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Contents of this issue on page 3

# The Canadian Engineer

*A weekly paper for engineers and engineering-contractors*

## A COMBINED GAS AND STEAM ENGINE UNIT

NOTABLE UNDERTAKING INVOLVING TWO 42 x 72 IN. GAS CYLINDERS, ONE 36 x 72 IN. H.P. AND ONE 68 x 72 IN. L.P. STEAM CYLINDER TO DRIVE A COMMON SHAFT.

**By M. E. GRIFFIN, Mem. A.S.M.E.,**

Mechanical Engineer, Franklin, Pa.

WHEN the additions to the power plant of the Ford Motor Company, of Detroit, are completed there will be housed in one engine-room gas and steam engines capable of developing over 30,000 h.p., and the complete installation will embody many novel and interesting features.

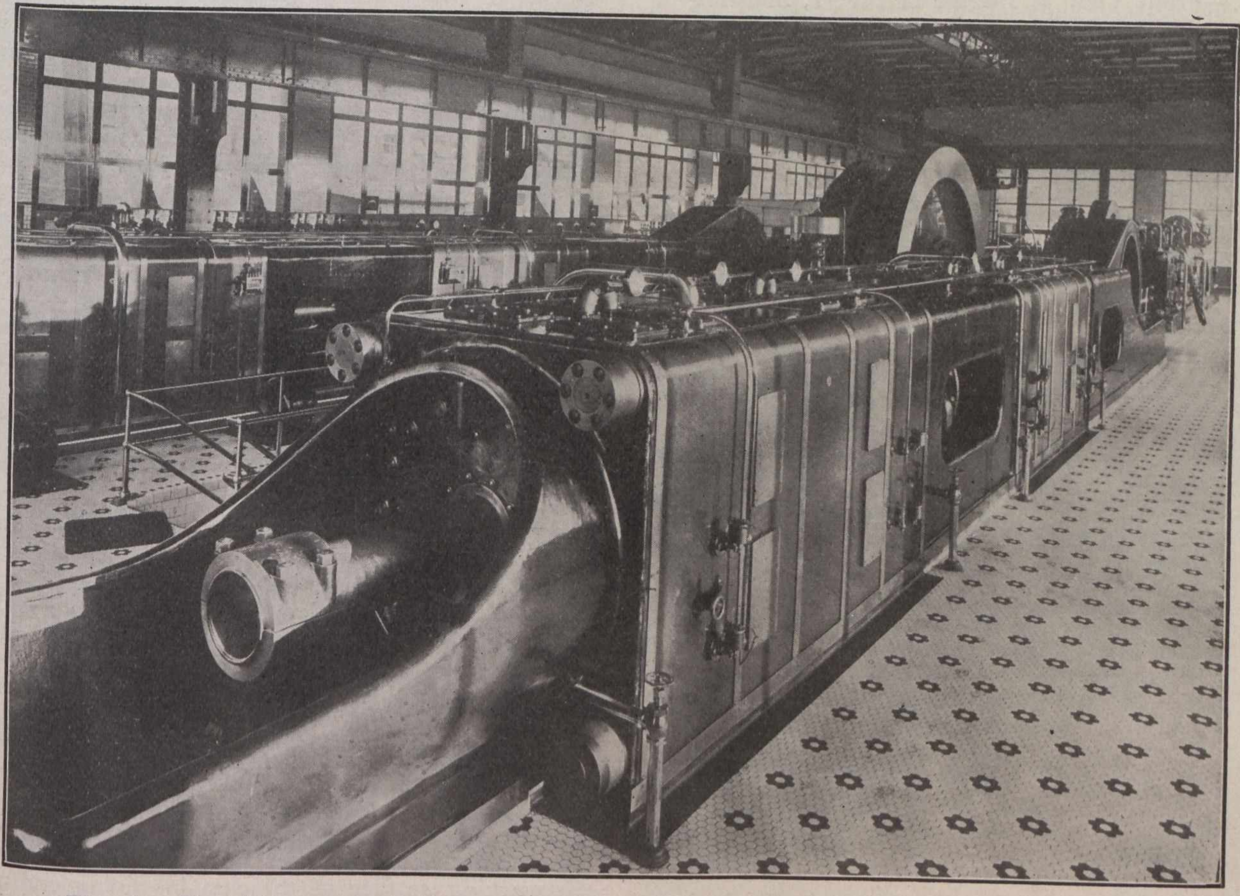


**Fig. 1.—Side View, from Tail Rod End, of One of the Ford Motor Company's Engines.**

When the plant was started the producer-gas engine was in great demand in the power field, and Henry Ford adopted this type of prime mover to operate his plant. His first gas engine was a 1,600 h.p., two-cylinder, double-acting tandem, having cylinders 35 in. diameter by 48 in. stroke, and operating at 100 r.p.m. This engine was direct-connected to an 850-Kw. Western Electric d.c. generator, and cross-connected to a 2,000-cu. ft. air-compressor of the central port hurricane valve design. The company from which this engine was purchased was unable to fulfil its contract and the purchasers completed its construction. This unit proved satisfactory, but the phenomenal increase in business soon necessitated additional power. Another producer-gas engine of greater capacity than any other internal combustion engine yet built in any country was decided upon. Edward Gray, the Ford mechanical engineer, designed this engine, embodying in it many special features which his many years' experience in gas engine design and operation suggested. It is what is called the one-story-and-basement type, with all the valve gear in the basement. There are 4 double-acting cylinders, 42 in. diam. by 72 in. stroke, arranged two in tandem upon each side. The engine is direct-connected to a 2,500-k.m. d.c. Crocker-Wheeler generator, and operates at 85 r.p.m., or a piston speed of 1,020 ft. per min. The generator is designed for 25% overload capacity, and the engine is rated at approximately 6,000 I.H.P.

The magnitude of this engine may be realized from the following data: The 20-ft. flywheel weighs eighty

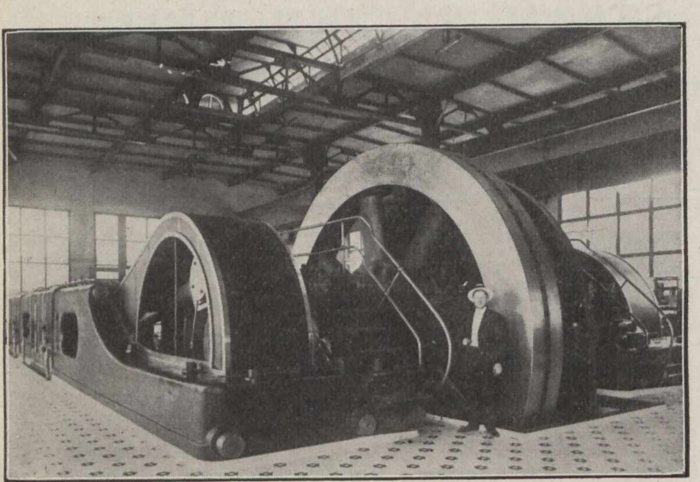


**Fig. 2.—Front View of Engine in Fig. 1, Showing General Design and Massiveness.**

tons, and the engine complete, without generator, weighs approximately 700 tons. The total length of the engine from rim of flywheel to the end of tail-rod guide measures 80 ft., and the overall width is 32 ft. The shaft in middle measures 32 in. in diam., and has an overall length of 26 ft., weighing, with crank discs, almost 100,000 lbs. Each complete connecting-rod weighs 10,300 lbs., and each bed or frame approximately 150,000 lbs.

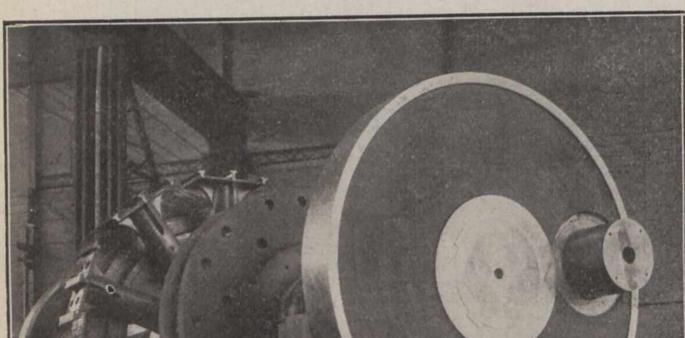


**Fig. 3.—Crank Shaft with Armature Rotor, Ready for Transportation.**

The engine is designed symmetrically around the centre line, and the massive bed-plate, common to nearly all large gas engines, is omitted, the object being to make the engine self-contained and securely anchored on its foundation, allowing the cylinders perfect freedom to adjust themselves according to stress or temperature changes. The massive frames are reinforced longitudinally by 6-in. steel tie-rods, shrunk into place. The cylinders and distance-housings are secured to their respective beds by a continuation of 6-in. steel tie-rods and nuts.

The total weight of the pistons and rods is supported by the main, intermediate and tail-rod crossheads, all riding on bored guides. The main crosshead body is made in two parts and of annealed steel casting. The two halves or sides are held together by turned steel bolts in reamed holes, and the bolts at the throat are arranged to produce a clamping effect on the piston-rod, where it is screwed into the neck. The shoes are independent of, and secured to the crosshead by the trunnion method.

The main bearing is of massive and unusual construction, the caps being set into the housing in such a manner as to form a strut and tie, and are secured in place by 6-in. steel tie-rods placed longitudinally. The lower shells are water-cooled by means of brass coils, which were bedded in recesses in the cast-iron shell, and the babbitt metal, poured on top, encasing each, thus avoiding the possibility of trouble from waterjacket due to defective casting. The crank discs are of the counter-balanced type, made of annealed steel casting, and the crank pins are cast integral with the discs.

The lay shafts are located above the floor line, and are driven by semi-steel spiral gears from the main shaft (bronze gears were used at first, but found impracticable). These lay shafts are in sections, secured to each other by pin couplings, so that each section remains with its particular cylinder, and perfect alignment between crank and the walking-beam, which it drives, is preserved. On each lay shaft there is secured a crank for each end of the two cylinders in the set, and each crank operates both inlet and exhaust valves through the medium of the walking-beam at the end of its respective cylinder. The walking-beam and lay shaft carrier brackets are made double in order that the pins may have double support instead of being overhung. The design throughout eliminates overhung pins or bearings.

The inlet, or admission valve at each end of the cylinder, is actuated by a cam, the operating bell-crank lever of which is located between the sides of the walking-beam and pivoted at the centre. One end of the bell-crank actuates a hook, steel-faced, which engages with another hook-plate lever, fulcrumed in the projections on top sides of the walking-beam. An eccentric upon the governor shaft operates a cam, which trips the valve mechanism at any point of the stroke determined by the governor, similar to the cut-off arrangement of a Corliss steam-engine. The valve is closed by a spring, and cushioning is effected by an air dashpot. The admission is of the quantitative method, and the governor performs no other work than adjusting the position of the tripping cams.

The exhaust valve is operated by a cam, which receives its motion through a link secured to the extreme inner end of the walking-beam. The leverages of the cam are so proportioned that a very slight movement of the walking-beam produces a considerable movement of the working surface of the cam in sliding contact with the lower end of the exhaust valve projection. The arrangement is such that at a certain position the movement of the valve is rapid, but when the outer end of walking-beam is at its lower range of travel there is a pause in the exhaust valve mechanism. The pistons and rods are hollow and water-cooled. The water enters the rods at the intermediate crosshead by means of a telescopic oscillating arrangement, the outer end of which is pivoted below the engine. The piston-rod contains an inner tube for the inlet water to the pistons, and the water outlet is around this tube, thus raising the temperature of the incoming water.

The engine just described has been in successful operation for about two years, and from the beginning of its operation the exhaust gases, instead of being wasted during the winter season, were utilized to heat water for the heating system of the immense plant. The idea of utilizing exhaust gases for this purpose is, perhaps, not a new one, but it gave rise here to an entirely original idea. When the unprecedented increase in Mr. Ford's business demanded more power he analyzed the economy question from all angles, finally deciding, if possible, to adhere to the internal combustion prime mover. From an efficiency standpoint he reasoned that he could not use nearly all the heat energy from the exhaust gases, as his system would not increase in the same ratio as the necessary power; therefore, if gas engines were to be installed, much waste heat would be the result. His final decision was for an increased installation, comprising steam and gas units, and it is without doubt one of the most daring engineering undertakings in the engine line thus far presented.

