water in the pipes is generally determined by means of a measuring rod. Taking the difference in depth of the water in the various pipes and knowing their distance apart, the angle of saturation is easily calculated.

The angle of repose is obtained by trying successive slopes to determine how steep a slope the material will stand when subject to water. This test should be supplemented by another. Have the tank full and suddenly let the water out and note the behaviour of the material. Often this will show what was supposedly a safe slope is too steep, as slips will occur as the water is being let out of the tank. It is well after these tests have been made to let the material dry out and notice whether it cracks or shrinks badly.

There are many types of dams using earth in conjunction with some other material, such as crib dams, earth and rock fill dams, etc.

We will, however, confine ourselves to a discussion of dams composed wholly or principally of earth, viz.: Earth dams with a masonry core wall; earth dams with a puddle core wall; hydraulic fill dams, and homogenous earth dams with masonry or puddle cut off walls.

Many of the larger earth dams have been built with a masonry or concrete core wall. However, of late years, the general tendency of the best engineering practice has been against the building of dams with masonry core wall, believing that they are a source of weakness rather than strength. Earth dams with masonry or concrete core walls are open to many objections. First they do not fulfill the purpose they are supposed to, that of making the dam impervious to water, as in practically every instance it has been shown, where tests have been made that water passed under them or through cracks in them, and had saturated the lower half of the dam.

Lastly the expense of a masonry core wall is very great as compared to the rest of the dam. The only useful purpose they serve is in case of the dam being over topped by water, when it will prevent a sudden breakage of the dam. However, this danger is wholly imaginary if adequate spillways have been provided.

The earth dam with puddle core wall is open to the same objection as the dam with a masonry core wall although in a lesser degree. However, in many cases where sufficient materials of the proper kind are not at hand it is necessary to build this type of dam. It answers fully as well as the masonry core wall type and is far less expensive. The puddle core wall does not crack or if it does, soon fills up the cracks on account of the pliability of the materials of which it is composed.

The building of hydraulic filled dams is confined chiefly to Western engineers. It is an outgrowth of the old placer mining days of California. Several dams of considerable heighth have already been built and have given satisfaction. However, the dam requires considerable experience on the part of the builders, and is not a common type although it is increasing in favor. It possesses the great merit of cheapness. Dams have been built by this method at a cost of four or five cents per yard, as against a cost, by the usual method, of thirty or forty cents.

If it is possible to secure a site where water can be secured in abundance and the materials are of such character and lie in such positions as to allow of sluicing, and where an engineer can be secured who has had experience in the building of such dams, they would probably prove very satisfactory. Mr. J. D. Schuyler is their chief exponent, and his work entitled, "Reservoirs for Irrigation, Water Power and Water Supply" will give the engineer quite a complete idea of the claims that are made for them.

The homeogenous earth dam is the oldest type of dam we have knowledge of and is now generally accepted as being the best type of earth dam. It depends upon the fact that it is of the same material and the same texture throughout. If any settlement takes place, it will not settle more in one part than in another on account of its homogenous character.

We will adopt this type of dam as the type which we will study more fully in its design, its construction, etc., and because we think that it will be more applicable to the conditions which will have to be met by the engineers of this Society when operating in this State.

The preliminary calculations for the profile of an earth dam are simple, and will be illustrated:

Let us assume the following values:

Central height of dam, 100 ft.

Maximum depth of water, 90 ft., surface being 10 ft. below crest of dam.

Effective head, 90 ft.

Weight of material in dams 125 lbs. per cubic foot.

Co-efficient of friction, 1, or equal to the weight of the dam.

Weight of water 62.5 lbs. per cu. ft.

Factor of safety against sliding, 10.

The width corresponding to the vertical pressure of one ft. is:

$$\frac{625 \times 10}{125} = 5 \text{ ft.}$$

The hydrostatic pressure at 90 ft. depth is $62.5 \times 90 =$ 5,625 lbs. The dam having a factor of safety of 10 must present a resistance of $5{,}625 \times 10 = 56{,}250$ lbs., or approximately 28 tons to the square ft.

The theoretical width of bank corresponding to a 90 ft. head with a factor of safety of 10 is 450 ft., slopes 2-1 and 3-1. To this must be added the width of bank above water and the width of crest. The former would be 50 ft. and the latter by Trautwine's formula, which is $2+2\sqrt{\text{height}}$ or $2+2\sqrt{100}=22$ ft., making 72 ft. to be added to the base of the dam, or the base equals 522 ft. This, of course, increases our factor of safety to 11.6 but this is on the side of safety.

We will suppose that the angle of saturation was 40 in 100; then the line of saturation would meet the ground 27 ft. inside the outer toe of the dam, but if the angle should be 35 in 100 then the line of saturation would meet the ground 27 ft. inside the outer toe of the dam, but if the angle should be 35 in 100 then the line of saturation would reach the ground 5 ft outside the toe of the embankment. In this case we had better add a berm of say 15 ft. at an elevation of 50 ft. above the bottom of the slope as we do not want springs appearing on the face of the dam. A berm on the face of a dam of this size is almost a necessity any way to prevent rain water from cutting the face of the dam. The berm should have a drainage ditch next to the face of the dam to carry off the rain water.

We have allowed a factor of safety of about 10 against sliding on its base in the design of this dam. But in reality it will only have a co-efficient of about 5 as the co-efficient of earth when saturated with water is 0.5 instead of 1. The saturation by water reduces the effective weight of our material by 62.5 lbs. per cubic ft.

Assuming the crest at 10 ft. above the water was taken as an illustration. In practice we would arrive at our safe water level by caluculating the height of our waves by the following formula:

$$X = 1.5\sqrt{F} + (2.5 - \sqrt{F})$$

Where X equals the height of the waves, and F equals the distance in nautical miles.

It is well to add 2 or 3 ft. to the calculated height of the wave, as the speed of approach will carry it further up the slope than its calculated height would indicate.

The site must be cleared of all vegetable growth, which should be burned. If there are any stumps these should be pulled out, and the roots should be dug out. If it is not too far to bed rock the whole inner half of the dam site should be excavated to solid material. If this be done there will be no need of a cut off wall of puddle or masonry along the axis of the dam.

If it is decided to strip the inner half of the site, which is undoubtedly the best course to pursue, when it is economically possible to do so, springs may be found flowing from the bed rock. These must either be carried to the outer toe in bed rock drains, or capped with cement.

If we find that it is not feasible on account of the expense entailed to excavate the inner half of the site, a trench should be excavated along the axis of the dam, and the rest of the site should be bond plowed. This trench must be excavated to bed rock, and should be carried down into the solid bed rock so as to allow the passage of any water under it. It is well to excavate in the bottom of this trench a smaller trench say a foot wide and a foot deep which is filled with concrete, forming a wall extending about two feet into the puddle cut off wall. The width of the bottom of the puddle trench depends upon the depth to which it is excavated, but should never be less than 5 or 6 feet.

The trench should always be excavated with sloping sides so that if there is any movement in the puddle material it will, on account of its wedge shape, tend to consolidate. The lower portion of this trench should now be filled with the best puddle material carefully tamped and placed. The puddle material should not be placed in the trench on the side slopes but should be placed as the dam is being built upward. The puddle should never be allowed to dry, but when work ceases, should be protected by a covering of earth or boards. The puddle cut off wall should not be allowed to extend into the dam more than a few feet.

In some cases another trench is excavated just outside the cut off wall and is carried up the sides of the slope. This trench is filled with loose rock, and is connected with a trench leading out to the lower toe of the dam. This is done to provide drainage for the lower half of the dam. In other cases this trench is excavated at the beginning of the outer third of the dam, but in any case means must be taken to provide adequate drainage for the outer half of the dam.

Only the lower part of the puddle trench is filled with puddle until the dam is partly constructed, and as the dam is carried up, the puddle trench is carried up the sides of the slope with it.

The materials in the body of the dam should be placed in six or eight-inch layers. If there is any rock mixed with the material, it should be picked out and placed in the last third of the dam, toward the dry face where it will help in the matter of drainage.

The layers are formed by dumping the earth in rows and levelling off with a road grader. The material should then be sprinkled. The amount of water to be applied to each layer can only be determined by observation and experiment, as the absorptive power of various earths varies greatly. The layers are then rolled with a roller which should not weigh less than a ton per linear foot. A light roller is worse than useless, as it merely irons the surface of each layer leaving a body of uncompacted earth in the center which will tend to form channels for seepage water. After rolling the material until it is thoroughly compacted, it is harrowed. A good test for compactness is to see whether a shovel can be thrust into the earth. Thoroughly compacted earth will resist the efforts of a man with a shovel and will require picking to loosen it.

Before closing this part of the discussion it would be well to take notice of some interesting experiments made by Prof. E. W. Hilgrad. Prof. Hilgrad experimented on various sands and soils to determine the effect of black alkali, or sodium carbonate. He found that one-tenth of one per cent. of sodium carbonate rendered sands and soils tough and impervious to water so that by watering with a solution of one-tenth of one per cent. of sodium carbonate he made them so tough and solid that they would resist the errosive effect of water to a remarkable degree. We have never heard of this fact being applied to the construction of earth dams, but it seems a valuable suggestion and one that would not be excessive in cost.

Finishing.

The face of the dam should be rip-rapped with rip-rap at least one foot thick. The stones should be as large as practicable and all openings should be filled with spalls, hammered in. This rip-rap should extend down at least to the level of the low water line, and if it does not extend all the way down to the foot of the dam it should rest on a berm. If it extends to the toe of the dam it should rest on a firm foundation which will prevent the rip-rap from sliding. It is generally a good idea to have a sub-facing of a foot or so of gravel under the rip-rap. The dry face of the dam should be sodded down as soon as possible to prevent errosive action by rain water.

Putting the outlet pipe through the body of the dam has caused more failures than any other feature. Whenever possible the outlet of the reservoir should be through a tunnel situated at one side of the dam. If it is impracticable to run the outlet tunnel at one side of the dam, it should be placed in a specially prepared trench sunk in the bed rock or foundation material of the dam. This outlet pipe should be of concrete surrounding either a wood or metal pipe. This concrete pipe should be formed with frequent cut-off collars and should be thoroughly surrounded with puddle material. These cut-off collars are supposed to prevent the passage of water along the surface of the concrete.

The valves may be at either end of the pipe or tunnel. The valve at the outlet has the advantage of being more accessible, and the mechanism is simpler.

In constructing a spillway provision must be made for conducting away an amount equal to the greatest recorded or calculated flow into the reservoir plus a liberal factor of safety.

Having determined the quantity of water that we expect the spillway to discharge, the proper length and depth can be determined from the following formula, which is the formula for the ordinary broad crested weir:

$Q = 3.012\ L\ H^{153}$
Q = Discharge in second feet.
L = Length of weir in feet.
H = Depth of water above the crest of the weir.

Spillways should never be fitted with flash boards, as in an emergency they can not be removed readily, and they are not automatic in their action. If it is desired to raise the level of the water in the reservoir above the level of the bottom of the spillway a dam of loose sand is the best thing to use.

The rule for placing the bottom of the spillway is to put it at or a little below the level of the high water in the reservoir.

BRITISH INVESTMENTS IN SOUTH AMERICA.

The British capital invested in South America alone—that is, not all Latin America—is calculated to have been in the preceding year $2,909,690,000, an amount considerably superior to the sums invested by capitalists from any other source in the same regions. Five-sixths of that amount has been placed in Argentine, Brazil and Chile, but in the last-named scarcely a tenth portion of what the two other countries hold. The result is that Great Britain has the largest share of the South American trade. This amounts to 35 per cent., and Germany, which comes immediately after, only reached 16 per cent.

THE EFFECT OF VARYING THE SUPPLY OF STEAM TO A GAS PRODUCER.*

E. A. Allcut.

The experiments recorded in this paper were performed with a small gas producer at the University of Birmingham. The chief object was to determine the influence of varying quantities of steam on the general working and efficiency of a producer plant of small size. The supply of air to the producer was, therefore, kept as nearly constant as possible in all the trails, while the steam supply was varied from nothing to a moximum of 1.14 pounds per pound of coal. In order to avoid complication and to eliminate all uncertainties of measurement which must necessarily arise from the presence of tar and volatile hydrocarbons, as well as to obtain a fuel as nearly approximating to pure carbon as possible, anthracite pea coal was used throughout the trials.

The steam required for the process was generated within the producer, so that the general conditions closely resembled those under which a modern suction plant works; the sole exception being that the draft was produced by a fan instead of by engine suction. The conditions were thereby kept fairly steady throughout each trial.

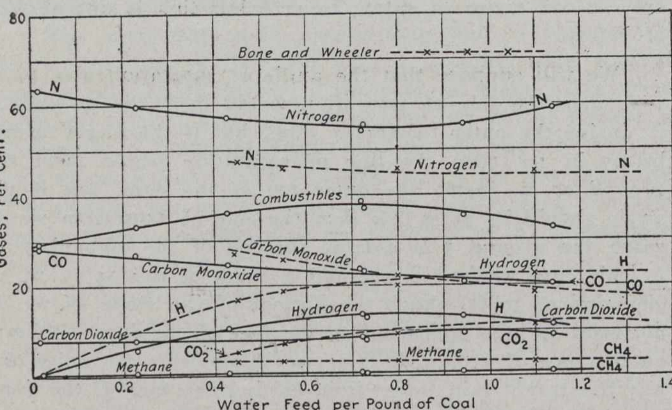


Fig. 1. Comparison of Present Tests with Those of Bone and Wheeler.

The true nature of the combustion of solid carbon is still, among scientists, a vexed question. Some chemists hold that with excess of carbon the combustion proceeds in two stages: first of all with the production of carbon dioxide,

$$C + O_2 = CO_2 \tag{1}$$

and then with the reduction of the dioxide on further contact with carbon,

$$CO_2 + C = 2CO \tag{2}$$

Others maintain that the combustion proceeds in a single stage direct to carbon monoxide,

$$2\,C + O_2 = 2\,CO \tag{3}$$

At the bottom of a gas generator, however, the carbon is never in excess, so that the author is of opinion that the first two reactions probably take place within the generator. However this may be, the final chemical and thermal results of the combustion are the same in each case.

When steam is admitted with the air it may react on its own account with the carbon in the following ways:

$$C + H_2O = CO + H_2 \tag{4}$$

$$C + 2H_2O = CO_2 + 2H_2 \tag{5}$$

* Abstract of a paper read before the Istitution of Mechanical Engineers of Great Britain.

Both of these reactions absorb heat, the former to the extent of 4,300 B.t.u. per pound of carbon, and the latter to that of 2,820 B.t.u., so that each of them has the practical advantage of reducing the temperature of the producer. It has been found that at a temperature of 1,112 degrees Fahrenheit and under, the latter reaction takes place, but at temperatures above 1,832 degrees Fahrenheit, reaction (4) is more likely to occur. At temperatures between 1,112 and 1,832 degrees, the two take place simultaneously, the predominance of either being entirely a function of the temperature. It is clear that as equation (4) gives the richer gas and the greater absorption of heat, it is advisable to maintain the highest temperature consistent with practical working. The high percentage of CO_2 in Mond gas is due to the predominance of the reaction expressed by equation (5), which results from the low temperature and excessive steam supply

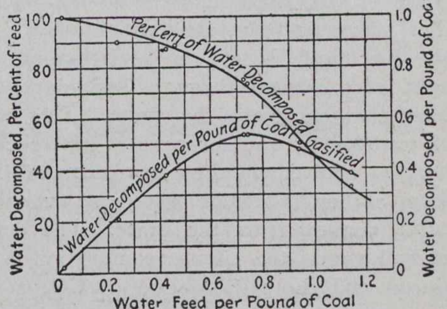


Fig. 2. Effect of Water Feed Rate Upon Decomposition.

necessary for ammonia recovery. This latter consideration does not enter into the practical working of plants of less than 2,000 horse-power, so that in small plants the steam supply can be cut down to any point consistent with the nonformation of clinker.

The actual conditions inside the generator are by no means as simple as would appear from the preceding reactions. When CO and steam are both present in a gas producer, the following reversible reaction may be set up:

$$CO + H_2O \quad CO_2 + H_2 \qquad (6)$$

This reaction which takes place at temperatures above 932 degrees Fahrenheit, also depends for its balance upon the temperature. At high temperatures (1,832 degrees Fahrenheit) the left-hand side predominiates and at low tempera-

TABLE I.

Temperature	$\frac{CO \times H_2O}{CO_2 \times H_2} = K$	Temperature	K
786 C. (1,447 F.)	0.81	1,086 C. (1,987 F.)	1.95
886 C. (1,627 F.)	1.19	1,205 C. (2,201 F.)	2.10
986 C. (1,807 F.)	1.54	1,405 C. (2,561 F.)	2.49

tures carbon dioxide and hydrogen are formed. At any temperature between 932 and 1,832 the product of the percentage volumes of CO and steam bears a constant ratio to that of the CO_2 and hydrogen. Oscar Hahn gives the values in Table I for this ratio at different temperatures. As the ratio rises with the temperature, the addition of steam, lowering the temperature will cause a change in the opposite direction. The oxidation of CO, however, liberates heat and raises the temperature, thereby tending to check the action. The conditions for stability are always in the direction of high temperature and the consequent formation of CO.

Reaction (2) also is a reversible reaction and depends on the temperature. At 1,790 degrees Fahrenheit, Boudouard found that the percentages of CO and CO_2 in equilibrium with solid carbon under atmospheric pressure were 99 and 1 respectively; while at 1,497 degrees they were 90 and 10, and at 1,090 degrees they became 20 and 80. Generally, then, increase of temperature favors the formation of CO, giving richer gas and higher efficiency, and at lower temperatures a higher proportion of CO_2 is obtained.

The steam supply to the producer has then an important effect, as it controls the temperature at which these reactions take place. If the steam supply is increased above a certain amount per pound of carbon, the temperature and efficiency of the plant both fall. If, on the contrary, the supply is cut down too low, the temperature rises, gives bad working and increased heat losses and yields a poor gas. There is then clearly a certain proportion of air and steam that will give maximum efficiency, and it was one of the objects of these trials to find that point.

Deductions From Tests.

The first noticeable point in the results is to be found in Fig. 1, which shows that the percentage of hydrogen in the gas did not increase with an increase of water fed into the fuel bed when the water exceeded 0.75 pound per pound of coal. This corresponds, as shown on Fig. 6, to the decomposition of about 72 per cent. of the total weight of water fed to the fuel bed. This result is very important, as it shows that the maximum amount of steam that can be decomposed by anthracite at a temperature of about 1,832 degrees Fahrenheit is about 0.535 pound per pound of coal; see Fig. 6. It follows that there can be no advantage, but only loss, in pushing the steam supply much beyond ¾ pound of steam per pound of coal in small anthracite gas producers. If this rate is greatly exceeded, the increased supply of steam merely takes heat from the producer and loses it in the washer. Large quantities of steam are not necessary for the prevention of clinkering. The shallow

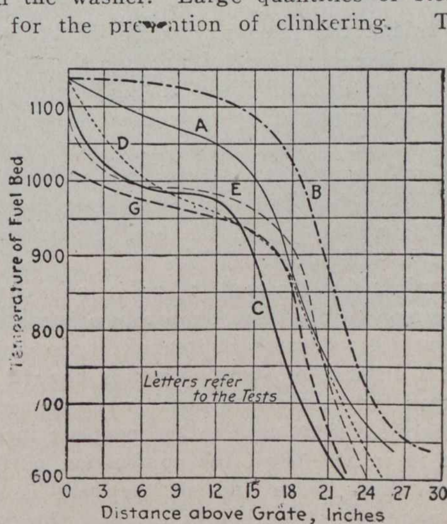


Fig. 3. Temperatures in the Fuel Bed.

fuel bed in the producer tested by the author, however, with its consequent high mean temperature, resulted in the advantageous use of a higher proportion of steam than could be economically used in a producer having a deeper fuel bed.

The low percentage of hydrogen in the gas throughout these trials was due to the large quantity of air which had to be used to keep the vaporizer at a sufficiently high temperature to supply the necessary amount of steam, owing to the inefficiency of the steam coil. This resulted in a high ratio of air to steam and the consequent presence of a large quantity of nitrogen in the gas.

Combustion of Carbon.

The most significant result of these trials is that the percentage of CO_2 remained practically constant, in spite of the increasing feed of steam to the fire. The high content of CO_2 in the trials where little or no steam was supplied was due, as explained, to a leakage of air. Eliminating the 7 per cent. of CO_2 in the first trial as due to this cause, it is found that the maximum rise during the whole of the trials is merely about 2.5 per cent. It would naturally be expected that the increased supply of steam would diminish the temperature inside the generator and result in the production of increasing quantities of CO_2, from reactions (5), (6) and (7). This is admirably shown in the trials of Messrs. Bone and Wheeler, where the CO_2 (shown dotted in Fig. 5) rose from 5.25 per cent. at 0.45 pound of water per pound of coal to 13.25 per cent. at 1.55 pounds of water per pound of coal.

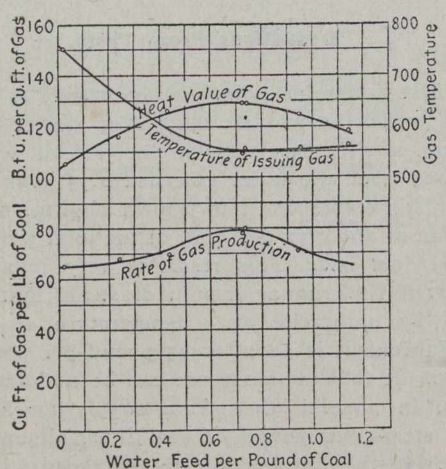


Fig. 4. Effect of Water Feed Rate Upon Gas Made.

Why does not the same rise occur in the author's experiments? It seems at first sight that these experiments contradict the theory laid down at the beginning of this paper—a theory supported by experimental evidence in the tests of Messrs. Bone and Wheeler. The contradiction, however, is only apparent. At the end of each trial the temperature of the fuel bed was taken at equidistant levels from the grate at the top of the bed. Although the temperature curves thus obtained (see Fig. 7) are somewhat erratic, as might be expected, there is one characteristic which is common to all. The temperature keeps fairly constant at about 1,832 degrees Fahrenheit (1,000 degrees Centigrade) for a distance of about 18 inches upward from the grate and then falls rapidly to about 1,112 degrees Fahrenheit (600 degrees Centigrade) in the next six inches or so. In the first 18 inches, then, the combustion of the carbon is obviously taking place and all the heat is developed. Above this point the steam begins to affect the temperature and causes it to fall with extreme rapidity.

Now as has been explained, at a temperature of 1,832 degrees Fahrenheit, no CO_2 can exist in contact with excess of carbon. The large excess of oxygen at the grate causes the carbon to burn to CO_2 with the evolution of large quantities of heat and the maintenance of a high temperature. The excess air burns [?] higher up in the generator and maintains the temperature, but farther away from the grate the reduction of CO_2 to CO and the endothermic steam reactions begin to have the predominating effect on the temperature. The first 18 inches, then, may be termed the zone of active combusiton where, owing to the high temperature, the gases produced are almost entirely CO and hydrogen. There is above this about 6 or 7 inches of fuel bed in which the temperature is rapidly falling. This would have its due effect in re-forming CO_2 by reactions (5), (6) and (7) if it were not so thin. The shallowness of this comparatively cool layer of fuel does not allow sufficient time for these reactions to seriously affect the composition of the gas and the efficiency of the producer. This shows that in a generator which has a shallow fuel bed, provided there is no leakage, there need not be more than 2 or 3 per cent. of CO_2 in the gas. If more than this quantity is present, it is due either to leakage or to the use of too great a quantity of air for the size of the producer. In the latter case, the velocity of air through the fuel is high and some of the CO_2 formed by combustion in the fire zone escapes reduction to CO. The depth of the fuel bed should therefore be cut down to the lowest value consistent with practical working.

In large generators a deep fuel bed is necessary, as the larger sizes of coal used in them do not pack as close as the smaller pieces and the distribution of air across the section of the fuel mass is apt to be irregular. In such cases it might even pay to have a secondary air supply admitted some distance above the grate. This would have the effect of introducing another zone of active combustion, in which the heat evolved by the combustion of the secondary air to form carbon monoxide would be available for reducing the CO_2 coming from the grate. The depth of the cool layer of fuel above the active combustion zone would thus be reduced and the re-formation of CO_2 according to the reaction expressed by equation (6) would be greatly diminished.

Heat Value of the Gas.

The heat value of the gas is very low throughout, as shown in Fig. 8. This is partly due to the low percentage of hydrogen which is the outcome of the high ratio of air to steam. The nature of the fuel also is accountable for the very low percentage of CH_4 which has a great influence on the heat value. It is noticeable that the percentage of combustibles in the gas regularly increases until 0.7 pound of water per pound of coal is reached, and then decreases again. The heat value also reaches maximum about this point.

Efficiency.

The efficiency of the producer is taken as the ratio between the heat generated which does useful work outside the producer itself and the total heat in the coal used during the same period.

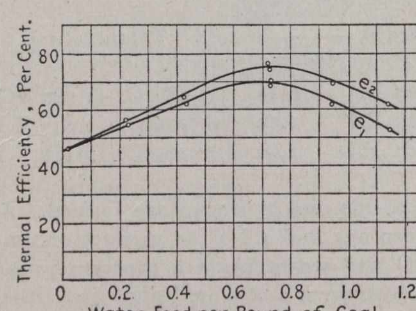


Fig. 5. Water Feed and Heat Efficiency.

It will be evident from Fig. 8 that the maximum yield of gas occurred at a water feed of about 0.75 pound per pound of coal. This is near the point where the maximum percentage of hydrogen was obtained, and where the heat value of the gas was highest. It follows, therefore, that the efficiency of the producer reaches its maximum at this point. The lower curve e_1, Fig. 9, gives the ratio of the heat per hour in the gas produced to that in the coal used, expressed as a percentage. The higher e_2, includes the heat necessary to vaporize the water supply; the latter represents heat that would otherwise be lost in the washer and as it is taken from the generator it should be credited to that source of supply. The higher value e_2, is, therefore, the true efficiency of the producer.

The temperature of the gas leaving the generator is shown in Fig. 8. The highest temperature was attained in trial A (in which no water was fed into the vaporizer), being about 750 degrees. A steady fall was maintained with the increase in water feed until trial D was reached, when the temperature was about 550 degrees; after this, the temperature remained fairly constant.

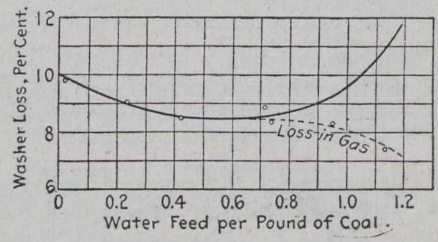


Fig. 6. Water Feed and Washer Loss.

The washer loss is almost constant from trials A to D, the fall being simply due to the drop in temperature of the gas. After this point, however, it rapidly rises, owing to the sensible and latent heat carried over by the surplus steam. The dotted line, Fig. 10, shows the heat carried away by the gas alone. The sharp upward slope of the latter end of the curve shows the necessity for regeneration where large quantities of steam are used.

NEW YORK CENTRAL PLANS.

Plans are under way for the merger into a single corporation of the many corporations which now make up the New York Central system. It is by far the most extensive readjustment of railway capitalization ever undertaken.

In connection with the consolidation a new bond issue is proposed in sufficient amount to cover the existing outstanding obligations of the system, besides providing for future capital expenditures. This will mean a mortgage covering bonds to the extent of several hundred million dollars, for the outstanding funded debt of the New York Central & Hudson River Railway itself exceeds $270,000,000. Additions to the funded debt through issues of new bonds will be made only as the necessity for fresh capital expenditures arises. The length of the lines included in the New York Central system exceeds 12,400 miles. These lines earned last year over $260,000,000 gross and more than $63,400,000 net. Exclusive of the securities of subsidiary companies the New York Central is capitalized at close to $500,000,000, of which $222,000,000 is stock and over $270,000,000 bonds.

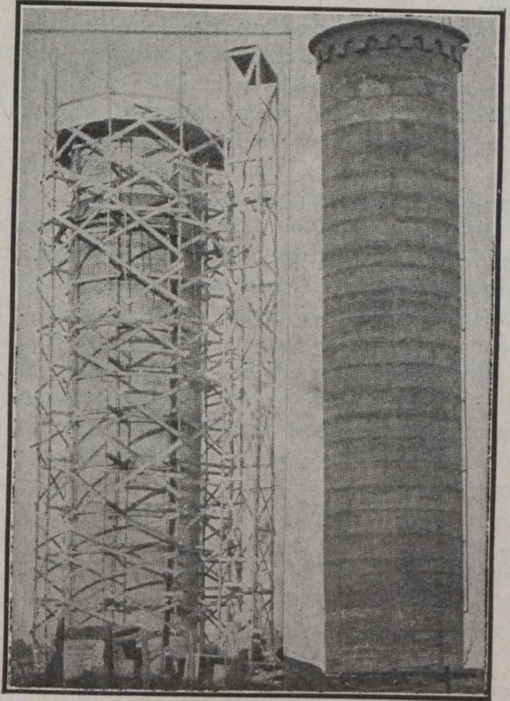
The Ontario Government returns of the mineral production for the first three months of 1911 show an increased production of 1,130,560 ounces of silver, and an increase in value of $667,386. The total production of the metalliferous mines and works of Ontario for the period amounted in value to $6,808,769. The output of silver was 7,530,487 ounces, worth $3,708,544. The Gowganda and Elk Lake district produced 132,000 ounces, and South Lorraine 66,795 ounces. The production of copper was 2,121 tons, valued at $303,240, a decrease of $53,834; of nickel, 4,124 tons, valued at $884,992, a decrease of $246,032; iron ore, 11,621 tons, valued at $24,404, an increase of $9,370; pig iron, 115.454 tons, valued at $1,823,717, an increase of $73,321; cobalt and nickel oxides, 107,046 tons, valued at $28,082.

CONCRETE WATER TOWER AT WAVERLY, OHIO.

The stand pipe shown herewith is 82 ft. from top of foundation to bottom of cornice. The cornice and roof are 4 ft. higher, making the total height 86 ft. The overflow is 18 in. from top of shell, so that the total height of water space is a trifle more than 80 ft.

The foundation is 22 ft. in diameter, octagon, and 7 ft. deep, and is made of concrete 1 part Portland cement, 3 parts sand and 4 parts gravel with enough water to make a "quaking mix," but not slushy. When within 18 ins. of top of foundation, the first reinforcing steel was placed consisting of ⅜-in. rods, bent at right angles with about 4 ft. of rod resting on foundation and spaced 18 in. on centres so they would stand 4 in. from outer side of the shell. One piece of ⅝-in. steel was placed in the angle and the perpendiculars wired to it. And the foundation was completed with a mixture of 1 to 2 to 2.

The shell for the first 9 ft. is 12 in. thick, then 45 ft. is 9 in. thick, and the balance 6 in. thick. The roof is 4 in. thick. The outside of shell is perpendicular, and the reductions in thickness are made on the inside. The reinforcement consists of ⅜-in. perpendicular rods placed same as



those in foundation, and ⅝-in. horizontal rods spaced according to pressure requirements, from 8 rings at the bottom to 3 rings at the top for each foot of height. About 35,000 lb. of steel was used for reinforcement.

The same mixture of 1 to 2 to 2 was used throughout the shell, using no gravel that would not pass a 1-in. mesh, and making mixture very wet or slushy. Metal forms were used in three sections. Scaffolding was placed on the outside, and material was hoisted in wheelbarrows with a small derrick.

The construction was begun late in the fall of 1910, and when about half completed, work ceased on account of cold weather. The job was finished in February, 1911, and required under such adverse circumstances 60 days. It should have been tested in 40 days. It was tested early in May and was found very satisfactory. The cement used was superior Portland.

The capacity of tank is 120,000 gal. and cost about $4,500. H. C. Babbitt of Lockland, Ohio, engineer, and J. L. H. Barr of Batavia, O., contractor.

THE PRESERVATION OF TRESTLE STRINGERS AND CAPS BY MEANS OF HOUSING.*

Hunter McDonald, M. Am. Soc. C.E.

In 1893 the writer had charge of the renewal of a number of combination spans which had been in service about 20 years. The main and second braces and top chords were of yellow pine, and since their original construction all had been carefully covered with weatherboarding on the sides and tin on the tops, the latter carefully fastened to sheathing, with air space beneath, and soldered. All of the timber upon removal was found to be sound, and was used again for trestle stringers.

The value of such protection had been previously observed, and in 1887 the plan of protecting intermediate sills on double-deck trestles with sheets of galvanized iron was adopted. The sheets extended about 3 ins. over the sides and 6 ins. over the ends, and the posts of the upper section were held in place by allowing the drift bolts, passing through the cap into the posts below, to extend about 6 ins. above the cap, through the galvanized iron protection and into the feet of the upper section posts. In a number of instances the top caps were similarly protected about the same time.

The intermediate caps were found to be sound in 1906 when the trestles were filled. The top caps, although the housing had not been well maintained and the stringers rested directly on the galvanized iron, with drift bolts through it, did not require renewal until 1908.

About 1900 the writer had occasion to notice a large pile of stringers which had been removed from the trestles on the Cincinnati Southern R. R. These stringers were put in place about 1879, and had been protected with galvanized iron according to the designs of Mr. G. Bouscaren, Chief Engineer. The ties rested directly on the stringers, holes being made at frequent intervals in the galvanized iron in order to confine the ties to position. Col. G. B. Nicholson, Chief Engineer of the Cincinnati Southern R.R., was present with the writer at the time these stringers were examined and told him that the galvanized iron had not been carefully removed as it rusted out, nor had any great effort been made to keep it from creeping or leaking. Trestles which were still covered were examined, and many leaks found in the iron and many sheets found out of position. The condition of the stringers removed showed remarkable preservation, rot occurring only in local spots—around bolt holes—and at points where the protection had been improperly maintained. This examination convinced the writer that, whether the galvanized iron was properly maintained or not, the results obtained fully justified its use, and since 1900 stringers and caps when renewed on the lines under his charge have been so protected.