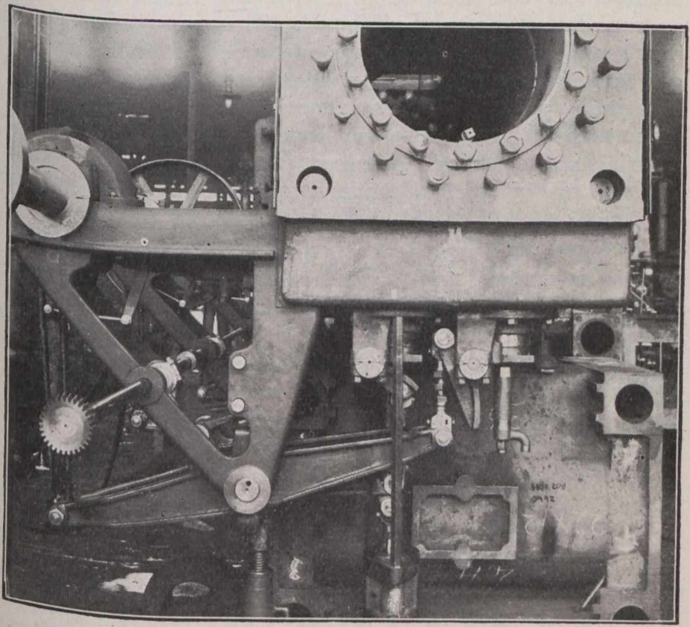


**Fig. 4.—Valve Gear, with Exhaust Valve Cam in "Pause" Position.**

During the past year he has placed orders for four 6,000 h.p. units, each direct-connected to a 2,250-k.w. d.c. Crocker-Wheeler generator. Each unit consists of a pair of 42 in. by 72 in. (stroke) gas cylinders, placed in tandem on one side, together with a 36-in. high-pressure and a 68-in. low-pressure by 72-in (stroke) tandem compound, condensing steam cylinder on the other side, the gas and steam engines driving a common crank shaft. The cooling water from the gas cylinders and pistons, which has its temperature raised usually to approximately 192° F., is to be used as feed water for the boilers, in which the steam will be raised to 150 pds. pressure, and, by means of a superheater employing exhaust gases, the steam will be superheated to a stage insuring its dryness. By using the available heat units thus, and operating the steam engines as condensing units, it is aimed to obtain the most economic, practical prime mover so far attempted. The intention is to use one condensing apparatus of sufficient capacity to accommodate the combined steam units, the piping and valves being arranged so as to cut one or more units in or out of commission as occasion demands.

The completion and actual operation of this new installation is awaited with keen interest by the engineering profession, because as a venture of such magnitude it possesses many intensely interesting and novel features hitherto undeveloped.

From a thermodynamic standpoint expert opinion differs, some admitting that it will be an economical success, while others argue that if the units were entirely of the internal combustion type, the total efficiency would be higher, on the supposition that the cost of coal necessary for the steam boilers, added to the initial cost of boilers, condenser, settings and auxiliaries will amount to much more than the expenditure necessary for producing gas.

Another feature causing much discussion is the question of regulation. While it is true that each new wheel will weigh 100 tons as against 80 tons in the case of the former wheel on the all-gas unit, it is also true that the impulses in the steam unit will not harmonize, so to speak, with those of the gas unit, and, therefore, the question of regulation arises, even with individual or combined governing mechanism.

The general design of the new units is similar to the former gas engine where conditions permit. The frames and all gas engine parts are duplicates of the gas engine heretofore described. The steam valve gear mechanism will be operated by lay shafts, and poppet valves are used where necessary in order to have the design of steam cylinders harmonize as nearly as possible with the gas engine cylinders. If perchance it is desired in the future to convert the units into all-gas units very little alteration will be necessary except exchanging the steam cylinders and their valve gear and piping.

## UNITED STATES WATER-POWER BILL.

The water-power bill, relating to the construction of dams across navigable streams, and known as the Adamson bill, was passed by the House of Representatives of the United States on August 4. In accordance with its requirements, plans and specifications for such dams must be approved by the Secretary of War and the Chief of Engineers before work of construction is commenced. Approval may include the condition that water-power to operate locks, etc., be supplied without cost, or a reasonable annual charge may be made for the benefits that accrue to the grantee by the authority given under the act. The dam shall be located so as to be best adapted to a comprehensive plan for the improvement of the waterway for the use of navigation and for the full development of the water-power. The rights granted under the act extend over a period of 50 years beginning on the date of the original approval. Upon two years' notice prior to the expiration of the grant, the United States has the right to take over the property of the grantee necessary and useful for the generation, transmission and distribution of energy, the payment therefor being based on the actual cost of the lands purchased and used by the grantee and the fair value of the other properties taken over. Allowance will be made for deterioration but not for goodwill or profit in pending contracts. The Secretary of War is empowered to prescribe reasonable rates of charges for energy transmitted in "interstate or foreign commerce." When the energy is used within a state having adequate regulation for rates and service to the consumer the Secretary of War will not interfere with the established rules for rates and service.

The semi-annual report of the operation of towns and cities, included in the hydro-electric system, for the first six months of 1914 shows surpluses in every case. A number of reductions will result. The city of Galt, with an average monthly surplus of over $1,000, gets a 16 per cent. reduction which brings the domestic rate to about 2½ cents. Other towns are eager for reductions and it is expected a number will be granted. Toronto's rates have not yet been finally determined.

## THE CORROSION OF IRON.

By F. N. Speller, B.A.Sc.,
Metallurgical Engineer, Pittsburgh, Pa.

In writing on the "Corrosion-Resisting Qualities of Modern Mild Steel vs. Old-Time Iron" in *The Canadian Engineer* of June 4th, 1914, Mr. A. T. Enlow draws attention to a few of the erroneous ideas which prevail on this subject which have been quite generally overlooked in recent discussions. Some of these points are of such practical importance that they will bear referring to again. He emphasizes the fact that chemical analyses showing the sulphur, phosphorus, silicon and manganese (and he might have added oxides and slag) may be very misleading as to the enduring qualities of the metal. He goes on to say: "The idea that the analysis tells the whole story has its origin in the statement, so often reiterated when the idea of a modern rust-resisting metal was first conceived several years ago, that 'the purer the material as regards the absence of foreign chemical elements, the better would it withstand corrosion.' At best this statement only conveys part of the truth."

Referring to the exceptional cases where old-time iron has withstood the ravages of time to such an extent as to be, in some cases, in a state of good preservation to-day, Mr. Enlow points out that this is no proof that the old-time irons were all of this character—quite the reverse is the case—for the few samples which can now be found are merely the survival of the fittest. In speculating as to the cause of the long life shown in these exceptional cases by old-time iron the author seems to reach the conclusions that this was due to the absence of manganese in this iron and the presence of something which, perhaps for lack of a more definite term, he calls "vitality." This, it is presumed, is lacking in iron which shows more rapid corrosion. There is no question but that modern iron and steel, no matter by what process it has been made, varies to some degree in quality according to how carefully the metal has been refined and worked. This was most probably true, if not to a greater extent, in regard to the old-time iron referred to.

Regarding the effect of manganese, I believe the author is inconsistent and reaches a conclusion which 's not supported by evidence. It is well known that manganese alloys with iron more uniformly than any other element and shows very little tendency to segregate. Many comparisons have been made of low-carbon steel made in the open-hearth furnace without manganese and ordinary soft steel carrying .30 to .40 per cent. manganese. On the whole, these tests show no decided difference in corrosion. The writer has had an opportunity of studying the effect of hot aerated water in pipe lines made up of modern puddled iron and soft steel. Here the conditions as to uniformity were ideal. From over one hundred of such comparisons no difference in the extent or depth of the corrosion could be seen, although the wrought iron had a mere trace of manganese, and the soft steel carried over .30 per cent.; so that the manganese is no exception to the general conclusion which Mr. Enlow has drawn that "chemical analysis of the carbon, sulphur, phosphorus, silicon and manganese may mean much or little."

As to the absence or presence of "vitality," it is true that by aiming at exceptional purity and not using such additions as ferro-manganese, properly applied, the steel may be rendered very sensitive to subsequent heating, and, as a practical welder would say, "it is dry." The metal in this state may have a very high degree of purity as in the case of so-called "ingot iron," but probably due to this extreme purity it readily absorbs gases when heated, and when fabricated may be decidedly inferior to soft steel carefully made by standard practice and carrying sufficient manganese to protect the iron from oxidation.

While in the writer's opinion the various operations of refining and working the metal have a bearing on corrosion, there is another factor of far more importance which is too often overlooked. The writer had an opportunity a few years ago to study some old iron of French manufacture on the Panama Canal which had shown remarkable resistance to corrosion under adverse conditions. This material was found to be of a variable analysis, corresponding to modern soft steel in some cases and in others the metal was evidently made by the puddling process. A close examination showed that corrosion had not penetrated through the surface of the metal, which was protected by a film of tenacious scale. Upon removing this surface skin and exposing the clean metal under the same conditions it was found to corrode as rapidly as modern soft steel. This was tried out a number of times where other instances of more or less perfectly preserved old iron have come to light, and it invariably proved that on removing the protective skin from these metals corrosion proceeds quite rapidly, the metal being destroyed apparently as fast as in the case of unprotected steel of modern manufacture.

Considering the fact that the iron and steel made up to 30 or 40 years ago was slowly fabricated, so that, especially where hand-forged, the finish was not nearly so smooth as nowadays, it seems that the film of cinder which was left on the surface of the forged article adhered tenaciously, and in most cases was responsible for preserving the metal from corrosion. In some cases these cinders are in the nature of a thin enamel and are quite impervious to moisture.

From our experience I am quite in accord with the author's conclusion that "the physical qualities unquestionably have very much to do with this question . . .," but I am inclined to question the statement that as a rule old irons are more dense than modern mild steel. It is very important, in my opinion, that the metal be uniformly finished in the final stages of refining and afterwards carefully heated and given as much work as possible in the process of fabrication. It is of advantage to apply this work in more than one direction, as in forging operations, so as to get as uniform density as possible, and in working metal in this way as far as practicable all loose scale should be removed from the metal between passes so that the finished surface may be as uniform as possible. This is the ideal to which we have been working in the manufacture of soft steel to withstand corrosion. It is obviously impracticable to make the large tonnage which is produced nowadays by the old-time methods, even though it was proved that iron so made had superior durability. Modern requirements call for a smoother finish, and protection, where required, should be applied to the carefully-prepared surface after fabrication.

After all, it seems that durability in service is more often a question of protection of the surface of the metal from moisture, either accidental or by means of protective coatings, than by virtue of any inherent quality in the metal itself. Chemical composition, *per se*, so far as the common metalloids are concerned, seems to have less influence on the corrosion of iron than any other factor.

# COST OF CANADIAN RAILWAY CONSTRUCTION

MOST RECENT COMPILATION OF FIGURES FROM CONSTRUCTION ACCOUNTS OF CANADIAN RAILWAYS, GIVING DETAILED AND ORIGINAL STATISTICS FOR THE YEARS 1906-1913.

By J. L. PAYNE,
Comptroller of Statistics, Department of Railways and Canals, Dominion Government, Ottawa.

THE construction account of Canadian railways during the past decade runs into amazing figures. I cannot, however, go into details for the years prior to 1907, in which year an entirely new system of statistics was made effective, and must, therefore, content myself in this relation to deal with the facts since 1906. For that seven-year period, from 1907 to 1913, inclusive, there was an addition to capitalization of $465,949,063, or an average of $66,564,152 per annum. Cash aid by the Dominion, the provinces and municipalities amounted to $49,171,811 during the same term, or at the rate of $7,024,544 per year. Joining these two items of capitalization and aid, we have a total for seven years of $515,120,874, which would be equal to an average of $73,588,695 per annum. It might fairly be assumed that this large total represented the outlay, dollar for dollar, on construction. The increased capitalization includes $193,000,000 of stocks, which ordinarily would yield little or nothing in cash; but, in this instance, all but $65,000,000 of the aggregate has been made up of Canadian Pacific issues, which were sold at a substantial premium. It might, therefore, be taken for granted that the actual expenditure did not fall far short of the liability.

On the assumption that construction cost is fairly represented in the growth of capital liability, plus cash aid, two or three interesting facts are disclosed by analysis. During the seven years immediately under review, 7,951 miles were added to operative mileage in the Dominion. Of course, all the capitalization in question did not produce railway mileage in actual operation in 1913. Liability must necessarily precede the handling of traffic. On the other hand, there was undoubtedly more than $100,000,000 worth of bonds outstanding which had not been brought into the account; so that operative mileage left out might be regarded as balancing liability omitted. On that basis of calculation, since 1906 capitalization equalled $58,410 per mile per annum, and cash aid $6,183 per mile per annum. Such averages clearly show that (1), on the whole, we have been building railways up to a good standard, and (2) that public aid has been extended in generous measure. It is not straining the truth to say that no other country has been making such great sacrifices to provide itself with transportation facilities.

The cash aid of something like $5 per family per annum during the past seven years is only part of the story. Within a little over ten years the Canadian people has made itself liable for principal and interest in connection with guarantees of bonds aggregating $320,000,000, including the liability of $45,000,000 on account of the Canadian Northern, voted by Parliament in May last. This would bring the total of aid in cash and guarantees up to not less than $25 per family per annum during the past decade. It may demonstrate a splendid faith, or, in another aspect, it may merely reflect a sense of urgent need. No matter in what light it may be regarded, the liability, direct and indirect, is a matter of serious importance. The Canadian Northern has received a large proportion of the aid, both in cash and guarantees; and that system will unavoidably have a considerable unproductive mileage for some years to come. That is to say, the construction work it has had under way, and is about to undertake, lies very largely in those portions of the north-west which have not hitherto been served by railways; and it is a railway axiom that pioneer mileage does well if it earns operating expenses for the first three years. Nevertheless, the rapid settlement of the western provinces may create traffic quite sufficient to provide for the large fixed charges of the Canadian Northern system when it has been completed and placed on an operating basis.