At that time the standard trestle consisted of two 8 x 16-in. stringers on each side, packed 1-in. apart, each pair being spaced 6 ft. apart on the inside. The chords were confined to the caps by what was called "stag bolts"—that is, drift bolts driven slantingly through their sides into the caps. The ties were 8 x 8 ins. x 9 ft. 10 ins., and each was doweled to the chord by ¾ x 5-in. dowels, two dowels to each tie passing into alternate members of the chord on each side. Holes were bored into the tie and the dowels driven in to a tight fit, the corresponding holes in the stringers being a loose fit. The guard rail was directly over the outside member of the chord. Two bolts to each span on each side passed through guard rail, tie, and stringer.

*Portion of a paper read before the Engineering Association of the South.

The galvanized iron was applied to the caps in the manner already described, and that on the stringers by jacking up the ties, the dowels following them, inserting the iron under them and lowering them again. The weight of the ties caused the dowels to perforate the sheet iron and settle snugly to place after a slight blow with a hammer. It was supposed that the dowels and guard-rail bolts would confine the iron permanently to position, but subsequent observation showed that the iron at many points crept, always outward, no matter whether on sharply elevated trestles or not. The creeping was very slow, and slots were torn in the iron by every dowel and bolt. Careful observations were made with a view of determining the cause of this creeping, but so far the exact cause has not been ascertained. No doubt it is due to different causes at different points. There are many trestles on which no creeping occurs, others where isolated sheets are found to creep, and

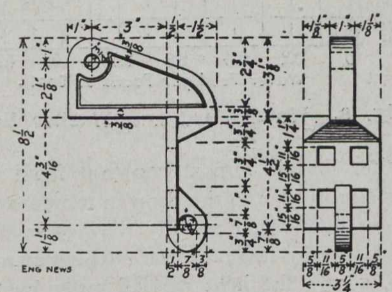


Fig. 1. Detail of Line-Brace Casting for Wooden Trestles Used on Nashville, Chattanooga & St. Louis Ry.

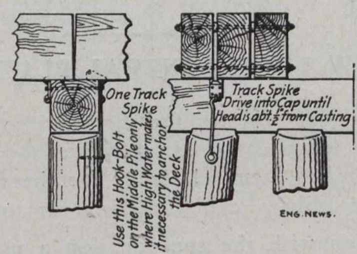


Fig. 2. Application of Casting Shown in Fig. 1.
When it becomes necessary to line stringers, pull track spikes out of cap then shift stringers to desired position and redrive spikes through most favorable holes.
Clean sand out of holes in castings thoroughly before driving spikes.

others where nearly all the sheets creep. It is believed to be generally due to imperfect bearings on the ties on the stringers, longitudinal vibration of the structure, and vertical movement of stringers on the caps or caps on the piles. The problem of remedying this, and also the leaking of water through the dowel and bolt holes, has been continuously studied, with the result that the method of housing hereafter described has been adopted and has been found to be almost entirely successful, both as to leaking and creeping.

To dispense with the drift bolts through the stringers into the caps, which are not only destructive to the timber, but cause much expense in adjustment for line and surface, a malleable casting, called a "line-brace casting," has been devised. Its form and methods of application are shown on accompanying sketches (Figs. 1 and 2).

The line-brace casting serves as a packing ring, and also as an anchor for the chord to the cap. The chord members are packed only 1 in. apart to prevent the nesting of sparrows between them.

The four holes in the bottom part of the casting admit of fine adjustment and shimming where necessary, new wood into which to drive the anchoring spike being always available. This device has been found after long test to

(Continued on Page 167.)

The Canadian Engineer

ESTABLISHED 1893.

Issued Weekly in the Interests of the

CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

Managing Director.—James J. Salmond.
Managing Editor.—E. A. James, B. A. Sc.
Advertising Manager.—A. E. Jennings.

Present Terms of Subscription, payable in advance:

Canada and Great Britain:		United States and other Countries:	
One Year	$3.00	One Year	$3.50
Three Months	1.00	Six Months	2.00
Six Months	1.75	Three Months	1.25

Copies Antedating This Issue by More Than One Month, 25 Cents Each.
Copies Antedating This Issue by More Than Six Months, 50 Cents Each.
ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone, Main 7404 and 7405, branch exchange connecting all departments.

Montreal Office: B33, Board of Trade Building. T. C. Allum, Editorial Representative, Phone M. 1001.

Winnipeg Office: Room 404, Builders' Exchange Building. Phone M. 7550. G. W. Goodall, Business and Editorial Representative.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central.

Germany and Austria Hungary: Friedrich Lehfeldt, 2 Lindenstrassa, Berlin. S.W., 68. Telephone IV., 3198; Telegrams, Advertise, Berlin.

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor.

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS.

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

Printed at the Office of The Monetary Times Printing Company, Limited, Toronto, Canada.

Vol. 21. TORONTO, CANADA, Aug. 10, 1911. No. 6.

CONTENTS OF THIS ISSUE.

Editorial:

Leading Articles:

CIVIC INCINERATORS.

An extremely valuable report dealing with the refuse destructor of the city has recently been issued by the Milwaukee Bureau of Economy and Efficiency. As a report of a civic organization it is especially valuable and interesting in that it is based upon an investigation carried on by unprejudiced experts.

Up to the time of the investigation, the plant has merely been operated to burn garbage and a sufficient quantity of combustible material from ash collections to ensure the proper running of the furnace. It goes without saying that such conditions are not the most economical, as the plant was originally designed to utilize the heat created, and thus produce a revenue which would in all probability make the plant self-supporting. It is interesting to note, however, that the cost of labor amounts to only 55 cents per ton of refuse burnt and 77 cents per ton if general superintendence be included, there being no cost of fuel to be taken into consideration. The highest average of garbage burned per day is given at 141 tons. Operating under these conditions, it is stated in the report that a mixture containing 60 per cent. garbage and manure can be burned very satisfactorily.

The most important point of the whole discussion is that dealing on the utilization of the steam. It is pointed out that this plant, using three boilers and keeping one in reserve, could generate 770 kilowatts with an installation for a capacity of 1,500 kilowatts to take care of any future requirements. It is also estimated that the surplus steam that is at present being wasted is worth in the neighborhood of $48,000 per year of 310 days. It needs no deep thinking to see the value of the utilization of the steam that may be made with such a plant.

Another product of the plant is the clinkers, which amounts to about 30 cubic yards per day, and which may be sold for various purposes in conjunction with concrete work.

In conclusion, it is stated that too much emphasis cannot be put upon the point that an incinerator plant without the utilization of its products is not an economical method of disposing of civic garbage and waste.

A BUREAU OF PUBLIC EFFICIENCY.

One great obstacle that confronts municipal engineers in the bringing about of good results is interference from civic aldermen, councillors, etc., as the case may be. That much of this interference or criticism may come with good intent must be admitted, but the results are often notoriously disastrous to the welfare of the community.

In order to obviate such trouble as much as possible, some such arrangement as that which exists in the city of Chicago might well be copied extensively. In that city there is a Bureau of Public Efficiency whose purpose is to make studies of the expenditure of the local governing bodies, and to furnish the public with exact information and constructive suggestions relative thereto. As an example of the work done by this body, the recently published report on the enquiry into the street pavement conditions of the city may be pointed out. This report sets forth in very lucid style information relative to the construction of pavements, etc., in such a way as to leave even the layman in no doubt as to the requirements of this department.

This is what is especially needed, for it is often under the mistaken impression that they represent public opinion perfectly that civic representatives make suggestions which are mere personal opinions. The public is so often misinformed by incorrect reports that the elected representatives can very easily appear to be acting rightly, when, as a matter of fact, to put it mildly, they have very little business interfering in matters of which they have a very limited knowledge.

Then, looking at the question from the other standpoint, one can very readily see that even a municipal engineer can make mistakes from which the public should be safeguarded. It can be easily seen that some such body as referred to can, by employing independent expert advice, arrive at a fair decision in such cases.

HUDSON BAY.

The distance from Churchill to Liverpool is 2,926 miles, and from Port Nelson to Liverpool, 2,966 miles. The Canadian government railway will probably run from The Pas, north of the Manitoba boundary, to Fort Churchill. The Temiskaming and Northern Ontario Railway will probably be extended from Cochrane to James Bay, or more likely to some point on Hudson Bay. These facts give additional interest to any authentic information respecting the Hudson Bay region. Mr. R. W. Brock, the director of the Geological Survey, accompanied Earl Grey in his recent trip to that territory, and made some notes of value. The party left Winnipeg and travelled down the Red River across Lake Winnipeg to Warren Landing at the outlet of the lake, and from there down the Nelson River to Norway House. From that point the canoe route was followed via Hayes to York factory. By small steamer six hundred miles across Hudson Bay to Hudson Straits were then traversed.

Large areas of land suitable for agriculture lie to the north. Mr. Brock says that soil became more noticeable near Oxford House, until later no rock exposures were seen. In place, artificial drainage will be necessary to render the land fit for agricultural uses. At Norway House wheat, barley, vegetables, small fruits, cucumbers and melons have been cultivated. At York, potatoes and some vegetables have been successfully raised. But the area near Hudson Bay, while perhaps suitable for ranching and dairying, is probably outside the limit for ordinary agriculture.

The whole country from Lake Winnipeg to York is timbered. As in other parts of the country, the forest wealth has suffered repeatedly from fires. Where the original forest is preserved, merchantable sizes may be expected in the upper portion of the district and pulpwood for some distance down. It seems unlikely that the timber will prove of great value except for local purposes.

Mr. Brock gives an interesting description of Hudson Bay, which has a length of about 900 miles and a maximum width of 600 miles. The east coast, which is composed of Pre-Cambrian rocks, is rugged, but the west coast from the mouth of Rupert River at the head of James Bay to the mouth of Churchill is low and flat, being underlain by flat-lying Palæozoic rocks. At ebb tide wide, often boulder-strewn, mud flats are exposed. From Churchill north, the Pre-Cambrian rocks obtain and the coast becomes rugged.

York Factory is situated on the narrow point of land which lies between the mouths of Hayes and Nelson Rivers. Both have funnel-shaped mouths opening northeastward, the Hayes being about three miles across and the Nelson about fifteen, but rapidly narrowing up stream.

The sediment brought down by the rivers, particularly by the Nelson, has silted up the mouths of the rivers and formed a huge bar, that extends for many miles out to sea. As the Nelson is one of the large rivers of the world it may be expected to maintain a well-marked channel through the bar, but the Hayes is rapidly silting up with the material discharged by the Nelson. Fort Churchill is situated at the mouth of Churchill River on a tidal lagoon enclosed by rock ridges, that form a fine, well-protected, though somewhat circumscribed natural harbor. It lies within the barren grounds, but only a short distance beyond the northern limit of the forest. On both sides, a few feet above high tide, are dry sandy flats, parts of an old raised beach. Several other gravel beaches are found on the sides of the hills and up to their summits. These raised beaches are also marked features along Hudson Strait and all the way down the Labrador coast. The rocky ridges that enclose the lagoon rise to heights of from 60 to 100 feet, and are composed of a massive, coarse-grained feldspathic, arkose quartzite. In the quartzite are a few irregular quartz veins up to a foot in width and a few small pegmatite dykes. From the physiography it is impossible to say whether the bottom of the lagoon has a thick mantle of gravel, and thus would be easy to deepen by dredging, or whether it has practically a rock bottom, but it is quite possible that it has the former. On Coats or Mansfield Island the sedimentary rocks of the lower Palæozoic could be seen.

Sagluk Bay, which is on the south side of Hudson Strait between Cape Wolstenholme and Cape Weggs, is a fine harbor about 8 miles long enclosed between hills about 500 to 1,000 feet high. The mouth is about a mile wide. Soundings gave us 10 fathoms of water over the bar at the entrance. The rocks are gneisses and granite with heavy trap dykes. No other rocks than these Laurentian gneisses and granites were seen until the Labrador coast was reached.

No economic minerals were oberved at the points touched at on the Hudson Bay and Hudson Strait, and little is known of the mineral possibilities of this section as, except on the east coast of Hudson Bay where some prospecting has been done on the iron ore formation, the territory is still unprospected. The observations of explorers, however, would indicate that there are opportunities here for prospecting, and if anything is found there are no natural difficulties that would prevent mining. On the west coast of Hudson Bay south of Marble Island, Tyrrell has found promising showings of copper ore (chalcopyrite). Iron ore formation occurs along the east coast of Hudson Bay and on the west shore of Ungava Bay, and as previously remarked, the widespread occurrence of boulders of iron formation makes it probable that it may be found at other localities. Mica is being mined at Lake Harbor on the north side of Hudson Strait. Graphite occurs in extensive bands to the south of Port Burwell. Gold has been found at the head of Wager inlet, and argentiferous galena, and molybdenite have also been noted.

On account of its great size and length of coast-line, a tremendously large territory is tributary to Hudson Bay. At present it is unprospected, but when the railway is built to the bay, access to all this territory will be comparatively easy and prospecting will no doubt be undertaken. Having regard to the results obtained from prospecting similar formations in Northern Ontario, it is only reasonable to suppose that prospecting in the Hudson Bay district will result in some gratifying discoveries.

THE PRESERVATION OF TRESTLE STRINGERS AND CAPS BY MEANS OF HOUSING.

(Continued from Page 164.)

be entirely effective, even where heavy floods have overtopped the trestle and deposited driftwood against and under it.

The covering of the cap, instead of being continuous over the entire length as formerly, is made in three pieces, flaps being turned up on the sides of the chords under the overhanging sheet-metal chord cover. Fig. 3 shows the present standard open-deck trestle, and Fig. 4 the details of housing. These covers are fastened to the cap by nailing through strips of galvanized iron riveted to the underside of each cover piece at four points. This arrangement

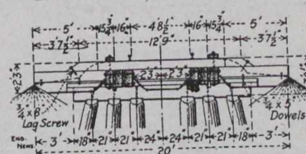
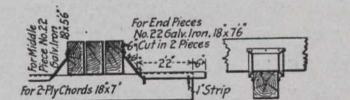


Fig. 3. Section of Timber Trestle with Protected Caps and Stringers. (Showing also bulkhead for 20-ft. bank.)



Galv. Iron for Caps.

Galv. Iron for Stringers

Fig. 4. Details of Application of Galvanized Iron to Stringers.

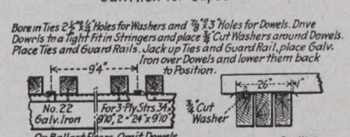


Fig. 5. Section of Ballasted Floor on Timber Trestle.

permits direct bearing of the stringers on the caps and ready removal of sheets for the purpose of adjustment. In place of two, the plans show three stringers on each side, which is now the standard on lines of heavy traffic. The addition of the third member to each chord was begun in 1905, and the iron applied in 1900 was found in many cases to be rusted out. The timber underneath the iron was found in as good condition as when covered in all cases where protection had been placed over new timber; but where timber had already been in place a few years before being covered the rotting begun in the open was found to continue under the cover. Upon removal of the covering all chord members beginning to show decay are marked with white paint on the underside and all defective covering replaced.

In the present plan the dowels are driven to a tight fit into the stringer instead of the tie, thus perforating the sheet-iron upwards instead of downward. Before driving the dowels the holes are filled with creosote, which is allowed to soak in. It was found necessary, in order to secure perfectly cut holes in the iron, to cut the upper end of the dowel in a lathe instead of by shearing.

After many experiments to determine the best way to prevent leaking through the dowel holes, it was found that this leaking was generally due to the churning of the ties and to capillarity, and that shearing the dowels was sufficient.

The plan now in use is to bore with an extension bit, a recess in the bottom of the tie concentric with the dowel hole ¼-in. deep and 2 ins. in diameter. Before putting the sheet iron on the stringers cut washers 1½-ins. in diameter are dropped over each dowel in the stringer. When the sheet-iron is settled home by the weight of the ties, the washer forces it up into the recess in the tie, secures a better hold on the iron to prevent creeping, and to a great extent destroys capillarity by creating an open space instead of tight contact around the hole in the iron. The water must be forced up an incline in order to enter the hole.

The sheets of iron are connected to each other by bending and lapping and riveting at one point on each side of the joint where it overhangs the stringer. The sheets are ordered in such lengths as to bring the joints between instead of under the tile. This method has been found almost universally effective to prevent creeping, and has reduced the leaking very greatly. No remedy has been found for leaks aroung the guard-rail bolts, but all holes in the stringers are carefully plugged at the bottom after framing and filled with creosote which is allowed to soak in.

It is still found necessary occasionally to stop creeping by bending the iron downward on the inside of the chord, nailing it to the stringer and flaring the lower edge of the iron to keep the drip off the sides. Small squares of galvanized iron or washers are used when this plan is resorted to in order to keep the nail heads from pulling through the iron.

The method of covering the caps has proved entirely satisfactory; gum and red-oak caps in use five years show no signs of decay. No caps put on since 1900 and properly covered have required renewal. Caps next to the bulkhead and those subject to frequent overflow on low trestles are of creosoted pine, as housing does not prevent decay in these.

When the use of sheet iron on the stringers was begun in 1900, no attempt was made to secure metal of great durability. Failure of many sheets appeared in about three years at points where switching was done or much sand used. Under ordinary road traffic it lasted about five years, and on branch lines of light traffic even longer. No failures of the metal on the caps due to rust have yet occurred. Later on effort was made to secure greater durability, and after considerable investigation it was decided to use a charcoal iron made by an Eastern mill, the galvanizing upon which was found to be much heavier than on the ordinary galvanized (steel) iron purchased on the market. The difficulty with this iron was found to be that it would not stand short bending, the cracking causing leaks.