The construction of the Moncton-Winnipeg section of the Grand Trunk Pacific should also be taken into the account of public aid to railways. The expenditure by Government on this work has already reached $150,000,000, and the Minister of Finance has stated in Parliament that the final cost will be $235,000,000, including interest on capital outlay up to such time as the agreement with the company which is to take it over becomes effective. This would bring the public contribution up to a little over $34 per family per annum during the past ten years, with more to come. The cost of the Transcontinental has been placed at $100,000 per mile, and this fact should carry with it the assurance that Government has built 1,805 miles of line up to a standard not hitherto attempted in Canada. Whether or not Government was setting a pattern, it is obvious that the days of cheap and more or less makeshift railway construction have passed. A low-grade railway may have been defensible in earlier times. It was a case of that kind of construction or nothing. But in these days it is recognized as sheer waste to follow such methods. Experience has amply demonstrated that it is true economy to build on sound lines and with a view to future needs.

If, however, Canada has added on a large scale to her capital liability on railway account during the past seven years, it is clear that the next seven years, barring some extraordinary disturbance in the financial situation, will establish new records in both expenditure and additional mileage. This prediction is not based on mere optimism. It rests on facts. Just a year ago there were in the Dominion 18,648 miles of line in various stages of construction. That was more than the entire operative mileage of the country in 1901. Of these 18,648 miles reported as being "under construction," nearly 9,000 miles were actually under contract. About 3,500 miles were completed, and 6,560 miles had not passed the survey stage. These are big figures. While this vast work was scattered all the way between the two oceans, more than 70 per cent. of it was located west of Ontario. At this moment it cannot be said how many miles were moved into the operating column during the past year; but for every mile completed, it is probable the construction of another mile was begun. It will involve a very large expenditure to carry this mileage to a finish and to equip it for the movement of traffic. It will also mean the employment of an army of men not now identified with transportation.

The labor aspect of railway operations in Canada is not generally recognized. It may not be amiss, therefore, to present a few facts in that regard. In 1913 there were 609 employees per 100 miles of line, as compared with 551 in 1907. This magnitude will increase with the growth of traffic. The total number last year was 178,652; and that figure represents an average increase of nearly 10,000 per annum during the past six years. The wages bill in 1913 reached the large total of $115,749,825, and made up 63.59 per cent. of operating expenses. In fact, if the matter be carefully examined, it will be found that, directly and indirectly, transportation interests provide a living for about 20 per cent. of the entire population of the Dominion. On the other hand, the cost of transportation, viewed as a tax, rises above all other public imposts, both in magnitude and distribution. Speaking broadly, nobody can escape the levy for carriage, or its incidence; whereas customs, municipal and other forms of taxation may in large measure be avoided by a considerable number in every community.

The ancient controversy as to the priority of the hen or the egg has its counterpart in the question as to whether transportation facilities create trade or trade creates transportation facilities. Without expressing any opinion on the subject, I have long been watching the co-ordination of these forces; for they do co-ordinate. Traffic and trade must move together. They are dependent on each other. Trade cannot grow without marketing facilities; and, just as the ship preceded settlement, so the railway must provide the channel for a nation's commerce, otherwise, there will not be any considerable volume of commerce. Leaving the matter at that point, it will be helpful to see by ten-year periods how Canada's railway mileage has grown. Here are the facts:—

| | Miles. | | Miles. |
|---|---|---|---|
| 1863 | 2,189 | 1893 | 15,005 |
| 1873 | 3,832 | 1903 | 18,988 |
| 1883 | 9,577 | 1913 | 29,304 |

Traffic has moved upward with available mileage. Could old and new mileage be separated, it would undoubtedly be found that the former carries the larger proportion of traffic. New mileage, as has been said, must to a large extent develop its business; and this is often a slow process. The following little table shows the total tonnage hauled and the volume per mile of line since 1883:—

| | Tonnage. | Per mile of line. |
|---|---|---|
| 1883 | 13,266,255 | 1,384 |
| 1893 | 22,003,599 | 1,466 |
| 1903 | 47,373,417 | 2,495 |
| 1913 | 106,992,710 | 3,651 |

It will be observed that the productivity of old mileage has more than offset the dilution brought about by new mileage; and the table as a whole may be taken as showing in a most striking way the expansion of the Dominion during the past thirty years. That expansion is exemplified in the fact that while there was the largest addition to mileage between 1903 and 1913 there occurred during that same decade the largest increase of freight traffic. Passenger business does not show the same ratio of development, as the following table makes plain:—

| | Passengers. | Per mile of line. |
|---|---|---|
| 1883 | 9,579,984 | 1,000 |
| 1893 | 13,618,027 | 907 |
| 1903 | 22,148,742 | 1,166 |
| 1913 | 46,230,765 | 1,577 |

There has been little change during recent years in the proportionate relationship of commodities to the total volume of traffic. For example, products of agriculture made up 16.85 per cent. in 1907, and stood at 16.31 per cent. in 1913. Products of mines and manufactures have shown the principal growth. The former grew from 18,460,172 tons in 1907 to 40,230,542 tons in 1913, while the latter expanded from 7,974,641 tons to 19,694,240 tons during the same period. Nevertheless, the percentage of each class to the whole was not materially altered, except in those two cases. This would seem to show that production has followed along constant lines, and that growth, as represented in traffic, has been fairly uniform among the seven classes.

In no other respect does the widening of Canadian railway interests show up so impressively as in earning power. Going no farther back than 1888, and giving the facts at five-year intervals, the following table tells a strong story:—

| | | | |
|---|---|---|---|
| 1888 | $42,159,152 | 1903 | $ 96,064,526 |
| 1893 | 52,042,396 | 1908 | 146,918,314 |
| 1898 | 59,715,105 | 1913 | 256,702,703 |

It will be seen that as between 1888 and 1898 there was an increase of 41.6 per cent., whereas between 1903 and 1913 the betterment amounted to 167.2. This highly satisfactory result was achieved without any increase whatever in ratio. Net earnings showed up equally well. As between gross receipts and operating expenses—the popular method of measuring net earnings, but not the sound way—there was an advance from $11,507,106 in 1888 to $74,691,013 in 1913. Thus, while gross earnings grew by 509 per cent. during the whole period of 25 years, net earnings grew by 548 per cent. During at least 18 years of that period, there was on one hand a slight reduction of freight rates; while on the other there was a steady and pronounced advance in operating cost as represented chiefly in wages, prices for materials, and so on. Our railways have, therefore, raised net earnings very largely by better methods of operation.

At this point it would seem to be opportune to pause and ask: What, probably, will be the effect of the war now under way on the railways of Canada? No one knows; no one can do more than conjecture. The situation is as novel as it is staggering. It is a distressing topic, since war in all its aspects means waste. War is destructive and not constructive. To just the extent that Canadian commerce is hindered and production restricted there will inevitably be a reduction in the volume of traffic. Traffic is the life blood of railways. As it declines earnings fall off, and as earnings fall off the railways must cut down operating cost. The immediate effect of such economies will be a diminution of the pay roll, and we have already seen that salaries and wages make up 60 per cent. of operating expenses. The injury does not, however, end there. For every five persons who obtain a livelihood directly from the operation of railways at least one other person is dependent on that source indirectly. It therefore calls for no particular prescience to foretell a hard and trying year before the railways of Canada and all associated interests.

How far will the war bring about an enforced halt in construction work? The importance and far-reaching nature of such a question is obvious. Many thousands of miles of new line are in process of building, and other vast projects are assuming positive shape. The money markets of the world have been paralyzed, and money to the railway builder is what traffic is to the railroad operator. Therefore, we must look for some let-up in construction activity. It is inevitable. Let us hope it may be of short duration. When the war is over, we are likely to see a period of unparalleled expansion in Canada. We have the inchoate material for a development beyond our most sanguine dreams.

From the railway point of view, the recent troubled situation has been hurled upon us when we were proud of our progress and strong in our faith. Our railways had established a surprising record of growth, and great plans, expressive both of our transportation needs and our accumulating energy, were under way. In 1913 they had made an unprecedented addition to equipment, and were in a fine position to meet a swelling of traffic. Had all this happened as the result of mismanagement or miscalculation, from some cause suggesting internal weakness, the situation would be vastly different; but it came when our railway situation, viewed as a whole, was sturdy and sound. Therefore, while we may be embarrassed, we shall be able to take up again the immense work on this northern half of the American continent pretty much at the point where it suffered interruption.

## NEW PLANT FOR TREATMENT OF WOODEN POLES.

The Lindsley Bros. Company are just installing at their pole yard in Nakusp, B.C., a plant for treating the butts of their British Columbia cedar poles. For the past two years this company has been operating a similar plant at Priest River, Idaho, and last year treated over 5,000 poles.

The treatment in this plant, as also in the Nakusp plant, just installed, consists in immersing the butts to a point 12 inches to 18 inches above the ground line in genuine avenerius carbolinium at approximately 200 deg. F. for a period varing from 10 to 20 minutes; the period of immersion varying with the condition of the poles and time of the year. It is found that this immersion is the most efficient and gives a penetration of the entire sapwood of the butt—the only place where decay is likely to affect the pole.

At the present time this company is treating some 7,000 poles for the Great Falls Power Company of Butte, Montana, which will be used in a 100,000-volt transmission line to be erected between Great Falls and Anaconda and designed to carry power for the electrification of the Chicago, Milwaukee and St. Paul Railway. About 4,000 of these poles, which are from 45 to 50 feet long, will be used for the main transmission line which will be of "A" frame construction with six unit, suspension type insulators. This will probably be the highest voltage transmitted anywhere in the world on wooden poles and is all the more significant as the Grand Falls Power Company have had considerable experience with steel towers. At the present time they have a 60,000-volt line and an 80,000-volt line carried on wooden poles.

This year the company have entered orders for over 12,000, their customers including some of the most prominent public service corporations in the United States and Canada, one of these being the municipal electric light plant of Ottawa, Ont.

## SINKING A SEA-OUTLET.

In the treatment of sewage in seacoast towns, it has become the custom in almost all cases to use retaining tanks at a point close to the beach. The sewage is brought to this point and there passes through these tanks, giving a liquid effluent, and holding back the solid matter which is broken up, and the natural action of putrefaction takes place.

With the objection of having solid matter washed back on the beach, removed, it only remains necessary to place the liquid effluent at such a distance from the shore, and in a sufficient depth of water to insure a perfect dilution. Here the sewage effluent, being lighter, rises to the surface, mixes with the seawater, the dissolved oxygen of which completes the purification. This has been found very satisfactory in a depth of 20 feet or more of water, and at a distance of approximately 1,000 feet from shore.

So the problem arises to construct a sea-outlet which will withstand the heavy storms occurring along the coast during the winter months, for a sum of money within reach of the average seacoast town.

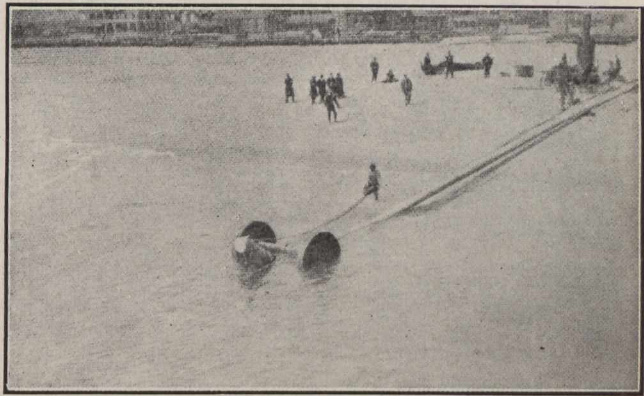


**Fig. 1.—Twelve-Inch Pipe, 1,000 ft. Long, Being Submerged After Assembling on Shores.**

An outfall was described by W. M. Aitchison, C.E., in a recent issue of "The Cornell Civil Engineer" that is worthy of note. It was installed April 22nd, 1913, to take care of the sewage of West Grove, New Jersey. After passing through the settling tanks in West Grove, the sewage flows through Ocean Grove to a manhole near the ocean from between the board-walk and the street, and from this manhole through the sea outlet into the ocean.

The outfall line was made up of 12-inch galvanized wrought iron pipe. The pipe came in lengths averaging 21 ft. and weighing approximately 48 lbs. per ft., with threaded joints fitting into recessed couplings.

While the material was being put on the ground a 3-drum hoisting engine was set up on the beach near the point where the pipe was to be installed. This being the anchorage of the whole operation, great care was used to have a substantial base. Eight-foot piles were driven in the sand, cross braced and capped, and the hoisting engine bolted to these caps.

For an off-shore anchorage five anchors were set at a place in a direct line with the proposed outfall, and at a distance of about 1,325 ft. from shore. The distance was determined with a light line drawn taut. The anchors were set in a line leading away from shore, the two nearest weighing 500 pounds and the remainder being somewhat lighter. These anchors were fastened together with a steel cable, and an 18-inch sheave attached to the nearest anchor. Through this was run a ⅝-inch steel cable and both ends brought ashore.

The outlet end of this line was made up with a 45° L, looking upward, and a nipple leading into another 45° L reversed, allowing the open end when completed to be six feet from the bottom, thus being out of danger from filling with sand or becoming otherwise clogged.

A sea-anchor of the contractors' own design, and consisting of two castings and two clamps was fastened to the riser just described. One clamp was bolted over the nipple leading from the lower 45° L, and the other over the main pipe just in back of the same L, both clamps fitting close to the pipe. These were held by eight one-inch bolts. The sea-anchor weighed 2,200 lbs. in all, and was assembled on the beach just above high-water mark.

Starting at the lower L the pipes were joined together with the recessed couplings, the threads being painted with white lead to insure watertightness. Platforms were built at intervals of about 30 ft. from this

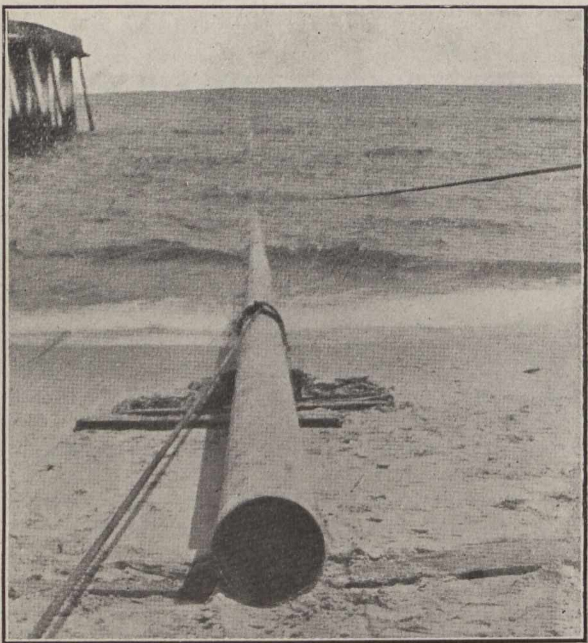


**Fig. 2.—View of Pipe After Being Hauled Overboard.**

point into the street. Rollers were set on these platforms at such elevations as would give an even fall from the street level and the pipe line was built up on these rollers.

A street leading from the ocean at this point formed a very convenient means to continue the work on the pipe line. The pipes were assembled on this street and raised on small wooden trucks, the latter being fastened at intervals equivalent to a length and a half of pipe, until the entire length from the river was sufficient to place it 1,200 ft. from the inlet point and have the last pipe above high-water mark on the beach. This much completed, there was 1,000 ft. of pipe intact, starting at high-water mark and extending in shore, all resting on either trucks or rollers.

The sea-anchor was carried on a big truck with two wheels six feet in diameter, made of two thicknesses of 2-in. plank and each having a rim of 2-in. by 8-in. plank to afford surface bearing.

A hook on the rear of the axle fitted into an eye on the rear of the coupling, thus supporting the sea-anchor and riser, and holding the same free from the ground. Extending out from the axle was a long tongue, at the end of which was a clevice. One end of the steel cable already running through the 18-in. sheave off shore was passed through this clevice and fastened firmly to the sea-anchor, with the other end on a drum of the hoisting engine.

The open end of the riser was next stopped up by means of a wooden plug inserted with white lead. So, with the outer end watertight and raised on a truck the entire line is ready and in a movable position.

The hoisting engine was then used to haul the entire length to sea (Fig. 1), the weight of the sea-anchor keeping the truck and outer end of the bottom, and the air in the pipe causing the balance of line to be bouyed up. A 3-in. pipe line extending through the entire length of large pipe acted as ballast and held the line partly submerged. This condition removed all of the unnecessary friction, and left only the resistance of the large truck holding the sea-anchor and the small trucks and rollers supporting the pipe. This diminished as the pipe went farther to sea. The small trucks were removed as they came up to the platform supporting the rollers.

The object of the sea-anchor being suspended by this hook and eye method, it will be noted, is to form a convenient means of depositing the pipe in its place when so desired. When the cable line is slackened the weight of the sea-anchor pulls the rear of the axle down, and the tongue up, and at the same time the hook releases the eye, and the sea-anchor is dropped in its permanent place.

The hauling finished, the five anchors off shore were raised singly, starting with the most distant anchor and coming in. This slackened the cable and dropped the sea-anchor. The cable was then cut as close as possible to the arm-anchor, releasing the truck, and with this the off-shore work was completed. Fig. 2 shows the pipe after being hauled overboard.

The open end in shore, at a point just above high-water mark was reduced to a 2-in. bushing, and water was pumped through this into the large pipe until a pressure of about 40 pounds was reached, thereby blowing the wooden plug out of the riser and sinking the remainder of the pipe in its place.

A block and fall was used in shore to relieve the strain on the five off-shore anchors, one end fastened to the 12-in. pipe and the other to a second drum on the hoisting engine. It was estimated that a force of about ten tons was required to haul the pipe overboard, this diminishing as the work progressed.

Next the in-shore end was lowered to its proper depth and the line continued to the manhole.

One of the largest factors to be contended with is the shore current, tending to bend the pipe out of line before it is lowered to the bottom. This makes it imperative that the temporary anchors and the engine base be absolutely secure before the hauling is underway. Another difficulty is the necessity of awaiting the proper weather conditions. While it took but 2½ weeks to put everything in readiness it was a considerably longer time before a combined light westerly wind and low tide made possible its completion.

The total, actual pulling time required was 39½ minutes in the intervals of about 5 minutes each, with lapses between to make sure every part was in proper working order. The total time from start of haul to finish was 2 hours and 15 minutes. At the start of the haul the pipe moved at a rate of 20 ft. in one minute while approaching the end it had increased to 20 ft. in 13 seconds. The average working force was six men, with about six added on the day of the haul overboard.

## NOTES ON THE DESIGN OF SEWERAGE REGULATORS AND STORM WATER OVERFLOWS.

In *The Canadian Engineer* for August 27th an article was published on the design of the new intercepting sewers for the City of Cincinnati and the investigative work leading up to their design. In connection with it there will have been noted that adequate provision was not made therein for the entire storm water run-off, and that the excess is to be taken care of by separate storm water overflows. This subject, together with that of sewage flow regulation, is also treated in the Cincinnati sewerage report, and from it the following is abstracted:—

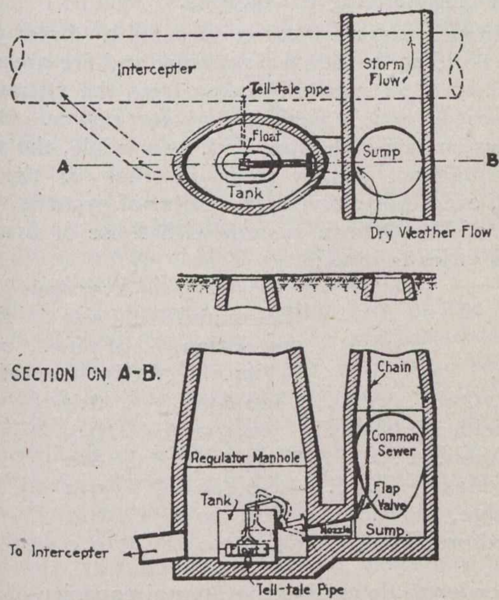



**Fig. 1.—Typical Sewer Regulator.**

The function of a storm water overflow is to supply a means of removing storm water in excess of a certain definite flow in the sewer to the nearest watercourse, or to a storm water channel provided for that purpose; in other words, to allow the escape from the sewer of all excess over a fixed quantity of sewage. A sewage flow regulator, conversely, is intended to prevent surcharging of an intercepting sewer by partly or wholly closing the inlet connections from the branch trunk sewers. The general object to be attained is the same in both cases, namely, to allow the admission of domestic sewage to the intercepting sewer and to divert the storm water to other channels; but an overflow provides an outlet for storm water from a trunk sewer, while a regulator prevents the admission of storm water to an intercepter.

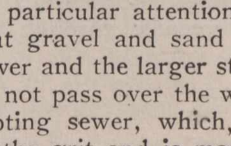
Overflows and regulators are frequently used in combination, the former allowing the excess above a certain flow to be discharged into storm water drains, the latter entirely cutting off inflow to the intercepter when the quantity of sewage in the latter has reached a certain point and when it is in danger of being surcharged.

**Regulators.**—A regulator is a mechanical appliance by which a gate is automatically closed by the rising of a float whose motion is controlled by the elevation of the sewage in the intercepter. A typical regulator is shown in Fig. 1.

The use of regulators of this type is open to the objection that frequent attendance is required in order to keep the apparatus in proper working condition. The regulators must be inspected and cleaned at short intervals, and after each storm must be carefully overhauled, if they are to be depended upon to perform their function.

**Over-Fall Weirs.**—There are two types of storm overflow, over-fall weirs and leaping weirs. An over-fall weir, as the name implies, is an outlet with a sill or crest arranged either across the sewer or longitudinally in one side of the structure, so designed that the excess flow, after the sewage reaches the height of the crest, is taken to a storm water channel, while the ordinary flow passes the weir and is discharged into the intercepter.

An excellent example of an overflow of this type is shown in Fig. 2, which illustrates the storm water overflow constructed in connection with the Walworth sewer in Cleveland, according to the designs of W. G. Parmley. In the case of large sewers, such as the one illustrated, an over-fall of considerable length is required. In this particular example the length of the crest was approximately 100 ft.




An overflow of this type, if properly designed, should be absolutely automatic in its action and should require no particular attention. The only objection to its use is that gravel and sand washes along the bottom of the sewer and the larger stones brought down by storm water do not pass over the weir, but follow the line of the intercepting sewer, which, therefore, receives practically all of the grit and is more likely to be obstructed by accumulations than if the heavy material brought down by storm water could be discharged with the overflow. This also involves undue wear upon the invert of the intercepter.

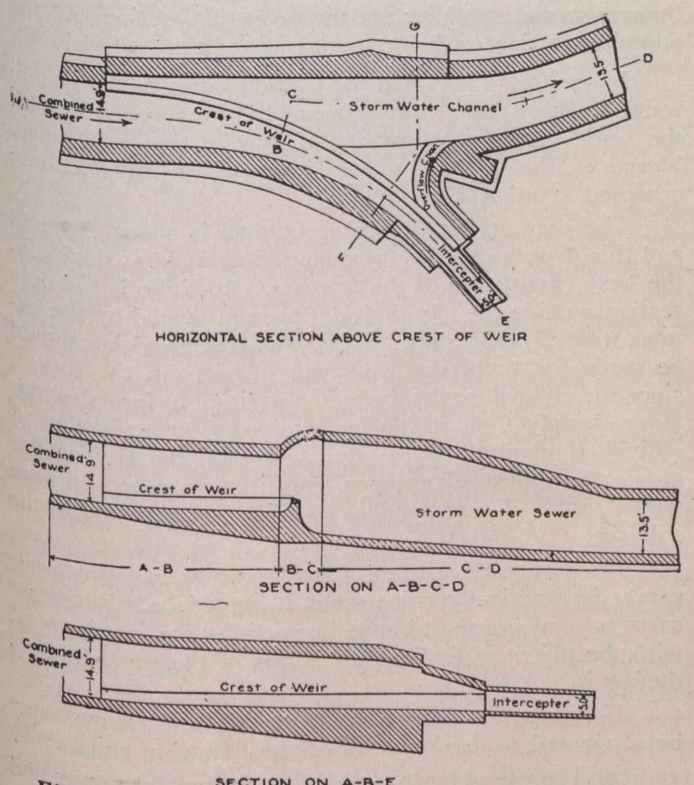



**Fig. 2.—Overfall Weir for Storm Water Overflow.**

**Leaping Weirs.**—The leaping weir type of overflow is suitable only for comparatively small sewers. As the name implies, it consists of a weir or crest over which the ordinary or dry weather flow falls into a connection leading to the intercepting sewer, while the storm waters leap the opening and pass on through the storm water channel.

A typical leaping weir is shown in Fig. 3, which illustrates an inlet constructed in connection with the Menomonie Intercepter at Milwaukee, Wis., from designs of George H. Benzenberg. Like the overflow weir, this type should require no attention, unless the opening becomes clogged by planks or other large substances which are not supposed to find their way into sewers, although they sometimes do. It is open to the same objection as the over-fall weir, that the gravel and sand are washed into the intercepter, although there is more likelihood with this type of overflow that a portion of the silt may be discharged with the storm water.

In view of the attention necessary to maintain regulators in proper working order, it is desirable to avoid their use as far as possible. Wherever found possible by studies of the details of design, the leaping weir type

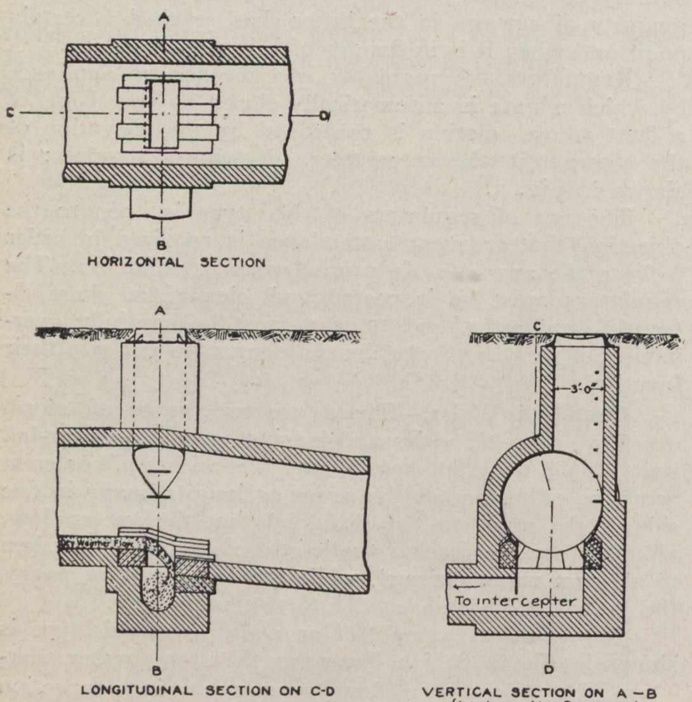



**Fig. 3.—Typical "Leaping Weir" for Storm Water Overflow.**

of overflow for the connections of the smaller trunk sewers and the over-fall weir for the larger sewers should be used rather than float-operated regulators.