Ballasted floors on trestles are meeting with much favorable consideration at present on account of the low cost of maintenance and decreased danger from fires, but it has not been heretofore considered advisable to use this plan without treating piles, caps and chords.

On account of the success attained in the preservation of chords by housing, a plan for ballasted floor similar to that shown in Fig. 5 has been adopted on the lines of which the writer has charge. The creosoted flooring on top of the stringers is confined to place by lag screws passing upward through a casting which also engages the packing bolts passing through the upper part of the chord. By this method all perforation of the chord covering is avoided. The chord covering can be renewed when required by jacking up the flooring from the caps below, and at the same time the members of the chord can be inspected on top. The cap covering is the same as for the open deck. This plan is much cheaper than one consisting of a larger number of creosoted stringers with plank spiked on top of them, and has the advantage of immediate conversion of present open-deck trestles to ballasted floors and admits of more ready inspection. It is believed to be able to take care of derailed equipment as successfully as any other plan. Driving spikes into creosoted timber penetrates the outer surface and admits moisture to the untreated interior, and will no doubt hasten the decay of the timber.

It requires 7⅓ sq. ft. of the galvanized iron to cover caps and stringers for every lineal foot of trestle with 12-ft. spans. The best quality of iron will cost about 0.042 cts. per sq. ft. or 0.308 cts. per lin. ft. of bridge. The labor cost for open decks, including the boring of recesses in the ties, is about 0.087 cts. per lin. ft. of bridge, making the total cost of covering per lin. ft. of bridge about 0.395 cts.

If the stringers and caps of open-deck trestles were creosoted instead of covered, the extra cost for treatment would be about $10 per thousand, B. M., or 75 cts. per ft. of bridge. To secure the full benefit of treatment, the framing should be done in advance, which is often quite difficult, in view of the varying span lengths, and cutting has often to be resorted to. If not done in advance, decay is likely to set in. Assuming that creosoted stringers will last 20 years, and that the galvanized iron on untreated stringers will last only five years, it would seem the best policy to use the creosoted timber. On the other hand, the creosoted timber should be protected against fire, and a covering which will answer this purpose will also protect the timber from decay.

For ballasted deck trestles the protection from fire is afforded by the ballast, and for all new work there seems no doubt but that the best plan is to use creosoted stringers and caps. However, for present conditions, where all stringers are already in place and sound, it seems most economical to cover the present stringers and to continue to renew the covering until new stringers are required. All patching should be done with creosoted stringers. Just what effect the placing of the creosoted timber on top of the galvanizing covering is likely to have on the durability of the latter is a matter for future determination.

It is also a question whether black iron painted with two coats of red lead applied immediately after mixing would not be more economical than the galvanized iron for the open-deck trestle.

PROJECTED RAILROAD LINES IN THE WEST.

An active railway construction program is projected for the Dominion generally and for Saskatchewan particularly, in the present fiscal year. In Saskatchewan over 1,000 miles of new line will be laid. Last year, this province led the others with total new track amounting to 476 miles. According to the plans so far announced by the three principal railroads of Canada, Canadian Northern will construct 330 miles in the province, Grand Trunk Pacific 342 miles and Canadian Pacific about 350 miles, making a total of about 1,120 miles. In addition to this new construction work, about 1,350 miles of new grading will be done.

The announced extensions of the Grand Trunk Pacific projected this year for Saskatchewan are as follows: Melville to Regina, 70 miles; Battleford to Biggar, 50 miles; Regina to boundary line, 90 miles; Regina to Moose Jaw, 40 miles, and Young to Prince Albert, 90 miles.

Concerning the completion of the Grand Trunk Pacific and the Grand Trunk from ocean to ocean, President Hays, who recently completed a six-weeks' tour of inspection of the greater part of the system, says the line will be completed in 1914. This is a year later than the estimate made early in 1910. Mr. Hays explained that in certain sections of the line good construction progress had been made while in other sections, owing to the difficulties presented by the rough country and also by a scarcity of labor, construction has been carried forward very slowly.

THE MUNICIPAL ENGINEER AND TOWN PLANNING.*

W. H. Wainwright.

The chief points to be kept in view by the municipal engineer when planning an extensive area are: Water supply, drainage, upkeep of streets, tramways, parks, and other ornamental features.

As water is delivered under pressure the only difficulty would be found when dealing with the parts of a town which are at a higher altitude than the source of supply. In this case it would be well to arrange for the public parks being placed at these eminences, and, provided they are not too high, the view obtained would compensate for the climb, even if there were no tramways available; this arrangement might save such costly works as water towers and pumping plant.

Drainage.

When considering drainage it would be well to draw on a contour map the natural lines of the main sewers, and then, at predetermined distances apart, draw branch lines at a good flowing angle to the sewers, and so arrange these branches that, even in a hilly district, they would not have an undesirably steep gradient. This would be the ideal town planning, so far as drainage is concerned, because the drains, in practically all cases, would be self-cleansing and, in a moderately hilly town, would never be at too great a depth from the street surface.

Keeping this plan always in mind, it might be possible to have ideal surface planning and only require a slight modification of the original drainage plan.

In dealing with the upkeep of streets it is now generally agreed that too wide streets are costly to maintain, and that it is better to have narrower roadways with either a belt of trees and grass at each side of the road, or else an excess of breadth for the footpaths; the former plan will, of course, find favor where it can be done, as, even if the road has to be widened, the trees could stand and the grass be cut away so as to allow of an extra road for very slow traffic, such as cartage for shops, etc. It would in general be found that if the streets followed the drainage plan, they would also be best for upkeep, and might facilitate the use of tar-macadam or asphalte, as fewer of the roads would be too steep: this would help to keep down dust and noise, which are two of the chief troubles of town life. In connection with streets there is the perennial question of tearing up roads for repairs of the various underground pipes and wires. Owing to improved methods, the latter are now generally laid down so as to be accessible for any necessary repairs, but not so the gas, water, and other pipes. It would be well seriously to consider if better methods than the present can be employed In the principal streets of a new town it might, in certain cases, pay to build a conduit, lay all pipes therein, and charge a rent for the same. No doubt it might require special powers, but, where practicable, the increased cost might be saved to the community in repairs and in there being less delay through streets being partially blocked while these are being carried out. . . .

Tramways.

It is difficult to foretell the ultimate extent of a town, but even if not at first required, provision should be made for possible tramway routes.

The inhabitant may require to go to any part of a town, therefore his convenience demands a radial service from his

* Read before the Institution of Municipal and County Engineers.

door to every point. In general, if he is at the circumference of the town, he can only get in one direction, and that towards the centre and even if he wishes only to reach an adjacent suburb, he must go into the congested area and then in a direction almost the reverse of that he has just traversed.

Usually a tramway terminus is taken to some convenient point beyond the real requirements, and cars there reverse their direction of motion and thus cause an unnecessary obstruction on the roadway, especially when two cars are standing, one on each line of metals; this inconvenience could easily be remedied, and at the same time other and greater advantages brought into view.

In diagram Fig. 1 is illustrated a suggested arrangement of tramway routes.

Suppose the intended terminus of one route was at A and that of another was at B, both of these being some distance beyond the actual requirement. Now, if instead of going to A the route was diverted at a, and joined up to b, which is returning from the proposed terminus B, it might not cost very much more than the original route, and it would avoid any blocking of the road. It would also serve a district hitherto out of reach, and offer at the point of f a double service, since, being at the most remote point,

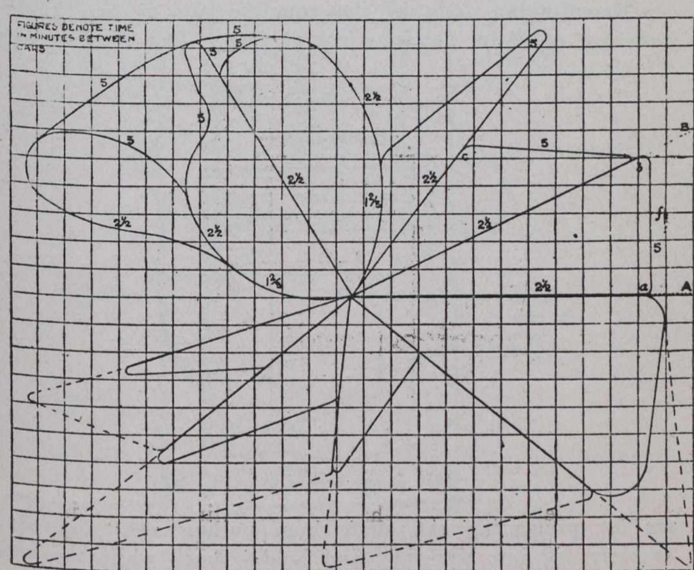


Fig. 1. Suggested Arrangement of Tramway Routes.

either car will serve, and for a certain distance on each side of this point it would be quickest to take the first car, even though a longer distance had to be traversed. At the junction b there is a double service, and from this point, if there is a five-minute service on each route, there will be a two and a-half-minute service to the centre of the town; from b round to c there will be a five-minute service, and from c to the centre a two and a-half-minute service as from b. There would also be the advantage of being able to reach adjacent suburbs without going into an already congested centre, and one which might be further enhanced by through or transfer tickets.

These and a few other routes are shown in straight lines, but they need not be so in the actual lay-out, and in the succeeding section of the diagram it will be seen how this principle could be adapted even to an elaborate scheme of town planning.

There is also here delineated a partly circumferential route, so arranged as to give a one and two-third-minute service in two densely populated districts approaching the centre of the town. The further elasticity of the system is demonstrated at the next section of the diagram, where dotted lines represent extensions to the system when the town has developed beyond its original boundary. . . .

Roads.

It is the engineer's duty to look ahead and prepare for any further change in the modes of transport, and it may be necessary to arrange for certain kinds of traffic to keep to certain streets, in which connection alternate routes to the same place would be an advantage. If the town had by-ways linking up main streets, as indicated when discussing tramways, these would help ordinary traffic, especially when one street was under repair, as it could be reserved for the slower and heavier traffic, the quicker and lighter being sent by the slightly longer route.

Since the introduction of fast traffic it has become imperative that corners shall not unduly obstruct the view, and the want of circumferential roads often causes motor vehicles to pass through the congested areas which they might avoid if there were an available good by-pass road. A town, therefore, should, have not only good radial roads, but also at least one good ring road near the outskirts of the town. Such a road is partly shown in diagram, Fig. 1.

Parks.

When public parks have to be laid out under the municipal engineer, it would be well for him to confer with an artist or a landscape gardener so that at the outset a well-designed scheme could be put in hand, and one that would be both pleasing and practical. There is no loss of dignity in such a course, as an engineer cannot be everything—even although some of the smaller towns expect it. A municipal engineer should make it his duty to call in expert advice when occasion demands it, as in that way unnecessary expenditure of public money may be avoided.

A town planning scheme may look well on a sheet of paper, but we must always bear in mind that only the immediate neighborhood is ever seen at one time unless under exceptional conditions, so that even if the scheme be practicable, much of the apparent beauty will disappear when the town is brought into existence, and local beauty may be sacrificed to fit in with a whole which can never really be seen as such.

In general the public recreation centre is not contiguous to the centre of industry, and in a new town is remote both from the factories and their accessories—the artizan dwellings. Now, it is the working class which requires the invigorating atmosphere of public parks, and unfortunately they have often too far to go to reach this desired spot.

In a new town, which has to be laid out on account of some industry coming into the neighborhood, this might be remedied. Suppose the sight of the works to be 1½ miles from the intended recreation centre and a road at present between them, the ground at one or both sides of this road could be acquired, making a total breadth of, say 100 yds. This could be laid out as follows:—

Twenty feet for footpath and ornamental gardens on one side, then a riding path 20 ft. wide, then an avenue of trees and grass 90 ft. wide, then the ordinary roadway 40 ft. wide for ordinary vehicular traffic; again, an avenue of trees and grass 90 ft. wide, next a double track for tramways of 20 ft. total width, and finishing with another broad footpath 20 ft. wide laid out with trees, shrubs, grass, and flowers. Chalets could be provided for refreshments and as waiting-rooms.

This broad avenue would serve the dual purpose of a road and a park. Residences would naturally be built alongside this ground, and the better class with architectural features would occupy the adjacent and more costly sites, while the smaller houses would be in the rear. The people could soon get to this space and thus be able to utilize a few spare moments which would not suffice to enable them to get as far as the recreation centre proper. This area of about 55 acres would be a very acceptable auxiliary park, and one obtained at comparatively little cost over and above that of the roads. If a stream happened to run or could easily be led along this avenue, it would further enhance its value as a recreation ground.

Engineers in the larger cities can concentrate their attention on a few branches of the profession, but those in charge of the smaller towns are not so fortunate and often have to dissipate their energies over far too wide a field. Unfortunately a town has grown to some considerable size before a fully qualified engineer is ever thought of, and often when things have gone too far to be remedied without a colossal expenditure of ratepayers' money. This is due not to neglect, but rather to the fact that a small community cannot—or think they cannot—afford to employ a competent engineer and have to engage such assistane as is available. This is a very strong argument for grouping several of the smaller towns together for engineering purposes.

CONCRETE DROP SHAFTS IN SHIFTING SANDS.

The following article by P. B. McDonald dealing with the construction of Drop Shafts is taken from the Mining and Engineering News:—

For mining an extensive ore deposit, overlain by a shifting or quicksand overburden, the operator is liable to consider a concrete drop shaft, put down with the aid of compressed air, for holding back sand and water.

The ordinary timber shaft might be successfully sunk to the ledge, or it might give so much trouble and take so much time that a substantial concrete casing would be cheaper. Perhaps a churn-drill hole will show the character of the overburden sufficiently to give grounds for choice. Modern tendencies are toward fewer shafts and larger outputs, and where previously several wooden shafts would have been attempted in less shifting parts of the formation, to-day's practice recommends a single concrete casing in a central location. As yet, however, there is so little competition in the contracting of concrete drop shafts, due to the holding of patents on the air-lock devices, that the profits and prices demanded are unduly large.

In the past few years there have been a number of concrete drop shafts sunk in the Lake Superior iron region, notably on the Mesabi, Cuyuna, Swanzi and Marquette ranges, and in the bituminous coal region of the eastern and middle states. It seems likely that the use of compressed air for shaft sinking will gain favor, just as it has in bridge pier, tunnel and foundation work.

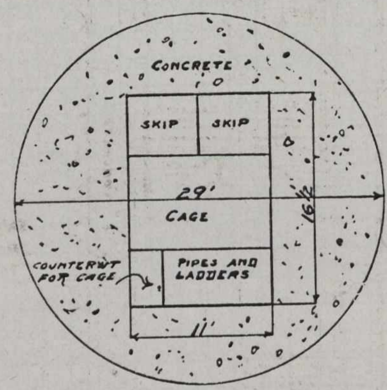
The favorite shape for the outside of the shaft is that of a circle. At first the inside was also made circular, and after partitions had been put in for skip and cageways, the odd spaces around the outside were utilized for pipe. Later practice makes the inside of the shaft rectangular. The Rogers shaft at Iron River, Mich., is 29 ft. outside diameter, and 16½ by 11 ft. inside at the bottom; there are three 6-in. offsets at intervals higher up, to allow leeway in aligning the guides for skips and cages. This shaft has very thick walls, but the weight is needed for forcing the cutting edge down through sand and boulders.

The principle of sinking the shaft previous to the turning on of compressed air, for holding back sand and water (and most of them are sunk some distance before the latter is necessary) can be likened to standing up a foot length of 4-in. pipe in the sand, and scooping out the material inside with a spoon, so that the pipe sinks gradually; more lengths of pipe are added at the surface as the first sinks down, and the dirt and pebbles are scraped away from under the high-side, so that the tube sinks evenly. The shaft, however, is a reinforced concrete casing, with a pointed steel cutting edge, and the dredging is done with "clam shells" or by men shovelling into a bucket. The "clam shells" are used whenever possible, and the shaft is preferably allowed to fill with water, so that the dirt is washed in from under the shoe.

The steel shoe, made in sections of 90°, of ⅝-in. steel, and re-enforced by vertical cross partitions of steel plate, held riveted to the shoe by angle irons, maybe 3 or 4 ft. high. The sections are assembled on the site of the shaft, usually in a hole or excavation dug as a starter, and the shoe is filled with concrete.

The walls are built up above the shoe, within circular steel forms on the outside and light wood forms on the inside (if the interior is rectangular.). During its gradual descent through the overburden, the shoe may become considerably bent from contact with boulders. When solid ledge has been reached concrete is added to the pointed cutting edge, which is thus filled out flush with the rectangular interior of the shaft, and is "sealed" to the rock.

Re-enforcing rods in the concrete are of two kinds; both are of ⅞-in. square steel or iron. The vertical rods



Plan of the Rogers Shaft.

are for preventing the shaft from pulling apart, in case boulders dig into the side, and hold it back while the bottom portion continues to drop away. At the start there may be two rows of the vertical rods, one a few inches from the outside forms, and one row near the interior walls; they are spaced about 18 ins. apart, and the first set is usually fastened to the shoe.