It must not be forgotten that in the case of trunk sewer outlets which are below the level of high water in the river, so-called tide-gates must be provided, particularly in any project which involves pumping and treating the sewage collected by the intercepters; otherwise river water will at times enter the intercepter through the storm water overflows.

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It is reported that timber limits extending over 115 square miles along the foreshore of Seymour Inlet and adjacent waters in British Columbia, including 3,000,000,000 feet of high-grade cedar, were recently transferred to a syndicate of capitalists from the United States. It is said to be the intention of the purchasers to begin logging operations on the limits in the near future, and the plans contemplate placing several sawmills on the property. The scarcity of cedar and the increasing price of high-grade timber in the United States have caused American millmen to turn their attention to British Columbia, which has the largest compact area of merchantable timber on the continent. The abolition of the duty on Canadian shingles and other forest products has encouraged and given impetus to the shingle industry, which has made great progress in the province recently.

## OTTAWA WATER DISTRIBUTION.

A COMPREHENSIVE review of the present water system at Ottawa, tests made upon its efficiency, the requirements necessary to afford modern fire protection, a plan of the immediate and future improvements recommended, together with detailed estimates of the cost of these improvements, are presented to the City of Ottawa in a report by R. S. and W. S. Lea. A short digest has been made from this report and is given in the following paragraphs.

Ottawa's water system is operated by direct pumping at from 80 to 90 lbs. normal pressure and fire pressures up to 110 lbs. The supply is taken from the Ottawa River and almost all of it is pumped by water power. Over 40% of the system is 5-inch pipe; and, as a whole, the pipes are smaller than are usually found in cities of the size of Ottawa, even those having the oldest of systems. A comparison of the Ottawa system with those of five Massachusetts cities follows:

| City. | Estimated population, (1913) | Average size of pipe. (Inches) | Relative capacity of system. |
|---|---|---|---|
| Ottawa, Ont. ........ | 100,000 | 6.4 | 1.00 |
| Springfield, Mass. .... | 100,400 | 10.5 | 3.66 |
| Lynn, Mass. ........ | 97,500 | 8.0 | 1.80 |
| Lowell, Mass. ....... | 110,100 | 9.2 | 2.59 |
| Cambridge, Mass. ... | 109,300 | 8.7 | 2.24 |
| New Bedford, Mass. .. | 112,500 | 9.0 | 2.45 |

In order to determine the normal capacity of the present system, a series of tests was made, using pressure gauges on the hydrants and a Curtis stream gauge at the nozzles, which were attached to 50 feet of hose. From these tests, the actual loss of head between the pumping station and any section of the city with ordinary domestic draft could be determined, as well as the additional loss resulting from a draft for fire purposes, not only at the hydrants from which water was drawn, but also both in their immediate vicinity and between this section and the pumping station. About 1,200 readings were taken in all.

It was found also that the friction losses in the system were, in many cases, three times what they would be with the usual permissible velocity of flow in the main pipes. Moreover, the hydrant pressures were below the commonly accepted standards.

The present population of Ottawa is about 100,000, and this population may be expected to at least double in the next twenty-five of thirty years. Rockliffe is the only section outside the city limits at present served by the Ottawa water system; but it is believed that provision should be made for supplying suburban districts in the future, since the city will probably be in a position to furnish water more cheaply than it can be obtained from a number of individual plants. More important still, the city cannot obtain the fullest advantages from its own proposed pure water supply if questionable supplies be continued in the suburbs.

The combined use and waste of water in Ottawa per capita is practically twice what it should be. Pitometer surveys and house-to-house inspections are in progress, with the object of finding the causes of the waste and reducing it.

The excessive normal draft per capita in Ottawa may be attributed to one or more of the following causes:

(1) The use of large quantities of water for power and manufacturing purposes;

(2) Carelessness in leaving taps running;
(3) Leakage from defective plumbing and fixtures;
(4) Leakage from the underground system.

The use of water for power and manufacturing purposes can be reduced to legitimate proportions by metering the supplies to such establishments. Education and inspection will probably reduce the losses due to (2). A long-continued extravagance in the use of water, however, becomes a habit, and no practicable method of effectively reducing it is known, except that of metering the domestic services. Leakage from defective plumbing and fixtures can be controlled by a systematic house-to-house inspection regularly maintained by a permanent corps, or by metering the services. The determination of underground leakage, the location of the leaks and their repair, is a work which may take much time, patience and money.

Obviously, the way to deal with the situation is, first, to determine for what proportion of the total waste each of the causes is responsible; after which remedial measures may be applied if their adoption is warranted by the waste it is practicable to prevent thereby.

Before permanently adopting any of the remedial measures referred to above, it is suggested that small sections of the system be chosen in typical residential, semi-commercial and business districts, and that their consumption be recorded for some time by means of a photo-pitometer or a Deacon meter. If there are any establishments in these sections using water for power or manufacturing purposes, these particular services should be metered. The number of domestic services and the number of consumers should be determined. After records from these small sections have been taken long enough to indicate the per capita domestic consumption, the house plumbing should be inspected and all defects repaired. Then tests could be carried out for underground leakage by the usual methods. Such a procedure as this would give some indication of the proportion which waste from the various causes bears to the total waste, and would serve as a basis for determining whether or not it would pay the city to adopt the available remedies.

An excessive use of water, it must be remembered, is responsible for a financial burden greater than is represented by the cost of pumping or filtering, as it may overtax the capacity of every part of the system. For instance, the per capita consumption is an important factor in the design of the improvements recommended; and the design is based on the assumptions that it will be sufficient to provide capacity in the distribution system for the maximum fire draft, and to maintain a domestic consumption at the rate of 125 gallons a day per capita. These assumptions presuppose the reduction of Ottawa's consumption to a normal figure, the steps for which are strongly recommended by the engineers.

An important question of policy is whether or not it is advisable to meter the domestic services. The larger services for power and manufacturing supplies should certainly be metered; and, moreover, no domestic connection should be permitted to any private fire service unless the service is equipped with a detector meter. Where the domestic services are not metered, a system of house-to-house inspection should be maintained to control the use of water for sprinkling purposes, and to insure that the plumbing is kept in a state of proper repair.

Unfortunately, there is a too general belief that the object of universal metering is to reduce the consumption of water by increasing the cost to the ordinary consumer. This view is entirely incorrect. It is true that the installation of meters has almost invariably reduced the water consumption to legitimate proportions; but this reduction in consumption is due to the restriction of waste on the part of careless consumers. With this waste eliminated, the total cost of providing a supply for a city cannot but be reduced. And, if there are sound reasons, based on carefully collected data, for believing that it would cost the city less to install and maintain meters on the domestic services than it would to supply the waste prevented by these meters, a city should not hesitate to adopt metering because of sentimental or imaginary objections.

The provision for fire draft is as follows:

For the principal business section, containing the risks of greatest value, 35 to 40 standard streams;

For the manufacturing districts, particularly the areas devoted to the lumber industry, 20 to 25 standard streams;

For the closely built semi-commercial section, 15 standard streams;

For the residential sections, depending on the character and proximity of the houses, 5 to 10 standard streams for the worst fires.

For direct pressure, it is desirable that with the usual hydrant spacing, running pressures of 65 to 70 lbs. be maintained in the residential sections under conditions of maximum draft, and 90 to 100 lbs. in closely built semi-commercial and manufacturing sections with no buildings over five stories in height. With a closer hydrant spacing than is generally adopted, fairly good protection is afforded with running pressures of 60 lbs. in residential sections, and 80 to 85 lbs. in semi-commercial and manufacturing sections.

In the scheme of improvements recommended, such capacities have been selected for the new feeders as will ensure satisfactory fire service with the available pressure direct from the hydrants over as large an area as possible. As the average static pressure on the Ottawa system is only 85 lbs., the friction loss from the point of supply to the centre of draft must necessarily be kept within close limits. In fact, it will never be possible to dispense with fire engines entirely for protecting districts with buildings over five stories in height, unless a high-pressure system is provided. And, since over 40% of the Ottawa system consists of 5-inch pipe or smaller, the only way that high local losses of head can be avoided and satisfactory hydrant pressures maintained, is to feed the general gridiron from relatively large mains crossing an area at intervals of from one-quarter to one-third of a mile.

Suitable fire pressures can be maintained for many years in the suburban districts without storage. When the suburban population is largely increased, it will probably be necessary to construct elevated tanks at three or more points to provide storage in the centres of these outlying districts for fire service. The construction of these tanks will maintain suitable pressures without any additions to the proposed feeders. Suitable sites for these tanks are available in Rockliffe for the southern district on the Buchan Road one mile from Billings Bridge, and for the western section somewhere south of Carling Avenue.

Cast iron pipe is recommended for the sizes under 16-inch, and riveted steel pipe for the 30-inch and 36-inch feeders. For the intermediate sizes, the choice between cast iron and steel should be determined by the prevailing prices when the pipe is purchased.

In general, valves are to be placed in the pipes immediately after they leave the main which feeds them, and also immediately after all branches of 12-inch diameter and over are taken off them. Where the branches are small, such as 6-inch and 8-inch, valves are to be placed at least as often as every sixth crossing; and where the mains run parallel to the long sides of the blocks, valves are to be placed at every third crossing.

Where the new mains are in rock excavation, it will be desirable to replace the present small pipes by the new main in order to take advantage of the easy excavation. It is advisable to do so in any case where the old main is known to be subject to considerable leakage.

It is usually recommended to place hydrants at all street intersections, with a maximum spacing of 500 feet in residential areas and 200 to 250 feet in business districts. No general rule can be indiscriminately applied, however, owing to the difference in the friction losses in pipe of different sizes. For instance, the loss in a 5-inch pipe is about ten times the loss in an 8-inch pipe for the same discharge. Taking into consideration the combined effects of differences of elevation, pipe sizes and dimensions of blocks, the placing of hydrants is plainly a matter which cannot be settled by adhering to a general rule.

A reasonable hydrant spacing in the residential sections, dependent on the distance apart of the mains and the sizes of the smaller street pipes, will be about as follows:

| Static pressure. | Distance between hydrants. |
|---|---|
| 80 lbs. | 500 to 550 feet |
| 70 lbs. | 400 to 450 feet |
| 60 lbs. | 300 to 350 feet |

In the semi-commercial manufacturing districts, the spacing should be kept down to about 300 feet, and in the principal business districts with buildings up to eight and ten stories high, it will eventually be necessary to adopt a limit of about 200 feet.

The presence of large lumber yards in certain sections of the city constitutes a serious conflagration hazard. If a fire should get beyond control within the yards, the interior hydrants might not be accessible, while the fire might be beyond the range of the adjacent street hydrants. In such an emergency, one or more monitor nozzles mounted on stand pipes in towers at the sides of the yard would be of great service.

The principal business district in Ottawa is at present covered by the "Booster System" which has been lately put into service; and the improvements that have been recommended do not include this district.

It is advised that the city should proceed with the installation of a system of main pipes in sizes ranging from 12-inch to 36-inch. To carry this system to completion will eventually require 30 miles of pipe at an estimated cost, based on current prices for labor and material, of $947,500. Within the total amount recommended, about 13 miles are required for the improvement of the system in the present built-up sections, at an estimated cost of $420,000.

If the "Booster" pumping capacity is increased to meet the demand in the business section, four or five standard fire engines will be sufficient for many years to come; and these can be stationed where they will generally be needed.

The proposed scheme is, in fact, a very desirable one, but it calls for heavy expenditure. Estimates have therefore been prepared for an alternative scheme based on maintaining such hydrant pressures as will permit all streams being taken directly from the hydrants for the small fires, and relying on the use of fire engines in every part of the city for the control of the worst fires. The total estimated cost for this alternative scheme is $776,400 for 34 miles of pipe. The difference in the first cost is $180,100. Taking interest and depreciation at 5½%, this difference in first cost represents an annual charge of nearly $10,000. It is altogether likely, however, that the underwriters would specify eight or ten more fire engines with the alternative scheme than would be required under the original proposition. The annual cost of each fire engine and the incidental equipment has been estimated at $4,000. Therefore, on the basis of ultimate annual cost, including fire engines, the original proposition is, if anything, the cheaper scheme; and as it affords much superior fire protection, it is recommended without qualification.

Referring to the future protection of the principal business district, the "Booster System" should suffice until the end of the year. As an ultimate solution of the problem, this system, with motor-driven pumps, is not favored, as the power for its operation must be purchased at rather high rates. Moreover, the pressure is bound to be limited by what the existing pipes will stand; and this is not sufficient to supply the high-pressure fire streams necessary. Consequently fire engines will still have to be used; and there is also some danger in carrying high pressure on an old system to which connections of all kinds will continue to be made. The additional pressure is dependent upon the operation of a number of check valves, and if any one of these should fail, the pressure would be greatly reduced.

Finally, it is pointed out that no system will effect a reduction in the annual fire losses at all comparable to that which would ultimately result from removing the cause of serious fires by the enactment and enforcement of a good building code embodying the recommendations of the National Fire Protection Association. However, as an efficient fire protection scheme, no other proposition compares at all favorably with the independent high-pressure fire system. That can be made practically free from danger of broken connections to buildings, which records of all great fires have shown to be responsible for an enormous waste of water at the time it was most urgently needed. But, above all, the chief advantage of the system lies in the fact that it provides the means whereby water can be applied to the seat of a blaze in the shortest possible time.