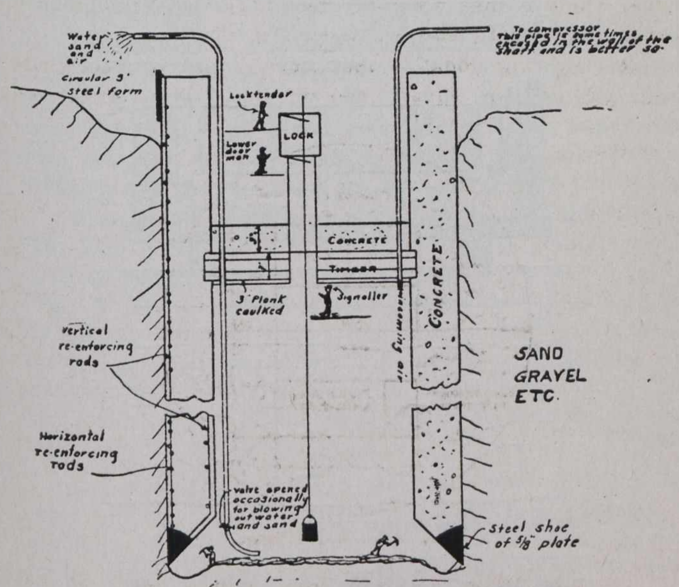
Later as the shaft nears completion, the inside row is usually let off, and the outside row is spaced at intervals of 3 or 4 ft. The horizontal reinforcements are bent in the arc of a circle, and are laid in the concrete near the outside walls, spaced at about the same distances as the vertical rods; they are for withstanding pressure from without—that of sand and water.

The concreting mixture should contain more cement than is specified for ordinary work, because in the case of a porous wall, compressed air will leak through, and later, when the shaft is finished, water will leak in. In loose overburden, after compressed air has been turned into the shaft, bubbles of the air can be seen rising out of the ground in great quantity, close to the casing, and in some instances as far back as 100 ft. from the shaft; this leaks through the walls and out under the cutting edge.

Preparatory to turning on compressed air for holding back sand and water, a timber deck is put across the shaft. Three 12-in. layers are fastened securely in a groove in the concrete; 3-in. planking underlies this, and is caulked tight with oakum. Over the 12 by 12-in. timbers is put 2 or 3 ft. of concrete. In spite of this 6 ft. of caulked timber and concrete, air will leak through, and impervious clay must be kept plastered on the under side of the plank.

When air pressure is turned on, the work consists of digging a ditch around under the shoe a foot or two deep, the dirt being thrown in the center, and later hoisted. This may require a little blasting in hard ground, but usually pick and shovel work will suffice; perhaps two or three days are taken (with each man working say two 40-minute shifts in 24 hours, there being 12 or 15 shifts).

The last shift comes up, the air is let suddenly out of the shaft through two or three exhaust valves opened simultaneously (perhaps 4 minutes being taken for the air to escape), and the casing should drop down an amount equal to the depth of the ditch dug. In case it hangs up from friction on the sides, it is sometimes necessary to explode several sticks of dynamite (in the water which has run in), for shaking or jarring the casing down. Occasionally the shaft has been weighted with pig iron or wet sand for forcing the cutting edge through the loose dirt, which runs in under the shoe, when the air is allowed to escape. The air



Sketch of Drop Concrete Shaft.

is blown out because its pressure holds the shaft up against the force of gravity. The greatest difficulty encountered in the whole process is from skin-friction on the sides of the shaft, which prevents the drooping down, and in extreme cases the casing has to be left hung up, and a concrete appendix built from the shoe down to the solid rock. The incoming air lines are often encased in the concrete walls, especially if much compressed air work is anticipated. When the pipes merely go through the timber deck, the air heated by compression makes the top of the chamber almost unbearably hot, so that not infrequently the men are overcome by the heat. This is particularly liable to happen to the man who works just under the timber deck giving signals and guiding the bucket into the hole.

One lock is now used for both men and hoisting dirt, where former practice used two.

Fifty pounds of air is the limit of endurance for men to work in. With 40 lbs. pressure per square inch two 40-minute shifts are worked per man per 24 hours. Three or four minutes are spent in the steel lock on the way down and the same time, or a little longer, in coming up. The lock is a steel reducing chamber where the air is turned on slowly or let out gradually, as the case may be.

GAS CAVITIES, SHOT, AND CHILLED IRON IN IRON CASTINGS.*

Thomas D. West.

Losses by defects as stated in the subject title above have caused many firms much worry and trouble before they could be made to disappear. The greatest annoyance, however, would arise from the fact that the trouble would be abated, but its origin could not be traced, and hence intelligently guarded against thereafter. As one of the letters received by the writer from a prominent Massachusetts firm is very pertinent, an extract from it is given herewith:—

"We note that you are accepting samples and suggestions regarding the formation of hard shot in cast-iron, and think, perhaps, some of our experiments will be of interest to you. From time to time we have had trouble with this shot forming in castings which we have made. A great deal of this work is finished, and, as shot in it is always sure to knock out the forming tool, so that they have to be reground, we have tried almost everything to stop this, and even when it does stop we do not know what we have done to do it.

"We conceived the idea of trying to make this shot in the iron, thinking that, perhaps, if we found out how to make it, we could then see how to stop the trouble. Our chemist informed us that the 'shot' was caused by the foundry 'mesh bugs' or small particles of chilled iron that drop in the meshes in the foundry. These, he stated, trickled down through the charges, and were not properly melted and run into the molten metal, in this way forming shot.

"We took some of these bugs and put them into the ladle, and poured castings from them, but were unable to make any shot. We also tried hard rattling stars, small set-screws, and small pieces of steel, and were unable to produce any shot. We tried putting these hard materials in the mould, and pouring the iron in the mould on top of them, but with the same result—no shot. We then wet a gate in the mould in an attempt to make the mould blow, without results. Damp, wet sand, while it caused blow-holes, did not produce the hard shot. In fact, we have tried everything that has been suggested that might cause this trouble, trying to make the hard shot, making the test as favorable to the formation of them as possible, and have been unable to produce anything. We are therefore coming to the conclusion that there must be something in the mixtures of iron, and are going in on that basis to try to cure it, although at the present time we have not had any trouble. We have no samples to send you, but, should any come along that show this formation, we will forward them to you."

The above experiences, with others that might be given in addition, would suffice to counteract the theory often advanced—that small chilled or hard bodies going into the cupola may cause hard shot, streaks, or spots in the iron castings.

Shot Causing Hard Spots and Blow-Holes in Iron Castings.—A few weeks after receiving the Massachusetts letter, this firm sent a sample of defective casting showing a small, hard button or "shot" loosely embedded within the nowel or down cast face of its surface. The sample (illustrated in Fig. 1) shows a crease made when the tool swerved off to one side in striking the hard spot. Also the chiselled indentations caused by removing the hard shot or button from the planed face of the casting. This defective sample is about as interesting a one as any re-

*Abstract of a paper read before the American Foundrymen's Association.

ceived by the writer. The peculiarity of this sample lies in there being a vertical small blow-hole leading directly from the top of the hard shot seen at A to the cope surface, so that upon removing the shot one could see clear through the body of the casting, this being about one-half in. thick. It gives evidence of the hard shot or foreign material while lying near the bottom surface of the casting emitting a gas, which went upward through the molten metal to the sand surface of the cope, but not sufficiently fast to prevent the creation of the small vertical blow-hole shown. In order to clearly observe the full surface and character of this blow-hole the sample was fractured, and the hole is sketched closely, as seen in Fig. 1, annexed. It is rather unfortunate that samples showing hard shot, &c. (like A, Fig. 1), are so small that they do not afford sufficient material for making a complete analysis, as this would, no doubt, assist in the solving of such problems.

Several samples of soft-iron castings have been received containing solidly encased or cemented small bodies of strictly white iron. The term "cemented" is used here, as the spots or white bodies, are in no wise loose in the casting. They form a part of it, showing differences in color of white and grey, but are as solidly united as this is possible for any two plastic materials each of a different grade and color, to be. Not only is this defect obtained in a shot or spot form by founders, but also in streaks and bodies of considerable area. Defects of these characteristics are most generally found at the upper cast body, face, or edge of castings.

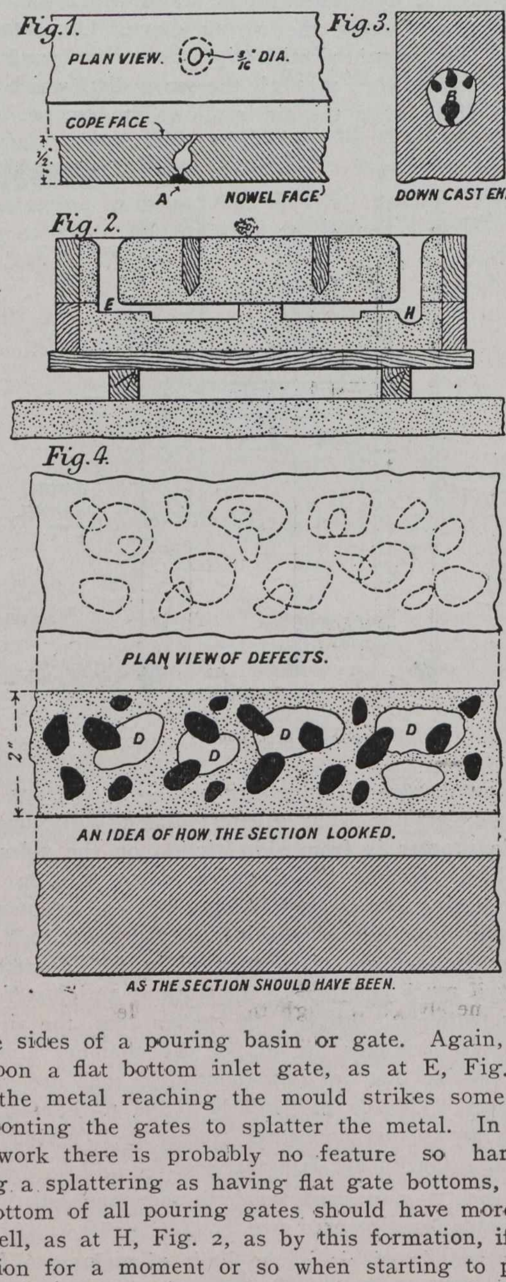
Experiments with Shot Iron Placed in Moulds.—Some shot iron was received by the writer which had been taken from a cupola spout after the bottom was dropped, on the supposition that it could cause blow-holes. Some of this shot he placed in the bottom of an "open sand" mould giving small castings, about 3/8 in. thick. In pouring these, no disturbance of the metal through any escape of gases was noticeable, and when the castings were broken through sections containing the shot they were perfectly sound. The writer also used some of the shot by placing it on the bottom of closed moulds, and pouring some of the moulds with "hot" and also with "dull" iron. In one case of "dull" iron a very small gas cavity, or blow-hole, was barely noticeable above the top of the shot. The party forwarding the shot stated none was observable at the first of the heat when nearly all pig iron was being melted, but noticed them at the latter part of the heat when the charges were composed largely of scrap iron.

The above shots were sufficiently soft to be squeezed or flattened slightly before cracking by placing them between the jaws of a vice, and applying pressure. The experiments conducted by the writer showed, apart from the "blow" question, that unless shot iron was up to a very high red-heat, or near the fusing-point (as is possible in many cases when they are formed in pouring a mould), that casting metal under 3/8 in. in thickness would have little effect in melting them, unless they might rise to be embodied in nearly the middle body of the casting, especially if the shot are roughly over 1/8 in. in diameter. The shot which the writer used in the above experiments were placed on the bottom face of the mould at the end farthest from the pouring-gate, so that the wash of the metal would not be so liable to disturb them. An examination of the castings when cold showed the shot in their original position, and not united to the body of the castings, when fractured along a line in their position.

Causes for the Creation of Shot Iron in Castings.—The logical reasoning regarding the creation of the small, hard particles or metal shot found in some castings, is that they become suddenly separated from the general mass of metal during the pouring of a mould. When thus separated they solidify so quickly that not sufficient time is given for the carbon to be separated out as graphite. Hence the shot does not have the softness of the rest of the casting which had more time to cool.

The longer the distance a shot is sent through the air before it lodges, and the cooler the air it passes through, the harder the shot. Affecting this also is the degree of dampness of the spot upon which the shot may lodge. Where shot is caught and covered by incoming metal before it has time to become cooled below a red heat, the chances for their being hard and discoverable in a casting is not, of course, nearly as great as when they can become of a dark color before being encased by the liquid metal.

Particles of iron or shot may be formed during the falling of the metal from the ladle's pouring-lip by striking the sides of a pouring basin or gate. Again, by falling upon a flat bottom inlet gate, as at E, Fig. 2. Or when the metal reaching the mould strikes some obstruction fronting the gates to splatter the metal. In ordinary plain work there is probably no feature so harmful in causing a splattering as having flat gate bottoms, as at E, The bottom of all pouring gates should have more or less of a well, as at H, Fig. 2, as by this formation, if there is hesitation for a moment or so when starting to pour, the first droppings from the ladle fall into the well shown, to stay there in a liquid bulk and not be splattered to create shot.



In starting to pour the majority of moulds, especially those of a light work and stove plate character, there should be no momentary stoppage after starting, but from the instant the falling metal first strikes the bottom of a gate, as at H, there should be a steady and unbroken stream to fill rapidly the pouring gate and have it kept so until the mould is filled. This applies to the flat top pouring gates generally used for stove-plate, &c., as well as those of the joint character, shown in Fig. 2. Following of the above practice closely in all admissible cases should help greatly to end some of the trouble experienced with shot iron and hard spots in castings, and is one illustration of where the master's skill in handling a ladle can be displayed.

Dampness and Sudden Cooling Causing Chilled or White Iron Bodies and Shot.—The too free use of a swab or sponge in wetting the joint of a mould, before drawing a pattern, or after this is done in finishing a mould, can easily harden or chill the metal parts of a casting formed where this excessive dampness existed. Again, also, by too damp a mixture of sand, hard ramming, or insufficient venting. Metal striking these damp sections will often bubble and splatter to a greater or less degree. This action in some cases creates suddenly chilled shot that will be carried to other sections of a mould to become encased in liquid metal, and thereby give the white iron or chilled shot found in some castings.

As white iron or hard spots can be produced at will in gray iron castings, especially those of a light character, by the immoderate use of the swab or sponge, damp sand, hard ramming, and insufficient venting, this would indicate that the skilful, broadly experienced overseer and moulder can master many troubles along these lines.

Creation of Globules in Gas Cavities and Blow-Holes.—The next defect to be taken up is that of globules in gas cavities and blow-holes, an illustration of which is seen in Fig, 3. These defects can be due to two conditions, but emanating from one cause, and that is the creation of excessive gases or steam that cannot find its liberation from imprisonment within a body of solidifying metal. They are found chiefly in the upper body or cast end of castings.

Excessive gas, causing blow-holes or cavities, may come directly from the metal or wholly from defects in moulding or pouring. Those due to the iron may be caused by oxides of iron or manganese reacting on the iron's carbon, the former producing carbon monoxide gas, or on liberated graphite creating kish (although of the latter there is very little in re-melted iron, it being chiefly found in direct metal at blast-furnaces); also indirectly through sulphur, by reason of the formation of sulphide of manganese. And, again, by a foreign body like that possibly created by the mixture of iron oxide and dross (the latter may contain some kish in connection with the dirt generally coming from clays of the cupola tap-hole and spout, and other sources), forming a slag on the top of a ladle's metal that could pass in small bodies into a mould at the starting of pouring, or later on, before a mould is filled, through defective skimming. Thereby often large as well as small blow-holes or gas cavities are formed. As a side issue, it can be said that a ladle's surface dross can easily cause dirt-holes, pin-holes, and a dirty surface to the finished parts as well as the rough surface of castings when skimming is at fault in pouring a casting.

Gas cavities and blow-holes, due directly to defects in moulding and pouring, are often due to not having properly tempered sand, regulated degrees of hardness in ramming, efficient means of venting, and correct methods of finishing cores and moulds, combined with needed experience in gating and pouring. These are all factors demanding the experience of a decade or more in the actual work of general moulding, in order one may be fairly qualified to best prevent the occurrance of the difficulties treated herein, or to stop them quickly when in evidence.

Defining Whether Globules are Due to Defects in Metal or Moulding.—Globules, when suspended from the roof of a cavity, as at B. Fig. 3, are evidence that the cavity is probably due to something being wrong in the method or manner of making, gating, or pouring the mould than directly with the metal. The mould's gases or steam creating these cavities may be originated during the filling of the mould, and again may not be formed until some time after the mould, and again may not be formed until some time after the mould has been filled, or before the main bulk of its metal has solidified. Imprisoned gases or steam, due to defects in moulding, form a cavity into which the outer body of liquid metal may, with favorable conditions, ooze to form loose shot or suspended globules, as seen at B, Fig. 3. The actions of globules, or any liquid, also any special elements, finding access to such cavities, may continue at intervals for a short time after a gas cavity has been formed, or as long as the body of metal surrounding the cavity remains in a fairly liquid state. The larger the cavity the greater the chances for this action. Globules finding access to a gas cavity at its upper end, as displayed in Fig. 3, may be credited to the law of specific gravity, and also to the condition that heat rises, and that the upper body of metal is, as a rule, more fluid than the lower, as is evidenced by the "hot spot," or shrink-hole, being the greatest in the uppermost cast end of castings.