The cost of a high-pressure system in the district covered by the present "Booster System" with pipes below the present system, a hydrant spacing limited to 200 feet, and a pumping plant capable of supplying nine standard pressure streams, each discharging 820 gallons per minute, is estimated at about $290,000.

## WAR AND AMERICAN BUSINESS

Authorities are unanimous in the opinion that America will benefit in various ways as the result of the war. They admit that all nations will pay a share of the cost, but generally speaking, they think that the United States, and Canada to a lesser degree, will receive benefits.

Mr. Franklin K. Lane, secretary of the interior at Washington, predicts greater industrial expansion and especially greater mining activity in the United States as a result of the struggle. He says:—"Of importance second only to that of food supply is the supply of mineral products. We have cause for self-congratulation that we are able to feed ourselves. What we possibly have not realized, is that we are nearly as independent in the possession of essential mineral resources as in food products, and that interference with manufacturing caused by interruption of flow of importations of many necessary raw materials, because of the war, may be overcome almost wholly by development of neglected resources in our country."

He added that these resources will be developed if formative legislation be passed.

## CLASSES OF PERMISSIBLE EXPLOSIVES.

In order that the users of explosives may know the nature and characteristic component of permissible explosives, and as an aid in the selection of an explosive to meet a specific requirement, the permissible explosives have been arranged in four classes by the United States Bureau of Mines, whose investigations of explosives and their use have been progressing steadily since 1908, with a view to lessening the accidents attending such use. Reports of tests of permissible explosives appear in Bulletin No. 66, from which the following useful information has been taken:—

It is divided into two subclasses. Subclass *a* includes every ammonium nitrate explosive that contains a sensitizer that is itself an explosive. Subclass *b* includes every ammonium nitrate explosive that contains a sensitizer that is not in itself an explosive. The ammonium nitrate explosives of subclass *a* consist principally of ammonium nitrate with small percentages of nitroglycerin, nitrocellulose, or nitrosubstitution compounds which are used as sensitizers. The ammonium nitrate explosives of subclass *b* consist principally of ammonium nitrate with small percentages of resinous matter or other non-explosive substances used as sensitizers.

All of the ammonium nitrate explosives readily absorb moisture from the atmosphere, and great care should be taken in storing them or in using them in damp places. They are not suitable for use in wet mines. If in such a mine a cartridge of an ammonium nitrate explosive is opened and its contents exposed for only a few hours to the damp atmosphere the explosive may deteriorate, and later fail to detonate completely. The ammonium nitrate explosives when stored in well-ventilated magazines for only a few months have shown signs of deterioration, and nearly all explosives of this class after six months' storage at the Pittsburgh experiment station have either failed to detonate or have detonated incompletely. For this reason ammonium nitrate explosives should be obtained in a fresh condition and should be used as soon as possible after their receipt. When fresh, these explosives, if properly detonated, have the advantage of producing only small quantities of poisonous and inflammable gases, and are adapted for mines that are not unusually wet, and also for mines and working-places that are not well ventilated.

**Class 2, Hydrated Explosives.**—To Class 2 belong all explosives in which salts containing water of crystallization are the characteristic materials. The explosives of this class are somewhat similar in composition to the ordinary low-grade dynamites, except that one or more salts containing water of crystallization are added to reduce the flame temperature. They are easily detonated, produce only small quantities of poisonous gases, and most of them can be used successfully in damp working-places.

**Class 3, Organic Nitrate Explosives.**—To Class 3 belong all the explosives in which the characteristic material is an organic nitrate other than nitroglycerin. The permissible explosives listed under Class 3 are nitrostarch explosives. They produce small quantities of poisonous gases on detonation.

**Class 4, Nitroglycerin Explosives.**—To Class 4 belong all the explosives in which the characteristic material is nitroglycerin. These explosives contain free water or an excess of carbon, which is added to reduce the flame temperature. A few explosives of this class contain salts that reduce the strength and shattering effect of the explosives on detonation. Nitroglycerin explosives have the advantages of detonating easily and of not being readily affected by moisture. On detonation some of them produce as large quantities of poisonous and inflammable gases as black blasting powder, and for this reason they should not be used in mines or working places that are not well ventilated.

**Rate of Detonation of Permissible Explosives.**—The energy developed by the detonation of permissible explosives, like that of other high explosives, depends on the change of the small solid and liquid particles of the explosive into large volumes of highly-heated gases and on the rate of detonation or the rapidity with which these gases are formed. The force exerted by these gases is the means of producing useful effects. The rate of detonation is the governing factor in judging the efficiency of an explosive, and it offers the best single means for selecting explosives suitable to meet the varying conditions of coal mining.

During the conversion of an explosive into solid, liquid, and gaseous products the cooling effect of the walls of the drill-hole tends to lower the temperature of the gases so that the maximum theoretical temperature or pressure is never reached. The more nearly instantaneous the explosive reaction, all other conditions being equal, the greater the volume of highly-heated gases produced, and the more violent the effect.

To meet the varying conditions of coal mining in this country the explosives manufacturers have devised explosives with rates of detonation that range from 4,750 to 14,560 feet (1,447 to 4,439 meters) per second.

**Suggestions Useful in Selecting Explosives.**—It is hoped that with few exceptions the classification given will serve as a useful guide for comparing the practical value of permissible explosives. It is evident that for certain work in which a shattering effect is desired, as in driving through or "brushing" rock, or in producing coal for coking purposes, the explosive reaction should be rapid. Hence, permissible explosives having a high rate of detonation should be selected. Similarly, for use in soft, friable coal to produce lump or steam coal, selection should be made of a permissible explosive that detonates slowly, and hence gives a more prolonged pressure. In medium hard coal an explosive having an intermediate rate of detonation would be expected to be most suitable, but is not always so. Coals vary in hardness and coal beds vary in the number and position of the joints, partings, shale bands, etc. These facts have to be considered in mining.

An explosive having a very low rate of detonation is not always best suited for mining soft, friable coal, because some of its energy may be lost by its gases escaping through cracks and fractures in the bed. Under such conditions an explosive having an intermediate rate produces the most economical results.

Another factor to be considered in connection with an explosive having a high rate of detonation or the use of a large charge of any explosive is the possible effect on the roof, or the strata overlying the coal bed. Large charges of explosives having a very high rate of detonation cause small fissures that may later necessitate extra timbering to prevent falls in rooms or entries, and thus make the operation of a mine more costly.

It is well known that the pressure developed by the detonation of explosives in a closed space is directly proportional to the charging density; in other words, a 1¾-inch drill-hole loaded with 1¼-inch cartridges will produce on the walls of the drill-hole about one-half as much pressure per square inch as it would if loaded with cartridges of 1¾-inch diameter. A limited experience indicates that explosives having a rapid rate of detonation will yield a larger proportion of lump coal if used in a hole of larger diameter than the cartridge. Such air-spacing to reduce the shattering effect of an explosive is recommended by the Bureau of Mines, provided the charge is confined with moist clay stemming tamped to the mouth of the drill-hole.

Other less desirable means of reducing the shattering effect of an explosive are the use of an improper detonator, reducing the amount of stemming, using an explosive that is frozen or partly frozen, using an explosive in cartridges of less diameter than those originally tested, and introducing foreign substances between the cartridges of an explosive; but these methods are all dangerous. They not only eliminate the safety qualities of the explosive, but increase the chance of a resultant dust or gas explosion, and should not be adopted.

**Results of Tests with Detonators.**—Permissible explosives are detonated by means of detonators or electric detonators, which are graded by number according to the weight of fulminating charge. Different types of explosives require detonators of different strength. Detonators are usually fired with fuse. A detonator fitted with a means of firing it with an electric current is called an electric detonator. As an electric detonator is embedded in the explosives with which it is used and is isolated by the stemming, it is the safest means of igniting a charge of explosive in a gaseous mine.

One of the conditions prescribed by the Bureau of Mines for a permissible explosive is that it shall be fired by a detonator, preferably an electric detonator having a charge equivalent to that of the standard detonator used at the Pittsburgh experiment station. It is further required that this charge shall consist by weight of 90 parts of mercury fulminate and 10 parts of potassium chlorate (or their equivalents).

An investigation undertaken by the Bureau of Mines shows that the average percentage of failures of explosives to detonate is increased over 20 per cent. when the lower grades of electric detonators were used instead of No. 6 electric detonators, and over 50 per cent. when compared with No. 8 electric detonators. However, when sensitive explosives were tested under the conditions most favorable to detonation, the same energy was developed irrespective of the detonator used. When tests were made with insensitive explosives under conditions which similate their use in blasting, the energy increased with the grade of the detonator used. For example, the average explosive efficiency of four different explosives was increased 10.4 per cent. by using a No. 6 electric detonator instead of a No. 4 electric detonator, and 14.9 per cent. by using a No. 8 electric detonator. The tests emphasize the importance of using explosives in a fresh condition, and, since this is not always possible, the importance of strong detonators in blasting to offset any deterioration of the explosive through ageing.

The results substantiate these conclusions: (1) That the explosive efficiency of the detonators made by any one manufacturer increases with the grade; (2) that No. 6 electric detonators of four different makes have practically the same explosive efficiency; and (3) each is considered equivalent to the Pittsburgh experiment station standard No. 6 electric detonator for use with permissible explosives in coal mines when the No. 6 grade is prescribed.

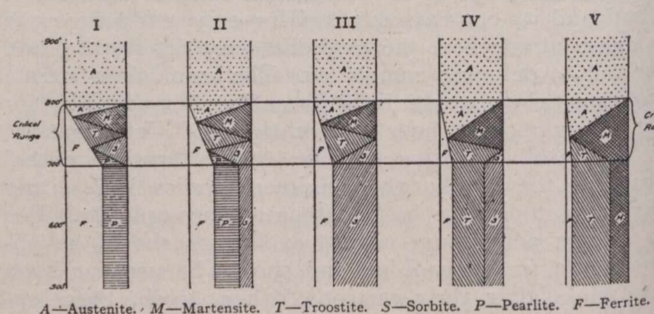
Receivers have been appointed for the International Steam Pump Company, a $29,000,000 corporation, by United States Judge Mayer. The receivership was granted in an equity suit brought by bondholders and stockholders and a creditor. The corporation joined in the application. The receiver was authorized to continue the business.

## MILD STEEL AND ITS TREATMENT.*

**By Albert Sauveur,**
Professor of Metallurgy and Metallography, Harvard University.

FOR the purpose of illustrating metallographic methods and their teaching we may select as a concrete example the treatment of mild steel, a metal so widely used in machine construction, as, for instance, in the manufacture of shafts, and extensively used, also, for a great variety of steel castings. Such steel may contain some 0.30 per cent. carbon, and should be of good commercial quality; i.e., should contain over 0.1 per cent. phosphorus—preferably not more than 0.05 per cent. of that element—nor over 0.05 per cent. sulphur. According to the treatment it has received it may have a tensile strength varying between 60,000 and 100,000 pounds per square inch, while its ductility, measured by its elongation, may fluctuate between 15 per cent. and 35 per cent. As cast into ingots or other forms this metal shares the shortcomings common to all steel castings—weakness, lack of ductility, and little resistance to shock. These unwelcome properties of steel in its cast condition are due primarily to the structure of cast steel, which is very coarsely crystalline.

It is well known that the properties of steel may be very greatly improved through properly conducted mechanical and thermal treatment, by which its structure




*A*—Austenite. *M*—Martensite. *T*—Troostite. *S*—Sorbite. *P*—Pearlite. *F*—Ferrite.

**Fig. 1.**

is modified or refined, and it is the purpose of this paper to describe briefly the various structures mild steel may be made to acquire as the result of work and of heat treatment, and to point out the relations existing between each structure and corresponding physical properties, such as hardness, strength, and ductility.

No explanation of the deep structural changes resulting from certain treatments can be given without reference to the thermal critical range of the steel considered. Fortunately, metallography has so diffused this fundamental knowledge that at the present time there is hardly a metallurgist or metallurgical student ignorant of it. A lengthy description of the occurrence of the critical range of mild steel and of its meaning will not be, therefore, necessary. It will be helpful, however, for the present purpose to illustrate graphically the relations existing between the critical range and the structural changes it is desired to describe.

In Fig. 1 the critical range is represented as covering a temperature zone extending from 700° to 800° C. It will not be necessary, for the aim in view, to take into consideration the existence of two critical points, $A_{3\cdot2}$

* Lecture delivered before the Mechanical Engineering Society of the Worcester Polytechnic Institute, Worcester, Mass., and published in the Journal of the Franklin Institute.

and $A_1$, within that range, nor the fact that the points on heating, $Ac_{3\cdot 2}$. and $Ac_1$, occur at temperatures some 25 to 50 degrees higher than the corresponding points on cooling, $Ar_{3\cdot 2}$. and $Ar_1$.