Cavities created solely through conditions of the metal, or its constituents, or, again, strictly by splashes of oxidised bodies of metal, or foreign solid matter, should by logical reasoning more generally present an unbroken smooth bright surface. The metal or confined oxidised shot conditions that start these cavities are such as can in some cases continue the creation of gases to make a higher internal pressure to prevent globules, liquid metal, &c., entering their space than exist where gases become imprisoned from a source that cannot add to their volume, or increase their pressure, as would more generally be the case if created wholly by defective moulding.

A casting may possess gas cavities that will be due to causes inherent in both the mould and the metal. This, for one case as an example, could occur through a mould bubbling or boiling its metal sufficiently to throw up small bodies or buttons of metal that would fall back oxidised into rising metal in the mould; and these bodies, buttons, or shot could, by reason of their oxidation and probable gathering of dross, create a gas to cause cavities that would be companions to those created solely by the mould's steam or confined gases endeavoring to escape, but was imprisoned in the metal. (See Fig. 4.)

Alloys used for Deoxidizing and Purifying Iron.—Quite a large number of alloys are now manufactured for the purpose of eliminating the natural and acquired impurities in iron, some of which may cause the defects treated in this paper, especially for light work. A large portion of these alloys are composed chiefly of manganese, and with the exception of where they are intended to strengthen iron, or give it some peculiar character, they can achieve little or no more than manganese used solely by itself.

We also have, apart from manganese as currently known, silicon and phosphorus, all of which are obtainable in a ferro form with other constituents, the manganese ferro being as high as 80 per cent., the silicon 50 per cent., and the phosphorus 20 per cent., and each obtainable in a lump, pea, or ground form. These ferros are best used by being placed on the bottom of a ladle and having the metal tapped on to it, to be sometimes assisted in their work by the metal being agitated with a green stick or rod of iron. The amount of these ferros to be used will depend on the character of pig and scrap melted in connection with that required in the casting. The three ferros can be used from having ¼lb. to 1 lb. of either per hundredweight of metal in the ladle. The phosphorus serves as a scavenger when used to purify metal, by reason of its increasing the fluidity of the metal to thereby permit sulphur, oxides, or occluded gases a better chance to escape. In connection with the above we have aluminium that can be placed on the bottom of a ladle to the extent of ¼ lb. to 1 lb. per hundredweight of metal in it. Aluminium is obtained from being all pure down to 85 per cent. of it in alloy with other constituents. Ferro-manganese and silicon are also used in the cupola along with lime or other fluxes to help deoxidise and desulphurize mixtures of iron. The above current generally known points of this paragraph are given here to make this paper more complete.

METHODS OF INCREASING THE EFFICIENCY OF SURFACE LINES IN LARGE CITIES.*

Williston Fish.

When this comparatively new instrument of civilization, the street car, shall have reached its highest degree of efficiency it will transport passengers: (1) With the highest degree of safety to the passengers on the car and to the public on the street; (2) with the highest degree of speed consistent with such safety; (3) with the highest degree of regularity and certainty as to schedule; (4) with the highest degree of comfort to passengers; (5) with the highest degree of economy.

Street car service in our large cities, through the labors of an army of able and zealous men, has reached a high degree of excellence, but undoubtedly in each of the points —safety, speed, certainty, regularity of schedule, comfort and economy—it is capable of further and perhaps even radical improvements. The question of improvement in the service is one of wide importance. It affects the majority of the people of our large cities daily and twice a day; moreover, the question is not only of great importance now, but it is of growing importance, because the large cities are increasing rapidly in population and still more rapidly in area.

The first matter to be considered in this article is whether in large cities the number of stopping points of surface cars can with advantage be diminished.

Assume a section of a route as shown on the plate, and consider the stops made by a car in running from north of "12th" street to south of "15th" street. Under the present practice in our cities, the car will stop for passengers to get on or off at any or all of the intersecting streets, so that on any trip the car may stop in succession at "12th" street, "13th" street, "14th" street and "15th" street.

The question arises then: Is this the system to produce the highest degree of safety, speed, certainty of schedule, and economy? The system, naturally, has a certain effect, small or great, upon each of these factors in street car effectiveness. Conspicuous in its results on important and long routes in large cities, is the intolerable multiplication of stops; but before examining the results of the system, let us first propose a different system; then, with the two systems before us the results may be studied and compared.

*Abstracted and reprinted from The Annals of the American Academy of Political and Social Science.

The proposed plan is this: That instead of stopping on signal at "12th" street, "13th" street, "14th" street and "15th" street, cars stop only at "12th" street and "15th" street, all stops at the two intermediate streets, "13th" street and "14th" street being entirely eliminated. The system, of course, would not be rigid, but the stopping places would be established so as to include transfer and other important points used by great numbers of street car patrons.

These are the two plans. What are their comparative results upon the great factors of street railway service?

Evidently a disadvantage of the proposed plan would be an increase in the walk of certain passengers. In detail this increase would be:

1. Passengers at "12th" street and "15th" street would still board or leave the cars at these points, and their walk would not be increased at all. These passengers would include all those to and from points between lines AB and CD and between the lines EF and GH.

2. Passengers to or from points between the line CD and "13th" street, and between the line EF and "14th" street would have an extra walk of from nothing up to one block. Assume the average extra walk of these passengers to be one-half block.

3. There remains to be considered the block between "13th" and "14th" streets. Passengers to or from points in this block would have one extra block to walk. They would use either the "12th" street stopping point or the "15th' street stopping point, as might be more convenient; about half of them would also lose the time required for the car to run a block.

What does the extra walk amount to on the average? If we assume that an equal number of people under the present system use each of the intersections (and this, of course, is a violent assumption, as will hereinafter plainly appear), the result would be that people between the lines AB and CD, or one-third of all the people, would have no extra walk; people between the line CD and "13th" street, and between the line EF and "14th" street, or another one-third of the people, would average an extra walk of one-half a block; people in the middle block, or another one-third of the total, would have an extra walk of one block. The average extra walk for all the people, assuming all present intersections to be now equally used, would therefore be one-half of a block. Under actual conditions, as will be hereafter shown, this extra walk would be about one-quarter of a block.

It is to be particularly noted that although the proposed plan puts the stopping points three blocks apart instead of one block, it increases no passenger's walk more than one block.

As far as I can see, the small extra walk—amounting, in fact, to about one-quarter block for the average passenger, and never rising above one block—is the only disadvantage of the proposed plan. Others may see, perhaps, other disadvantages.

Now, we may consider what the advantages of the proposed plan would be. I believe that in large cities the proposed plan, if installed outside of the most congested district, would result in many advantages, some of them of great value. It is evident that the advantages will vary with the conditions on the route involved. On a route doing a small business with passengers getting on and off infrequently, the single disadvantage of an average extra walk of one-quarter block might exceed the advantages to be derived from the plan. On the other hand, on an important route in a large city, with passengers, under present plan, making use of a great part of all the intersections for getting on or off, the proposed plan would show its maximum of advantage. If we had a route with one hundred intersections, and there were no street or steam railway crossings, boulevards or other necessary stopping points to break up the regularity of the proposed division into three-block stops, such a division would give 34 stopping points instead of 100; but, although cars may stop at every crossing, in practice they stop only at a certain number of them, and, except by actual observation of a route, it is impossible to say how many actual stops of the car would be eliminated upon that route by establishing the proposed plan. Without a knowledge of the number of stops that would be cut out, it is impossible to say how much time and expense would be saved.

To determine how many stops would be eliminated in actual service, observations have been made upon 12 main lines of street railway in Chicago. Each of the routes observed was carefully examined, and the stopping points which probably would be established, if the proposed plan were used, were determined. It is to be understood that no change was made in the actual operation of the cars, which continued under the present plan of one-block stops. In the theoretical selection of stopping points, a stopping point was included at each street intersection in the downtown district; outside of this district, a stopping point was supposed at each railway crossing, each steam road crossing, each boulevard, and each elevated station; then other stopping points were supposed intermediate between these necessary stopping points, so that in no case would more than three blocks of ordinary length intervene between stopping points. Good men were placed upon the cars in actual operation under the old system on a route to be observed, with blank books, showing in their order for a round trip, all the present stopping points on the route. The men indicated on the form at what point the car actually stopped, how many passengers got on at each stop. These books, when turned in, were carefully studied and the following table compiled.

Upon a consideration of this table and the general circumstances of this problem, it appears to me, first, that a change which seems to promise to eliminate 26 per cent. of all stops of street cars, except stops caused by traffic blockades, is worth examination and worth examination now, for, to eliminate twenty-six per cent. of such stops will save much time, increase regularity and certainty of schedules, promote comfort of passengers by reducing stops and starts, and effect important economy in operation by its saving in time, power and wear and tear:—

One block	Total for all 12 routes	Average for one route	Per cent.
Number of stopping points for round trip	2,079	173.25	100.00
Number of proposed stopping points for round trip...........	740	61.67	35.60
Number of present stopping points cut out	1,339	111.58	64.40
Passengers actually counted getting on or off	19,492	1,624.00	100.00
Of these passengers the number getting on or off at the proposed stopping points was	13,280	1,107.00	68.13
Number of passengers getting on or off at points that would be disused under the proposed plan	6,212	517.00	31.87
Number of stops actually made at all points	6,911	576.00	100.00
Number of stops made at proposed stopping points	3,853	321.00	55.70
Number of stops made at intermediate points	3,058	255.00	44.30
Number of unnecessary stops—that is, stops made to take on or let off passengers within one block of a proposed stopping point on a trip when the car actually stopped at such main stopping point	2,146	179.00	31.05
Passengers getting on or off at unnecessary stops as defined above, being the 2,146 stops....	4,290	357.50	22.01
Average extra walk entailed on all passengers by substitution of proposed stopping points estimated at about	¼ block		
Estimated stops per day on routes observed	199,238	16,603.00	100.00
Total unnecessary stops estimated	52,948	4,412.00	26.57
Estimated stops of surface lines in Chicago per day	1,200,000	......	.....
Estimated number of stopping points on all surface lines in Chicago for one-way trip, estimated at over	7,000	......	.....
Number of elevated stations in Chicago for one-way trip	177	......	.....

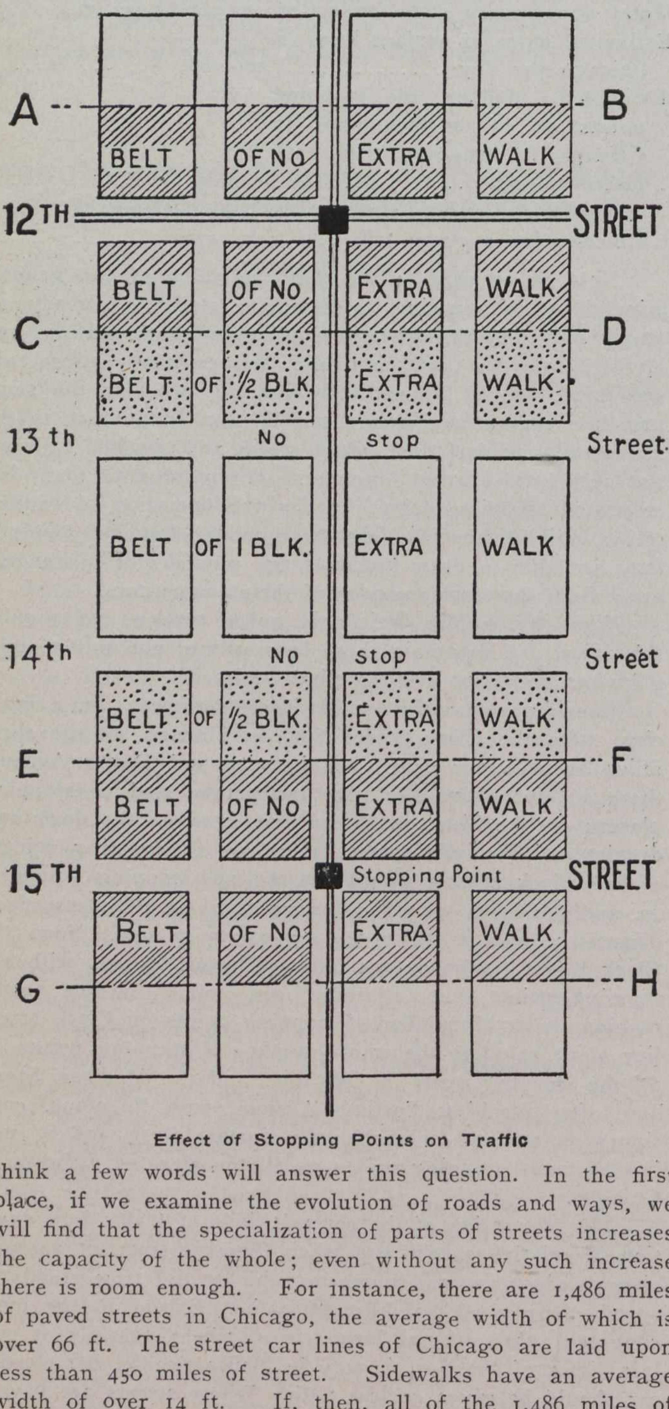
Next, it appears to me that the value of the general principle of eliminating intermediate stops is already so amply shown by the experience of urban steam railways and elevated railways that the public, and especially street railway men, should immediately inquire whether the same principle cannot and should not be applied at once to the street railway; for these urban steam and elevated railways not only attract great numbers of patrons to their far-separated stopping points but by the operation of express trains, still further reducing the number of stopping points, they are able to draw further large numbers of passengers away from the slower service of their competitors.

What the public desires is quick service and regular schedules, and to obtain these it is willing not only to take a longer walk, but even to climb stairs.

Consider what this one-block system means in a large city. On the Clark Street line, in Chicago, in the eight miles between the centre of the city and Devon Avenue, there are for a one-way trip, 130 points used as stopping places; on the Madison Street line, between the downtown district and Fortieth Avenue, there are 84 stopping points; a three-block system would cut the 130 stopping points to 47, and the 84 to 30, still allowing stops at all intersections downtown, and at all necessary points outside. Now, the Clark Street tracks do not end at Devon Avenue, with 130 stopping points, but continue six miles further north, making the total number of stopping points on Clark Street line alone equal to the whole number of stopping points on all the elevated roads in Chicago; and the Madison Street line, after reaching Fortieth Avenue, with 84 stops, continues on six and one-half miles further west, and it, too, has as many stopping points as all the elevated railways in Chicago.

The separation of the several kinds of traffic is a question of relative speed, and when there is frequent passage along a given general course by vehicles, differing greatly in speed, there must be different paths. Except in the most congested parts of our large cities, where possibly at certain times of the day, it may be impracticable, the electric car should be given a clear path. Where streets are paved, wagons should not run longitudinally upon the tracks at all, and they should cross the tracks only at street intersections. I suggest for serious consideration whether, at all street intersections, the street car should not be given the right-of-way. Steam cars are universally given the right-of-way at street crossings, and, here again, I wish to point out that this is done because it is inherently necessary in the economy of things. It is done because it would be a comparatively great tax imposed upon society if its heavy, rapid trains of steam cars were obliged to share their right-of-way at street intersections with other vehicles, which are able to stop without much loss of time or energy. The same principle of general economy, which makes it proper that the steam-railroad trains should have the right-of-way over the electric car at crossings, requires that the electric car should have the right-of-way over wagons at crossings.

While it will be admitted by every one that a clear right-of-way for the electric car would be of immense advantage to the public of large cities, the question may arise whether suitable room would be left for other traffic. I



Effect of Stopping Points on Traffic

think a few words will answer this question. In the first place, if we examine the evolution of roads and ways, we will find that the specialization of parts of streets increases the capacity of the whole; even without any such increase there is room enough. For instance, there are 1,486 miles of paved streets in Chicago, the average width of which is over 66 ft. The street car lines of Chicago are laid upon less than 450 miles of street. Sidewalks have an average width of over 14 ft. If, then, all of the 1,486 miles of paved streets of Chicago were thrown into one street 1,486 miles long, and the street cars were given the exclusive use of that part of the 66 ft. of width proportionate to the total space the tracks now occupy, the entire width of the street would be divided as follows: Sidewalks, 28 ft.; wagon roadway between sidewalks and car tracks, 33 ft.; car tracks, 5 ft.

Our streets are often called congested; in fact, there is plenty of room upon the streets, except in small territories, and the question is to use the streets so that all the people may derive the greatest advantage from them. All through the 24 hours of the day the greater proportion of the street area in the largest cities is practically empty—roadways, sidewalks, and all—and yet in unused streets, even when well paved, car passengers are now obliged to divide the way with wagon traffic. Moreover, it is a fact that exclusive of the parks, more space is taken up by boulevards in Chicago, mainly devoted to pleasure riding, than is used by all of the street railways in the city.