Above its critical range the steel we are studying consists, like all steels, of a solid solution of iron and carbon. In this condition the two constituents are so completely merged that their independent existence cannot be recognized by any physical means; they form a chemically and physically homogeneous mass. Whether carbon in its elemental condition is dissolved in the iron, or whether it is the carbide of iron, $Fe_3C$, which the iron holds in solution, is here immaterial. We may likewise ignore the various allotropic conditions assumed by iron. The solid solution of iron and carbon stable above the critical range is called "austenite." Whenever it is possible to preserve austenite in the cold to the exclusion of other constituents and to microscopically examine its structure, it is found to be made up of crystalline polyhedra or gains exhibiting in a polished section the appearance of a network, the meshes representing sections through as many grains, and the net itself, junction lines between adjacent grains. The size of the austenite grains increases with (1) the maximum temperature from which cooling starts, (2) the length of time during which the metal was kept at that temperature, and (3) the slowness of its cooling to the critical range. It will not be necessary, nor is it desirable, to further discuss here the probable crystallography of austenite. As to its physical properties, austenite is hard, tenacious, and ductile, but has a low elastic limit.

On slow cooling through the critical range, as shown in Fig. 1, Diagram I., the solid solution of iron and carbon is converted into a mechanical mixture or aggregate of ferrite and pearlite, the latter constituent itself being an aggregate, in definite proportion, of "ferrite" and the carbide $Fe_3C$, or "cementite." Ferrite and pearlite may be considered as representing the proximate structural composition of the steel, while ferrite and cementite are its ultimate structural constituents. Ferrite, like austenite, and, for that matter, like pure metals and solid solutions in general, is made up of polyhedric crystalline grains, giving rise, on sectional polishing, to network structures. Pearlite is built up after the pattern so characteristic of eutectic and eutectoid alloys, of parallel, alternate plates of its two components, namely, ferrite and cementite. These plates are so thin, however, that a magnification exceeding 200 diameters is generally required for their resolution. Ferrite is very soft and very ductile, but relatively weak, while pearlite is very tenacious and much harder, but also much less ductile.

It is seen that in cooling through its critical range steel undergoes deep structural changes, being converted from the state of a solid solution to that of an aggregate of varying coarseness. So great a transformation must be accompanied by no less momentous alteration of properties, and, indeed, there is little in common between the physical properties of austenite and those pertaining to the ferrito-pearlitic structure existing below the critical range.

Steel with 0.30 per cent. carbon is composed, after slow cooling through its critical range, of 64 per cent. ferrite and 36 per cent. pearlite, as graphically shown in Fig. 1, Diagram I. Bearing in mind the physical properties of its two components, ferrite and pearlite, it will be obvious that mild steel in its ferrito-pearlitic condition, while more tenacious and less ductile than ferrite, will be considerably less tenacious and more ductile than pearlite. Its tenacity, as a matter of fact, should be in the vicinity of 70,000 pounds per square inch, and its elongation in 2 inches should be about 20 per cent. These properties, moreover, will vary considerably in accordance with the coarseness or fineness of the ferrito-pearlitic structure, the finer structure being generally the more ductile. The structure of the steel, after slow cooling through the critical range, will, as a rule, be the coarser, the coarser the austenite immediately before its transformation, and this in turn, as already noted, depends chiefly upon the maximum temperature from which cooling started, the time the metal was kept at that temperature, and the rate of cooling.

It should be borne in mind that the ferrito-pearlitic structure just mentioned, and which corresponds to the end products of the structural transformation taking place within the critical range, results from slow cooling through that range, as, for instance, by allowing the piece to cool within the furnace in which it was heated. On hastening the cooling, structural conditions may be produced corresponding to widely different properties, as will now be described.

The transformation of the austenitic solution into a ferrito-pearlitic aggregation is not sudden, but, on the

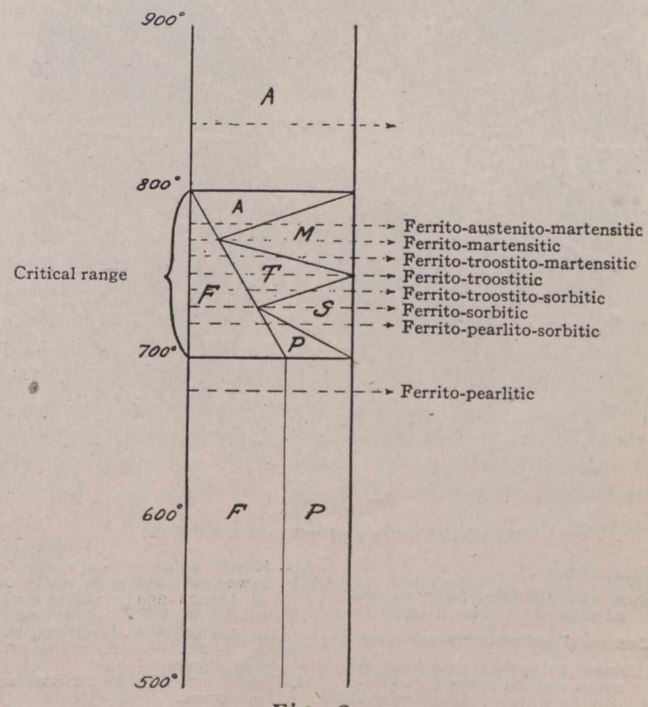



**Fig. 2.**

contrary, covers a notable range of temperature, while transition constituents are formed within the critical range, as depicted in Figs. 1 and 2. It is intended to show, by means of these diagrams, that, on entering the critical range, the austenite existing above that range is gradually converted into "martensite" with rejection of ferrite, a rejection which continues all through the range; that the martensite, on further cooling, is, in turn, transformed into troostite, which, at a still lower temperature, is itself converted into sorbite; while, finally, pearlite, the end product, forms as the steel emerges from its range. We thus recognize the existence of three so-called transition constituents—martensite, troostite, and sorbite—but it will be unnecessary to enter here into a discussion of their probable nature, a subject which is still, to a certain extent, a controversial matter. Martensite appears to be made up of needles, often forming equilateral triangles; troostite, which consists of irregular ragged or rounded masses; while sorbite exhibits a finely granular and rather indistinct structure. In regard to physical properties, martensite is very hard and brittle, less hard and less brittle than martensite, while sorbite is less hard than troostite and more tenacious, but less ductile than pearlite.

By referring to Fig. 2 it will be seen that, theoretically at least, seven different structural conditions may be conceived to exist momentarily as the steel undergoes its critical transformation; namely, ferrito-austenito-martensitic, ferrito-martensitic, ferrito-troostito-martensitic, ferrito-troostitic, ferrito-troostito-sorbitic, ferrito-sorbitic, and ferrito-pearlito-sorbitic.

The mechanism of the structural changes depicted in Fig. 1, Diagram I., and in Fig. 2, refer to the changes taking place when the cooling is slow enough to permit

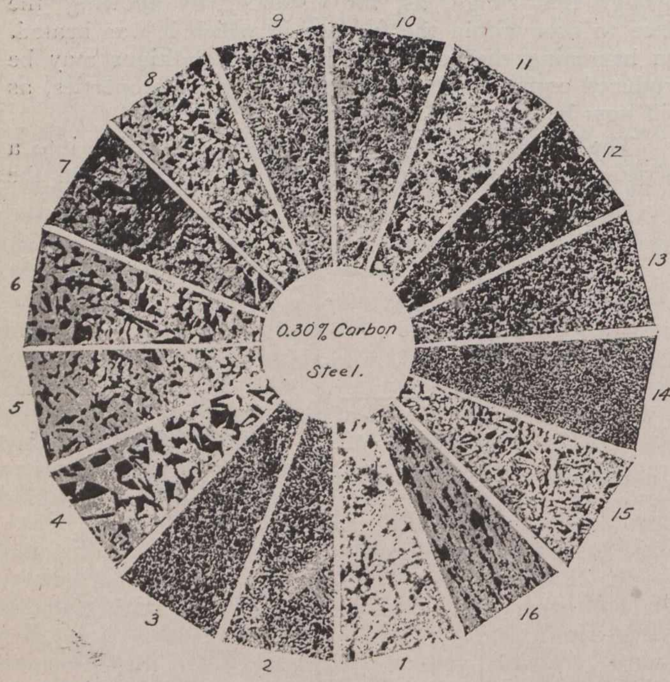



**Fig. 3.**

Various structures of mild steel (0.30% C.)

1. Steel as cast.
2. Steel cast and imperfectly annealed (remnants of ingotism).
3. Cast steel and properly annealed.
4-8. Heated to various temperatures above critical range for various lengths of time and slowly cooled in furnace. Ferrito-pearlitic structures of different degrees of coarseness.
9-13. Heated above critical range, followed by cooling in air or oil, or heated above critical range, cooled in water or oil and reheated to 600° C. Ferrito-sorbitic or ferrito-sorbito-troostitic Structures.
14. Forged and finished at low temperatures.
15. Forged and finished at high temperatures.
16. Cold worked.

a complete transformation of the metal with final production of a ferrito-pearlitic structure. It will now be shown that through properly regulated cooling the transformation may be arrested at any desired stage in accordance with the physical properties wanted, which may vary from the hardness and brittleness of the quenched metal to the great softness and ductility resulting from very slow cooling. Between these two extreme types lies a great variety of combinations of hardness, strength, and ductility, each set corresponding to a well-defined treatment; hence the science and art of the heat treatment of steel, the importance of which steel-makers and users are only now beginning to fully appreciate.

In Fig. 1, Diagram II., the cooling has been so hastened that on reaching the bottom of the critical range the sorbite had been but partially converted into pearlite, the necessary time for its complete transformation having been denied. This quicker cooling has also prevented a full separation of the ferrite, as indicated in the diagram. The resulting structure may be described as ferrito-sorbito-pearlitic. Large pieces cooled in air often acquire it. Obviously, because of the properties of sorbite, steel in this condition is more tenacious, but less ductile, than the same metal in its ferrito-sorbitic state.

In Fig. 1, Diagram III., is represented the mechanism by which we can conceive the production of sorbite to the exclusion of pearlite, owing to relatively rapid cooling in passing through the critical stage. The steel is now ferrito-sorbitic, while the amount of ferrite it contains is but half the amount of that constituent present in the ferrito-pearlitic metal (Fig. 1, Diagram I.), the necessary time for its complete separation having been denied. In its ferrito-sorbitic condition the steel is decidedly more tenacious, but less ductile, than when ferrito-pearlitic. It is also harder, has a higher elastic limit, and is in a better condition to resist shocks and alternate stresses. A ferrito-sorbitic structure is readily produced in allowing small pieces to cool in air, or larger ones in oil. It may also be obtained by quenching the metal from above its critical range in water or oil, thereby securing a fine structure, followed by reheating to some 600° C. to cause the transformation into fine sorbite of any existing troostite or martensite.

In Fig. 1, Diagram IV., the cooling has been so rapid that, on emerging from its critical range, the metal is caught in a ferrito-troostito-sorbitic state, only a small amount of ferrite, moreover, being present. The metal is now harder and has lost much of its ductility because of the presence of troostite. This structure may be produced by quenching small pieces in oil, or larger ones in water, or by a suitable tempering of hardened pieces.

In Fig. 1, Diagram V., the steel has been cooled so quickly that some martensite, as well as troostite, remains undecomposed on reaching the bottom of the critical range, while but a very small amount of ferrite has had time to separate. In this ferrito-troostito-martensitic condition the metal is hard and deficient in ductility. A structure of this type may be produced by quenching small pieces in water.

The retention of martensite to the exclusion of troostite, and, *a fortiori*, the retention of austenite, is quite impossible in mild steel. While martensitic structures, moreover, are those needed in high-carbon steel for the production of cutting tools, for instance, they are never wanted in low-carbon steel, the structures depicted in Fig. 1, Diagrams I., II. and III., being the only ones of interest to the users of such steel.

Fig. 3 is a composite photo-micrograph showing the various types of structure mild steel may be made to acquire. The legend makes it self-explanatory.

## ALASKA RAILWAY SURVEYS.

Good progress is being made with the surveys for the Government railway in Alaska, and it is possible that a preliminary report on the undertaking will be ready for submission to President Wilson late in October or early in November. At the present time parties are working south from the Tanana River, while engineers are working north. Work is also in progress at Portage Bay and Seward and along the line to the head of Cooks' Inlet. The surveys are being made for a route from the coast through the Susnita Valley to the Tanana. This, in general, follows the line of the Alaska Northern Railway to Grand View, 45 miles from Seward, the coast terminal of the railway. Cross-sectioning was started two or three weeks ago on the new route surveyed from Grand View to Turnagan Arm. The coast terminals under consideration at present are Seward and Portage Bay.

# Editorial

## "Business as Usual"

### ABOUT A MORATORIUM.

In these strenuous days engineers in Canada are inquiring as to the meaning and scope of a moratorium. It is a temporary and emergency measure and provides for the postponement of the settlement of certain debts. Its duration and the debts to which it shall apply are specified by government proclamation. The time and scope of moratorium laws in various countries, since the declaration of war, have varied considerably. In England the moratorium first was declared for one month to September 4th. Then it was extended another month to October 4th, although of 8,000 replies received to an inquiry of Mr. Lloyd George, Chancellor of the Exchequer, 4,500 were against an extension. A moratorium has not been declared in Canada; but the necessary legislation has been provided for its declaration, if thought necessary. It should be made clear that a moratorium does not cancel, but merely postpones a debt. In England, the press is advising the people to pay their debts whenever possible. That is good advice.