In conclusion, I wish it understood that I put forth these suggestions for the elimination of stops and for the further specialization of the street car's roadway, for consideration by the public and street railway men. Many good reasons that I have not given for the adoption of these suggestions will occur to them, and perhaps good reasons for not adopting them may suggest themselves. I see that, at present, street-car transportation has not reached an ideal condition. It is not rapid, but slow; the schedules are not regular and certain, but irregular and uncertain; passengers are subject to continuous annoying delays, and the present system is wasteful of time and money. At the same time I see that the history of the street car is but just begun, and from considering its present importance, and the general process of evolution in the contrivance of men, as well as in nature, I am led to trust that many great and important improvements are yet to come. When I see in large cities that it is impossible for the public to be given any but a poor, slow and irregular service; if a maximum of stops is made, and if the street-car tracks are used in common by all the street traffic, I am confident that a change will have to be made. People in the largest cities, like people in the smallest towns, have only 24 hours a day to live and accomplish their work. When substantial amounts of time are taken from them morning and night in waiting upon transportation they suffer a direct loss in their efficiency, in what they are able to do, and in the sum of their enjoyments. Their city suffers with them. Restore to the multitudes of people in the large cities who travel by street cars the 10, 20 or 30 minutes twice a day that they lose on account of clogged and obstructed street-car traffic, and you have made almost another race of beings, capable of more work and more enjoyment. When expensive boulevards from 80 to 250 feet in width, surrounding and dividing cities, provided with the best pavement, ornamented with trees and flowers and cared for by gardeners, all at public cost, are considered not too much to devote to pleasure riders, certainly a strip, 16 ft. wide, on the street-car streets is not too much to devote to the daily transportation of the whole army of city workers.

TRADE OF CANADA ANALYSED.

(The Monetary Times.)

The trade of Canada has undergone remarkable expansion during the past fifteen years. The total trade in 1897 amounted to 249 million dollars. At the end of March, 1911, the termination of the fiscal year, the total had increased to 759 millions, the largest aggregate amount of trade in the period under review. The increase has continued without interruption, except in 1909, when the returns exhibited a slight decline.

The following table shows the trade of Canada, compiled from the returns of the Department of Trade and Commerce, for the past fifteen years. From 1897 to 1907 the fiscal year terminated on June 30th. Since 1908, the fiscal year has ended on March 31st. This applies to all the tables printed below:—

	Imports for Consumption.	Exports.	Total Trade.
1897	$111,294,021	$137,950,253	$249,244,274
1898	130,698,006	164,152,683	294,850,689
1899	154,051,593	158,896,905	312,948,498
1900	180,804,316	191,894,723	372,699,039
1901	181,237,988	196,487,632	377,725,620
1902	202,791,595	211,640,286	414,431,881
1903	233,790,516	225,849,724	459,640,240
1904	251,464,332	213,521,235	464,985,567
1905	261,925,554	203,316,872	465,242,426
1906	290,360,807	256,586,630	546,947,437
1907	354,500,894	258,171,674	612,672,568
1908	358,428,616	280,006,606	638,435,222
1909	298,205,957	261,512,159	559,718,116
1910	375,833,016	301,358,529	677,191,545
1911	461,898,024	297,196,365	759,094,389

Total Imports and Exports.

The total imports for consumption in the fifteen years' period increased from 111 million dollars to 461 millions, a gain of 350 millions or 315 per cent. The total exports changed from 138 millions to 297 millions, a gain of 159 millions, or 115 per cent. Of the imports for consumption 66 millions were dutiable in 1897 and 282 millions in 1911, an increase of 326 per cent. Goods to the value of 45 million dollars came in free of duty 15 years ago and this year 179 millions, the change in the period being 134 millions, or 298 per cent.

Of our exports, 123 millions were Canadian produce in 1897 and 14 millions foreign produce. In March, 1911, the figures had changed to 274 millions and 22 millions, gains of 150 millions and 8 millions, or 121 per cent. and 59 per cent. respectively.

Canada's trade is roughly divided into three classes, trade with the British Empire, the United States and other foreign countries. The following table gives an idea of their comparative importance:—

Trade of Canada with	Imports for Consumption. 1897.	1911.	Exports. 1897.	1911.	Total Trade. 1897.	1911.
British Empire	$31,671,959	$129,431,348	$82,238,023	$154,335,874	$113,909,982	$283,767,222
United States	61,649,041	284,934,739	49,373,472	119,203,201	111,022,513	404,137,940
Foreign Countries	17,973,021	47,531,937	6,338,758	23,657,290	24,311,779	71,189,227
Total Trade	$111,294,021	$461,898,024	$137,950,253	$297,196,365	$249,244,274	$759,094,389

Gains in Trade.

The gain in Canadian total trade with the British Empire was 169 million dollars in the fifteen years. The gain in trade with the United States was 293 millions and with foreign countries 47 millions. The growth in trade in these three divisions respectively is best seen in the following table complied by The Monetary Times:—

Trade of Canada with	Gain in imports for consumption 1911 over 1897 Mlns. of $	Per cent.	Gain in exports 1911 over 1897 Mlns. of $	Per cent.	Gain in total trade. 1911 over 1897 Mlns. of $	Per cent.
British Empire ..	97	309	72	87	169	149
United States ...	223	362	69	141	293	263
Foreign Countries	29	165	17	283	47	195

The United States shows the biggest percentage gain so far as our import trade is concerned in the fifteen year period. The largest increase in our exports was 283 per cent. in our foreign markets. The greatest gain in total trade applies to the United States with 263 per cent. The British Empire makes a good showing with an import gain of 309 per cent., compared with the neighboring Republic, whose percentage in the Canadian import trade was 362 per cent.

Figures Last Year.

Analysing the trade of Canada for the latest year, it is seen that the total of imports entered for consumption last year was $461,898,000, and the total of the exports of Canadian produce was $274,316,000. The merchandise represented by these figures came from and went to the following countries as follows:—

	Imports from	Exports to
United States	$284,934,000	$103,922,000
United Kingdom	109,883,000	132,350,000
France	11,563,000	2,535,000
Germany	10,047,000	2,028,000
British W. Indies	6,391,000	4,459,000
British Guiana	3,877,000	614,000
Belgium	3,571,000	1,908,000
Japan	2,423,000	615,000
Newfoundland	1,818,000	3,714,000
Italy	962,000	374,000
New Zealand	907,000	999,000
British Africa	704,000	2,330,000
Australia	511,000	3,900,000

As regards imports, it will be seen that the greatest quantity, over 61 per cent. of the total, came from the United States, in face of maximum tariff duties, where duties applied, while less than 25 per cent. came from Great Britain, whose exporters have the advantage of the preferential tariff.

Dutiable and Free.

Despite the British preference, Great Britain's proportion of dutiable exports to Canada has remained high in the past fifteen years. The following table illustrates this point:—

Imports for consumption from	1897. Mlns. of $ Total	Dutiable	Free	1911. Mlns. of $ Total	Dutiable	Free
United Kingdom ...	29	20	9	109	84	25
United States	61	30	31	284	153	131
Foreign Countries.	18	14	4	48	34	14

In 1897, of Great Britain's total trade of 29 millions, 20 millions or nearly two-thirds was dutiable. In the case of the United States, with total trade of 61 millions, 30 or one-half was dutiable. More than three-fourths of our exports from foreign countries were dutiable in a total trade of 18 million. In the last fiscal year, 84 millions of the United Kingdom's total exports to Canada, amounting to 1909 millions, were dutiable. In the same year our imports from the United States were 284 millions, of which 153 millions were dutiable. Canada's imports from foreign countries in that year totalled 48 millions and 34 millions of that merchandise was dutiable. The benefits of the British preference do not appear to be clearly defined in these figures.

In view of the suggested appointment of a Royal Commission to investigate trade conditions in the various parts of the British Empire, it will be interesting to tabulate the details of trade with the Empire during the period under review:—

Year.	Total Imports.	Total Exports.	Total Trade.
1897	$ 31,671,959	$ 82,238,023	$113,909,982
1898	34,526,353	110,782,055	145,308,408
1899	39,893,887	104,707,000	144,600,887
1900	48,396,003	114,782,267	163,178,270
1901	46,852,904	113,383,157	160,236,061
1902	53,895,821	129,070,620	182,966,441
1903	65,010,271	141,975,986	206,986,257
1904	72,889,146	128,951,609	201,840,755
1905	72,430,750	113,877,323	186,308,073
1906	83,804,027	144,311,803	228,115,830
1907	103,877,713	138,692,878	242,570,591
1908	111,240,895	147,748,085	258,988,980
1909	87,042,250	147,297,851	234,340,101
1910	111,798,417	165,364,091	277,162,508
1911	129,431,348	154,335,874	283,767,222

amount dutiable changed from 21 millions to 96 millions, a gain of 75 millions, or 150 per cent. Free imports increased from 10 millions to 33 millions, a gain of 23 millions, or 224 per cent. The total Canadian exports to the various parts of the British Empire were valued at 82 millions in 1897 and 154 millions in 1911, a change of 72 millions, or 87 per cent.

Our exports of purely Canadian produce changed from 74 millions to 149 millions, a gain of 75 millions, or 101 per cent. Exports of foreign produce from Canada to the British Empire have fluctuated to a great extent. In 1897 they totalled 8 million dollars; 1899, 14 millions; in 1903, 6 millions; in 1905, 5 millions. In 1910, they had increased to 10 millions, higher than in any year since 1901, but last year they dropped to 5 millions, or nearly half the previous year's figures. The decrease in the fifteen year period was 3 millions, or 56 per cent.

One of the chief causes of these variations is the shipment of grain of United States production to the United Kingdom via Canadian ports. In the difference noted above, this was evidently the case. In the March, 1911, report, statistics are found as follows:—

	1910.	1911.
Export of foreign corn to United Kingdom	$ 107,360	$1,542,787
Export of foreign wheat to United Kingdom	9,271,036	2,430,243
Total	$9,378,396	$3,973,030

The difference between these two totals is $5,405,366. The difference in the total export of foreign produce to the British Empire for the two years was $5,252,282; so that it is more than accounted for in these two items alone. Examining the statement of exports in the March report, considerable variations are found in many other items, some showing increases and some decreases of foreign goods exported. The reason for these variations in exports is practically impossible to account for. In the case of the United States grain exported through Canada, transportation conditions probably play an important part.

British Africa and Guiana.

The total trade of Canada with British Africa increased since 1897 by $2,900,000, or 1,874 per cent. The figures of 1911, however, show a slight decrease from those of the previous year. This is almost entirely accounted by a loss in our imports from that country. Our total exports increased in the period under review by 2 millions, or 1,755 per cent. Our imports from British Africa made a gain of $677,000, or 2,491 per cent. The amount for 1911 was $704,860, compared with $1,041,565 in 1910.

The total trade with British Guiana changed from $376,000 in 1897 to $4,073,000 in 1911, a gain of 1,083 per cent. Our exports to that country increased in the same period from $271,000 to only $622,000, while our imports increased from $104,000 to $3,877,000, of which in the former year practically all was dutiable and in the latter year only $3,657 worth of goods was admitted free.

West Indies and Newfoundland.

Our trade with the West Indies has grown from $2,551,000 to $10,982,000 in the fifteen years, an augmentation of 8 millions or 336 per cent. Our total exports to the British West Indies, including Bermuda, changed from $1,445,000 in 1897, to $4,590,000 in 1911, a gain of $3,145,000, or 217 per cent. Imports for consumption from those islands were $1,106,000 in 1897 and $6,391,000 in 1911, an expansion of $5,285,000, or 477 per cent.

Canada's trade with Newfoundland totalled 2 millions fifteen years ago, while to-day it is more than 5 millions. Our exports to that progressive colony have changed in the same period from $1,692,000 to $3,872,000, a gain of $2,180,000, or 122 per cent. The total imports for consumption from Newfoundland changed from $452,000 to $1,818,000, a gain of $1,366,000, or 302 per cent. Of the total in 1911, $1,784,000 worth came in free of duty.

With Newfoundland, as has been the case for years, there was done in 1910-11, the population of the colony being considered, a large trade, the exports amounting to $3,714,000 and the imports to $1,818,000. The development of the iron ore deposits in connection with the Sydney steel industries has served to increase the import item, which has trebled in ten years.

Commerce With Foreign Countries.

The figures of the Department of Trade and Commerce respecting Canada's trade with foreign countries, include the statistics of the United States, in respect to the following table:—

Year.	Total Imports.	Total Exports.	Total Trade.
1897	$ 79,622,062	$ 55,712,230	$135,334,292
1898	96,171,653	53,370,628	149,542,281
1899	114,157,706	54,189,905	168,347,611
1900	132,408,313	77,112,456	209,520,769
1901	134,385,084	83,104,475	217,489,559
1902	148,895,774	82,569,666	231,465,440
1903	168,780,245	83,873,738	252,653,983
1904	178,575,186	84,569,626	263,144,812
1905	189,494,804	89,439,549	278,934,353
1906	206,556,780	112,274,827	318,831,607
1907	250,623,181	119,478,796	370,101,977
1908	247,187,721	132,258,521	379,446,242
1909	211,163,707	114,214,308	325,378,015
1910	264,034,599	135,994,438	400,029,037
1911	332,466,676	142,860,491	475,327,167

Some Large Gains.

The total trade with foreign countries has increased from 135 millions to 475 millions, a gain of 340 millions, or 251 per cent. Imports show a larger percentage gain than exports. Our imports from foreign countries, including the United States, have changed in the fifteen years from 79 millions to 332 millions, a gain of 252 millions, or 317 per cent. Of these amounts 44 millions were dutiable in 1897 and 186 millions in 1911, an expansion of 141 million, or 316 per cent. Imports for consumption which came in free totalled 34 million fifteen years ago and 145 millions last year, a growth of 111 million, or 320 per cent. Our exports to foreign countries, including United States, were made up of 49 millions of Canadian produce and 6 millions of foreign produce in 1897 and 125 millions of Canadian produce and 17 millions of foreign produce in 1911, gains of 11 millions, or 200 per cent. and 87 millions, or 156 per cent., respectively.

France and Germany.

The two foreign countries making most progress in their trade relations with Canada are France and Germany. In the case of imports last year there came from Germany nearly as great a value of merchandise, $10,047,000, as was sent here from France, $11,563,000. We have a commercial treaty with France, but with Germany were waging a tariff war, following Germany's action respecting British preference in 1899 until March 1st, 1910. Judging by the record for some years back, it would appear that in a few years the imports of German goods will exceed those of France ,as they used to do. It is noteworthy also that Canadian exports to the two countries were of about the same value, and, compared with the import items, were comparatively small. If the trade treaty with France affects the situation to any great extent it is on the import side. That this should be the case is reasonable, from a consideration of the conditions in the two countries. France is a country fortunate in the variety of its natural products and Canada as yet exports chiefly natural and food products or products that rank as raw materials.

Comparison of French and German Figures.

The following table gives details of the Canadian imports, exports and total trade of France and Germany for the past fifteen years:—

Year.	Imports from France.	Imports from Germany.	Exports to France.	Exports to Germany.	Total trade France.	Total trade Germany.
1897	$ 2,601,351	$ 6,493,368	$ 690,696	$1,045,432	$ 3,292,047	$ 7,538,800
1898	3,975,351	5,584,014	1,025,262	1,837,448	5,000,613	7,421,462
1899	3,889,295	7,393,456	1,557,722	2,219,569	5,447,017	9,613,025
1900	4,368,502	8,383,498	1,374,770	1,715,903	5,743,272	10,099,401
1901	5,398,021	7,021,405	1,581,331	2,141,552	6,979,352	9,162,957
1902	6,672,194	10,823,169	1,388,848	2,692,578	8,061,042	13,515,747
1903	6,580,029	12,282,637	1,341,618	2,097,699	7,921,647	14,380,336
1904	6,206,525	8,175,604	1,597,928	1,819,223	7,804,453	9,994,827
1905	7,059,139	6,695,414	1,511,298	1,146,654	8,570,437	7,842,068
1906	7,667,987	6,987,314	2,120,091	1,872,557	9,788,078	8,859,871
1907	9,145,885	7,410,920	1,757,786	1,385,347	10,903,671	8,796,267
1908	9,901,909	8,163,047	1,806,732	2,374,607	11,708,641	10,537,654
1909	8,197,435	6,050,365	3,176,096	1,476,552	11,373,531	7,526,917
1910	10,109,544	7,935,230	2,640,648	2,501,191	12,750,192	10,436,421
1911	11,563,773	10,047,340	2,782,092	2,663,017	14,345,865	12,710,357

Our imports from Germany were nearly four million dollars greater in 1897 than those from France, and in 1903 the German imports were nearly six million dollars greater. Last year they were more than a million dollars short of our French imports. Our exports to Germany fifteen years ago were almost double those to France, while to-day they are about equal. Our total trade with France has changed from three millions to 14 millions in the fifteen years, a gain of 11 millions, or 346 per cent. The Dominion's total trade with Germany has increased from seven millions to 12 millions, a growth of five millions, or 69 per cent.

Of our total exports to Germany in 1897, $764,000 represented Canadian produce and $280,000 foreign produce. In 1911, Canadian produce exported to Germany totalled two millions, a gain of $1,300,000, or 185 per cent. in the fifteen years, while our exports of foreign produce to that country made a gain of $354,000, or 126 per cent.. Canada's exports to France consisted of only $6,741 of foreign produce fifteen years ago and $246,788 last year. Canadian produce sent to France in 1897 was valued at $683,000 and last year at $2,535,000, a change of $1,852,000, or 271 per cent.

Of total imports for consumption from Germany fifteen years ago, amounting to $6,493,000, there was dutiable $6,055,000. In 1911, of the total trade of 10 millions, 7½ millions was dutiable. The increases in total, dutiable and free imports in the fifteen year period were 56 per cent., 479 per cent. and 25 per cent., respectively. France sent us goods for consumption in 1897 valued at $2,601,000, which had increased in 1911 to $11,562,000, a gain of $8,962,000, or 344 per cent. Of the total imports from France fifteen years ago, two millions were dutiable, while nine millions were dutiable last year, leaving two millions brought in free of duty.

Trade Per Capita.

Belgium, which is one of the smaller of the European countries, but with highly developed industries, ranks as the fourth of European countries in its business with Canada, sending here last year over three and a half millions worth of goods and taking in return almost two millions' worth of Canadian produce.

The Department of Trade and Commerce estimate is that on March 31, when the fiscal year closed, Canada had a population of 7,901,000. The export trade, therefore, amounts to about $34.75 a head of the population. Though it extends to nearly every country, it is only a small proportion of the total trade of the country, a proof of the value of our home markets.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, C. H. Rust; Secretary, Professor C. H. McLeod.

QUEBEC BRANCH—
Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH—
96 King Street West, Toronto. Chairman, H. E. T. Haultain; Secretary, A. C. D. Blanchard,, City Hall, Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—
Secretary, E. Brydone Jack. Meets first and third Fridays of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—
Chairman, Geo. H. Webster; Secretary, H. K. Dutcher, 40-41 Flack Block, Vancouver. Meets in Engineering Department, University

OTTAWA BRANCH—
Chairman, A. A. Dion, Ottawa; Secretary, H. Victor Brayley, N. T. Ry., Cory Bldg.

MUNICIPAL ASSOCIATIONS.

ONTARIO MUNICIPAL ASSOCIATION.—President, Mr. George Geddes, Mayor, St. Thomas, Ont.; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Háll, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALITIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Mayor Reilly, Moncton; Hon. Secretary-Treasurer, J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. E. McMahon, Warden, King s Co., Kentville, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Hopkins, Saskatoon; Secretary, Mr. J. Kelso Hunter, City Clerk, Regina, Sask.

CANADIAN TECHNICAL SOCIETIES.

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang; Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons. Regina; Secretary-Treasurer, M. B. Weeks, 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.

BUILDERS, CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

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

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

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

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Thomas Southworth, Toronto; Secretary, James Lawler, 11 Queen's Park, Toronto.

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

CANADIAN GAS EXHIBITORS' ASSOCIATION.—Secretary-Treasurer, A. W. Smith, 52 Adelaide Street East, Toronto.

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

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. Frank D. Adams, McGill University, Montreal; Secretary, H. Mortimer-Lamb, Montreal.

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

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

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 157 Bay Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, 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, August.

DOMINION LAND SURVEYORS.—President, Thos. Fawcett, Niagara Falls; Secretary-Treasurer. A. W. Ashton, Ottawa.

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

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, W. B. McPherson; Corresponding Secretary, A. McQueen.

ENGINEER'S CLUB OF TORONTO.—96 King Street West. President, Killaly Gamble; 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, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian Members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain, and W. H. Miller, and Messrs. W. H. Trewartha-James and J. B. Tyrrell.

MANITOBA LAND SURVEYORS.—President, George McPhillips, Secretary-Treasurer, C. G. Chataway, 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, S. Fenn; Secretary, J. Lorne Allan, 15 Victoria Road, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, W. H. Pugsley, Richmond Hill, Ont.; Secretary, J. E. Farewell, Whitby,

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. Whitson; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5 Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Alfred T. de Lury, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, H. P. Ray; Secretary, J. P. McRae.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, Grant Hall; Secretary, W. H. Rosevear, 199 Chestnut Street, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

Charles H. Mitchell
Percival H. Mitchell
Consulting and Supervising
Engineers.
Traders Bank Building
Toronto, Canada

July 8th, 1911.

The Canadian Engineer, Winnipeg Office,
404 Builders Exchange,
Winnipeg, Man.

Gentlemen:-.

We would request that you send the Prince Albert Plans and Specifications back to our office by express, collect.

We want to thank you, on behalf of the City of Prince Albert and own office, for the attention that you have paid to this matter. It is certainly a great convenience to Engineers and Municipalities and apparently it is very effective in getting results.

Yours very truly,

C. H. and P. H. MITCHELL
PER P. H. Mitchell

Engineers for the City of
Prince Albert.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page
Battleford, Sask., town hall	Aug. 14.	Aug. 3.	68
Gleichen, Alta., waterworks	Aug. 11.	July 27.	72
London, Ont., waterworks supplies	Aug. 12.	July 27.	64
Moose Jaw, Sask., sewer and water extensions	Aug. 14.	July 27.	68
North Toronto, Ont., main sewerage	Aug. 14.	Aug. 3.	70
Ottawa, Ont., harbor works, Courtney Bay	Aug. 10.	June 22.	68
Ottawa, Ont., public building, Tilbury, Ont.	Aug. 8.	July 20.	91
Ottawa, Ont., public building, Dundas	Aug. 8.	July 27.	121
Ottawa, Ont., pier and sheds	Aug. 10.	July 27.	72
Ottawa, Ont., bridge	Aug. 8.	July 27.	121
Ottawa, Ont., tunnel bay dock, Brockville	Aug. 21.	Aug. 3.	151
Ottawa, Ont., post-office building, St. Lambert, P.Q.	Aug. 15.	Aug. 3.	151
Ottawa, Ont., public building, Uxbridge, Ont.	Aug. 21.	Aug. 3.	151
Ottawa, Ont., wharf, Papineauville, Que.	Aug. 23.	Aug. 3.	151
Ottawa, Ont., addition to customs fittings; Calgary, Alta.	Aug. 9.	Aug. 3.	151
Penticton, B.C., generators	Aug. 10.	July 6.	68
Reil, Man., bituminous pavement	Aug. 14.	Aug. 3.	68
Reil, Man., roadway	Aug. 14.	Aug. 3.	68
Toronto, Ont., government house	Aug. 22.	July 27.	121
Toronto, Ont., special castings and valves	Aug. 8.	July 27.	68
Toronto, Ont., Hudson's Bay Co. departments	Aug. 12.	Aug. 3.	62
Toronto, Ont., cast-iron pipe	Aug. 8.	Aug. 3.	68
Toronto, Ont., electric lighting fixtures	Aug. 15.	Aug. 3.	70
Toronto, Ont., laying and jointing pipe	Aug. 8.	Aug. 3	70
Victoria, B.C., work on Parliament buildings	Aug. 15.	July 13.	54
Victoria, B.C., schoolhouse	Aug. 10.	July 27.	122
Victoria, B.C., bridge work	Aug. 31.	Aug. 3.	152
Victoria, B.C., construction of bridge	Aug. 31.	Aug. 3.	152
Virden, Man., steam heating plant	Aug. 18.	July 27.	122
Wilkie, Sask., electrical machinery, etc.	Aug. 21.	July 27.	64
Windsor, Ont., concrete outlet	Aug. 22.	Aug. 3.	68
Whitehead, Man., bridge and abutments	Aug. 25.	Aug. 3.	68

TENDERS.

Moncton, N.B.—Tenders will be received until August 15th, 1911, for the excavating and refilling trenches, laying and jointing pipes from the city of Moncton to the new reservoir, according to plans and specifications to be seen at the City Engineer's office, where forms of tender may be obtained. J. Edington, City Engineer, Moncton, N.B.

Moncton, N.B.—Tenders for pipe line will be received by J. Edington, City Engineer, until August 15th, 1911.

Ste. Anne de Bellevue, Que.—Tenders will be received until August 14th, 1911, for the construction of waterworks and sewers system and the installation of electric lighting in the town of St. Anne de Bellevue, Que. Plans and specifications, etc., can be seen at the office of V. H. Dupont, civil engineer, 62 St. James Street, Montreal. J. S. Vallee, Mayor, Ste. Anne de Bellevue Que.

Ottawa, Ont.—The Department of Railways is calling for tenders for the construction of the new branch lines of the Intercolonial Railway in eastern Nova Scotia. One line will serve the district between Dartmouth and Deans, a distance of 70 miles. The other line will run from Guysboro' to County Harbor. The cost of the two lines will be nearly two million dollars. Tenders are to be in by September 20th, and it is expected that construction work will be well advanced this fall. Tenders have also been asked for the proposed improvements to the Richmond yards of the Intercolonial at Halifax. The estimated cost of the work is $83,000. The plans provide for new tracks, the enlargement of the yards, straightening of curves, etc.

Ottawa, Ont.—Tenders will be received until August 21st, 1911, for the erection of trainmen's houses required on the line of the Transcontinental Railway at different points. P. E. Ryan, Secretary, The Commissioners of the Transcontinental Railway, Ottawa. (Advertisement in The Canadian Engineer.)

North Toronto, Ont.—Tenders will be received until August 14th, 1911, for providing and laying about 2,000 lin. ft. of 24-in. vitrified sewer pipe, with all necessary manholes and junctions, east of Bayview Avenue. J. A. Brown, Mayor, North Toronto. T. Aird Murray, Consulting Engineer.

Humberstone, Ont. — Tenders will be received until August 15th, 1911, for the construction of the Michner and Wignell drain. Tenders may be for the whole work or for sections of said work as follows: 1. Main drain, Sections 1 to 9, inclusive, of Wignell drain, south of Grand Trunk Railway. 2. All that portion of Wignell drain not described in above paragraph. 3. The whole of Michner drain. Plans and specifications may be seen at the office of George Ross, Engineer, Welland, and at the office of H. J. Knole, Reeve, Humberstone, Ont.

Humberstone P.O., Ont.—Tenders for Michner and Wignell dam will be received by H. G. Knoll, Reeve, until August 15th, 1911.

Welland, Ont.—Tenders are invited for the construction of the Michner and Wignell drain in the township of Humberstone. The estimated cost of this work exceeds the sum of $10,000.

Justice, Man.—Tenders will be received until August 14th, 1911, for the erection and completion of a two-roomed brick veneer schoolhouse, with a full stone basement, to be erected at Justice, Man. Plans and specifications for the purpose can be had at the office of Mr. W. W. Blair, architect, Winnipeg; Messrs. Barclay & O'Hara, and McDiarmid & Clark, Brandon; also from T. J. Pentland, Justice.

Justice, Man.—Tenders will be received by Mr. A. M. Robertson for the erection of brick veneer schoolhouse. Tenders to be delivered by August 14th, 1911.

Winnipeg, Man.—Tenders will be received until August 12th, 1911, for grading a double roadway on Inkster Avenue from Main Street to Keewatin Street. Plans and specifications may be had upon application to J. H. Blackwood, Secretary, office of the Public Parks Board, 229 Chambers of Commerce, Winnipeg.

Winnipeg, Man.—Tenders will be received until August 12th, 1911, for the installation of a pumping and compressor plant in Kildonan Park. Specifications may be had upon application to J. H. Blackwood, Secretary, office of the Public Parks Board, 229 Chambers of Commerce, Winnipeg.

Victoria, B.C.—Tenders will be received until August 23rd, 1911, for the erection and completion of a prison farm building at Burnaby, B.C. Drawings, specifications, contract and forms of tender may be seen at the offices of Hugh A. Hodgson, Esq., Rooms 309-309A, Cotton Building, Vancouver; Government Agent, New Westminster, and at the office of J. E. Griffith, Public Works Engineer, Department of Public Works, Victoria.

Victoria, B.C.—Tenders for prison farm buildings will be received by the Honorable the Minister of Public Works until August 23rd, 1911.

CONTRACTS AWARDED.

Halifax, N.S.—In awarding F. A. Ronnan & Co. the contract for building the new Tower Road School, the School Board permitted that firm to amend their tender, as the subcontract for plumbing had been omitted. The tenderers and their figures are given below: M. E. Keefe Construction Co., Limited., $70,500; Edward Maxwell, $67,980; Falconer and McDonald, $64,900; S. M. Brookfield, Limited $64,200; Samuel A. Marshall & Son, $61,879; F. A. Ronnan & Co., original, $49,916; F. A. Ronnan & Co., amended, $54,383, accepted.

Parrsboro, N.S.—Public building. Contractors, Falconer & McDonald, of Halifax, N.S., at $26,900.

Shawinigan Falls, P.Q.—Public building. Contractor, A. Durand, of Joliette, P.Q., at $32,860.

Ottawa, Ont.—A. S. Metcalfe, of Montreal, has secured the contract for the foundation and cement platform for the covered portion of the tracks near the rear of the new Grand Trunk Railway hotel and station. The amount is reported to be $100,000.

Beaumaris, Muskoka, Ont.—Wharf and stone approach. Contractors, Union Construction Company, Limited, of Ottawa, Ont., at $23,994.

Brantford, Ont.—P. H. Secord & Sons, Limited, have secured the contract calling for the erection of a business block on Queen Street for W. E. Cockshutt. The cost of the building will be $10,000.

Toronto, Ont.—The Board of Control have passed tenders amounting to $36,835 for the construction of the new Claremont Street police station. The chief items are masonry, Fussle & Thomas, $22,964; carpentering, M. Hutchinson, $6,893; hot water heating, F. Armstrong, $1,985; plumbing, F. Armstrong, $1,685; plastering, Hanna & Nelson, $1,098.

Berlin, Ont.—The contract for building concrete abutments at Armstrong's Bridge, on the Perth-Waterloo county line, has been awarded to Messrs. J. B. Lechty & Wellesley at $5.50 per cubic yard.

Ridgeway, Ont.—Philip Johnston, Ridgeway, has been awarded the construction work on 2,700 feet of concrete drain in the township of Bertie, the amount agreed upon being $10,000; $9,845 was tendered in competition.

Winnipeg, Man.—A contract has been let to Messrs. Carter-Hallis-Aldinger Company for the erection of a nine-storey building at the corner of Smith Street and Portage Avenue for the Sterling Bank. The architects are Messrs. James Chisholm & Co. The outside of the building will be of terra cotta and Minneapolis pressed brick, and the interior will be finished in mahogany and varigated marble with mosaic floors.

Wetaskiwin, Alta.—Public building. Contractors, The Brown Construction Co., Limited, of Winnipeg, at $25,650.

Prince Albert, Sask.—Wharf and protection work on the south side of the North Saskatchewan River. No action was taken on tenders received. Work to be done by this department by day labor.

Vancouver, B.C.—The British Columbia Electric Railway Company has just awarded the contract for the construction of a new freight shed at the foot of Carrall Street, near False Creek, to D. Matheson, of this city. The building is to measure 30 by 167, and will be used in connection with the existing freight shed for the interurban freight traffic of the company. McDonald & Wilson, the contractors for the company's new $350,000 five-storey office building at the corner of Hastings and Carrall Streets, have awarded the electric wiring sub-contract to Mather & Youill.

Trail, B.C.—John Burns & Son, of Nelson, have been awarded the contract for the erection of the new $40,000 public school building. The new school will be of brick and concrete on lines similar to those of the public school building at Nelson, B.C.

Victoria, B.C.—Out of a number of tenders received for the construction of roadways, curbs, etc., at the new courthouse, Vancouver, that of Robert McLean has beeen accepted by the provincial government, and he will enter upon this work under contract immediately. The successful tender is understood to have been in the neighborhood of $16,500.

Nanaimo, B.C.—The Worswick Company, of Victoria, have been awarded the contract for street paving and a portion of Bastion Street at $1.68 a superficial yard.

RAILWAYS—STEAM AND ELECTRIC.

Ottawa, Ont.—The new train sheds of the G.T.R. hotel will be constructed under the protection of the Bush patent, of the same character as the large one built recently in Chicago, Ill. It is a continuous shed with an opening in the centre for the smokestacks of the locomotives, so that it will be quite free from smoke. The roof will be of cement with inserts of heavy glass. This style has given satisfaction wherever used.

Ottawa, Ont.—A new company is in process of organization to build and operate an electric railroad between Ottawa and points up the Gatineau River. The intention is to take in all the summer resorts between Ottawa and Farmpoint, including Chelsea, Kirk's Ferry, Kingsmere, Cascades, and Farmpoint, which will in all likelihood be the ultimate destination of the road.

Toronto, Ont.—The Canadian Pacific Railway have secured the permit to erect the new office building on the corner of King and Yonge Streets. Some delay has occurred in issuing this permit owing to negotiations with the municipal officials regarding the expropriation of a portion of the property.

Calgary, Alta.—The engineers in charge of the construction work of the Calgary branch of the Grand Trunk Pacific Railroad have been notified by the attorneys of the road that the construction may be resumed, an agreement between the officials of the C.P.R. and the Grand Trunk Pacific having been made whereby the injunction against the G.T.P., restraining them from crossing the irrigation lands of the Canadian Pacific will be dissolved, and the crossings made.

British Columbia.—The Canadian Pacific Company is expending huge sums of money in rushing to completion extensions from the Pacific Coast and the northern boundary of the United States to its productive coal deposits in the Rocky Mountains. The Canadian Pacific lines already come within striking distance of the International boundary at several points, and with the other extensions that are now being built, the Rocky Mountain coal companies will be in active competition with United States mines for the trade of the Pacific Northwest.

LIGHT, HEAT AND POWER.

Toronto, Ont.—The Toronto Electric Light Company's street lighting service east of the Don and west of Dovercourt Road will be cut off this month, and it is expected to be discontinued throughout the whole city by the end of October.