### ENGINEERING ENGLISH.

Dr. Chas. H. Snow, Dean of the School of Applied Science of the University of New York, once said in an address to an assembly of young engineers: "The success of the engineer is influenced practically as much by a knowledge of English as by a knowledge of mathematics." Coming from one whose prominence in the advancement of engineering education has marked him as an authority, his audience had, therefore, no occasion to disbelieve.

It must be true that too many engineers do not know how to use good English. The appeal for a remedy comes, not from professional cranks always looking for the impossible and never satisfied with any attainable training, but from reasonable, practical men, at or near the head of their profession—men whose chief desire it is to try to better existing conditions. The appeal cannot, therefore, be disregarded by our engineering schools. It indicates that advancement is needed on their behalf in the interests of engineering education, that perfection has not been reached or the time at hand for a relaxation of united effort in this direction. The subject has been touched upon occasionally in these columns. The motive is by no means a reflection upon the present status of engineering, but it is an endeavor to emphasize that one of the sorest needs in our engineering schools to-day is the need for adequate instruction in English.

By "adequate" is meant sufficient attention being paid to it throughout the entire technical course (and carried even into the graduating thesis) until the student has become proficient in the subject. Every spoken and written report which he is called upon to make should receive proper consideration from the instructors as to its wording and its grammatical construction.

Let us place the facts clearly before our engineering schools and the students themselves. Among the most important deficiencies noted by practising engineers in the technical graduate is his inability to express himself correctly and forcibly in either writing or speaking. The English spoken by many graduates of technical institutions has occasionally been termed atrocious, their letters are awkward, misspelled, and ungrammatical, and their ability to write reports, specifications and contracts is deplorably lacking.

Who is to blame if all this is true? Who is responsible for the lack of good English among our engineers? Why is there a need for engineers to know good English? What is the remedy? These are questions that received some serious consideration at the meeting in Philadelphia some weeks ago of the Society for the Promotion of Engineering Education, an organization to which a great deal of the advancement of engineering education is due.

Three factors within the institutions of learning are concerned, viz.: the department of Engineering, the department of English, and the student. All three, individually and collectively, are to blame. The student, entering from the technical school, is not generally well-prepared, and his weakest subject is, invariably, English. Those technical schools which boast of courses of instruction in English confine it largely to the first year. To the student it appears of minor importance. He is seeking instruction in engineering and studies English as sparingly as possible. The result is that the subject is neglected, and when the stage is reached where it no longer forms a part of the curriculum, it is ignored outright.

The department of English recognizes this attitude of the student towards the subject and makes no attempt to alter it, for the instructor in English is, generally speaking, no more in sympathy with his engineering students than they are with his subject. He knows little or nothing of engineering and makes no attempt to acquaint himself with such a woefully practical study. Is it any wonder that this class of engineering students seek the merest margin of a past in his subject? Does he, with his disinclination to associate with such uncultured students, desire to restrain the delinquent ones for another term under his instruction?

The department of Engineering is disposed to nonchalantly observe that the student is extremely deficient in his English, and that it is regrettable since in the study of engineering there is no time for him to retrace his steps over past studies. Further, the department errs in not recognizing the value of English to the student and in not putting more of it into his work. More than this, the lack of co-operation with the department of English removes the last stepping stone toward retrievement.

It would appear, therefore, that upon the co-operation between the departments of Engineering and English, hinges a matter of gravest importance in the training of the engineering student. It is a mutual problem, and to turn out thoroughly efficient engineers it must be solved.

# SURGE TANK PROBLEMS—IV.

## BEGINNING A STUDY OF THE INFLUENCE OF A SPILLWAY BUILT IN THE SURGE TANK.

**By PROF. FRANZ PRASIL.**

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

PART 2.

*Special Case D—Involving Spillways.*

In order to decrease the surge in the surge tank, a spillway may be introduced in the surge tank or in the main conduit. The problem of interest, then, is to determine at what elevation and with what capacity such a spillway should be designed in order that the surge shall not exceed a certain elevation. The case will be investigated under the following assumptions: The spillway is

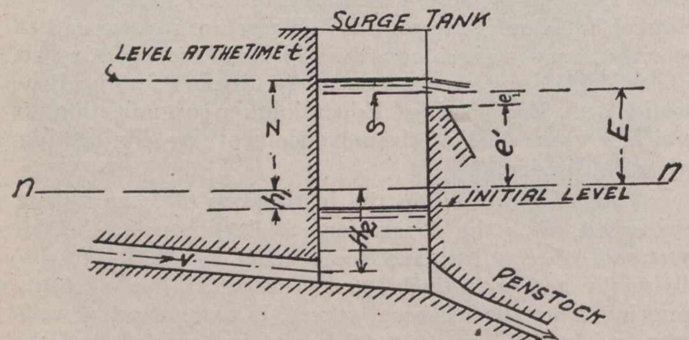



**Fig. 7.**

attached to the surge tank (Fig. 7). The crest of the spillway is at the distance $e'$ from the static level $n-n$; $e'$ is positive if the crest is above $n-n$ and negative if below. The width of the spillway is $b'$. The outflow of $Q$ cubic feet per second is suddenly interrupted.

We must take care of several periods of movement. Following a complete shut-down, the water surface in the surge tank will rise to the height of the spillway crest, as is described in case $(A)$.* Next, the rise will continue, but water will flow over the spillway up to a maximum elevation, then decrease to the elevation of the spillway crest. At this moment, the outflow ceases. The movement then takes the form of the case $(A)$, and retains this form thereafter, provided the crest of the spillway is not reached again. Otherwise, the same cycle is repeated or the condition remains one of constant overflow. Therefore, for the first phase the following equations are effective:

$$z = R.e^{-\frac{t}{2T_0}} \sin\left(\beta + \frac{t}{T_1}\right)$$

$$s = \frac{R}{T} e^{-\frac{t}{2T_0}} \sin\left(\gamma - \beta - \frac{t}{T_1}\right) \quad \text{with } tg\,\gamma = \frac{2T_0}{T_1}$$

The integration constants $R$ and $\beta$ are obtained for the conditions $t = o$, $z = -h_1$, $s = c_1$. The final value of $z$ is in this period of movement $e'$. From this we determine the time $t_e'$, which is necessary for the rise up to the level of the spillway crest and by means of the second equation we determine the final velocity $s_e'$. In the second period of movement now beginning, we have overflow on the spillway, that is, according to the familiar formula for spillways $q = \frac{2}{3}\mu b' h' \sqrt{2gh'}$ where $h' = z - e'$ represents the overflow height and we get

$$\frac{q}{A} = c = \frac{2}{3}\mu b' \frac{\sqrt{2g}\,h'^{3/2}}{A} \qquad (82)$$

The introduction of this formula and its derivation in the principal equation (23) would lead to a differential equation higher than the first degree, the integration of which might be accomplished by development in series. For practical purposes, however, an easier but sufficiently exact approximation may be obtained in the following manner:

If we plot the different values of $h'$ computed for the width $b'$ on a rectangular co-ordinate system, the values $h'$ as abscissæ, and the values of $q$ as ordinates (see Fig. 8), we obtain a parabolic curve, passing through the origin. The velocity $s_e'$ (which is the final value of the velocity of the surface at the end of the first period of movement) together with $A$ determines a quantity of water $s_e'.A$, which is certainly larger than the maximum value of the overflowing quantity during the second period. If we now draw tangents from the point of the quantity curve, which corresponds to $As_e'$ and assume as a preliminary approximation that within the heights of

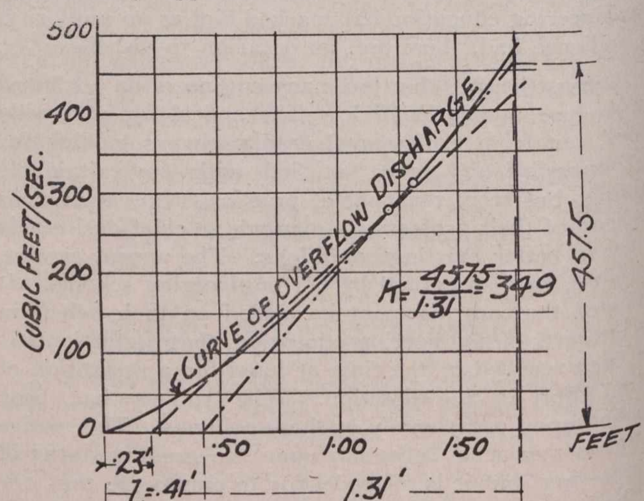



**Fig. 8.**

the overflow, which corresponds to the intersection of the tangent with the axis of the abscissæ, the overflowing quantity equals zero, which is the same as if we move the elevation of the spillway crest higher up by the same amount, and if we take from this location the water quantity proportional to the height of this new elevation of the spillway crest corresponding to the tangent, then

*See *The Canadian Engineer* for Aug 20, pp. 327-9 and Aug. 27, pp. 368-70.

we get a linear equation for the determination of the water quantity, whereas the differential equation for the determination of the elevations also becomes linear.

The results thus obtained from these equations are naturally only approximate ones, as the overflowing quantities are introduced as too small. The computed values of $z$ exceed the actual values. For practical purposes, this first approximation is generally sufficient, but we have no difficulties using the results of the first approximation for a second computation, drawing the tangent on that point of the overflow curve which corresponds to the maximum value of the elevation found in the first computation and repeating with these results the computation as before. We may use this second approximation in the first computation if instead of the value for the point in the curve, we take a somewhat smaller value, say, $u A s_e'$, when $u = 0.7$ to $0.8$. We use the latter method in the following:

The overflow height, which gives an overflow of $u . A . s_e'$, is determined by

$$h_u = \left(\frac{3}{2}\,\frac{u}{\mu} \cdot \frac{s_e' A}{b' \sqrt{2g}}\right)^{2/3}$$

The proportional factor $k$ for the linear variation of $q$ is obtained by differentiation of $q$ with respect to $k$. Therefore:

$$k = \frac{dq}{dh'} = (\text{as } h' = h_u) = \mu b' \sqrt{2g\, h_u} = \sqrt[3]{3/2\, \mu^2\, b'^2\, 2g\, u\, s_e' A}$$

$k$ has the dimension $l^2 . t^{-1}$, and the value of the abscissa $e_1$, which is the difference between the true elevation of the spillway crest and that obtained by approximation, is

$$e_1 = h_u - \frac{u . s_e' . A}{k} \qquad e_1 = \sqrt[3]{\frac{19}{12}}\left(\frac{u\, s_e'\, A}{\mu\, b' \sqrt{2g}}\right)^{2/3} \qquad (84)$$

The values are easiest obtained graphically from the curve of the overflow quantities.

Therefore, with $e_1$ the height of the ideal spillway crest above the static level $n — n$, (that is $E = e' + e_1$) once determined, the computation of the first period of movement must be extended to the elevation $E$.

We obtain from the previously mentioned formulæ $z_e = E$ and $s_e$. These are initial values for the second phase, from which beginning we measure the time anew.

$$c = \frac{q}{A} = \frac{k}{A}(z - E) \qquad \text{and therefore } \frac{dc}{dt} = \frac{k}{A}\,\frac{dz}{dt}$$

and the equation 23 becomes

$$\frac{d^2z}{dt^2} + \left(\frac{1}{T_0} + \frac{k}{A}\right)\frac{dz}{dt} + \left(\frac{1}{T^2} + \frac{k}{A\,T_0}\right) z - E . \frac{k}{A . T_0} = 0$$

Introducing $y = z + m = z - \dfrac{E}{\dfrac{A\,T_0}{k\,T^2} + 1}$ and abbreviating

$\dfrac{1}{T_0} + \dfrac{k}{A} = \dfrac{1}{T_0'}$; $\dfrac{1}{T^2} + \dfrac{k}{A\,T_0} = \dfrac{1}{(T')^2}$ we get

$$\frac{d^2y}{dt^2} + \frac{1}{T_0'}\,\frac{dy}{dt} + \frac{y}{(T')^2} = 0 \qquad (85)$$

Corresponding to the investigations regarding the form of the general integral of this differential equation, we must investigate whether the difference

$\dfrac{1}{(T_1')^2} = \dfrac{1}{(T')^2} - \dfrac{1}{(2\,T_0')^2}$ is positive or zero, or negative, which we obtain by substituting the values of $\dfrac{1}{T_0'}$ and $\dfrac{1}{(T')^2}$

$$\frac{1}{(T_1')^2} = \frac{1}{T_1^2} + \frac{k}{2A}\left(\frac{1}{T_0} - \frac{k}{2A}\right)$$

by which formula the investigation mentioned may be carried out and the corresponding form of the general integral may be used.

The integration constants must be determined with the initial values

$$t = 0; \quad z_0 = E; \quad s_0 = s_e$$

The duration of the second period of movement is obtained from the equation for $z$, which is given by that value of $t$ for which $z$ becomes $E$ once more. If that does not occur in a case of non-periodic movement, for instance, if the spillway crest lies below the level $n — n$, then the duration of the second period of movement is only limited by a new occurrence of any kind of outflow. Otherwise, the final values of the second period are the initial values of a following period, which must be handled the same as the first case. (Case $A$.)

The method of computation may be shown best by an example. Using the former example, we consider a spillway of 65.7 feet width, the crest of which is at the static level $n — n$. That is, for this assumption $e' =$ zero. The flow of 530 cubic feet per second is suddenly stopped.

From the results of case ($A$) we get

$$z_e' = 0; \qquad t_e' = 106 \text{ sec.}; \qquad s_e' = +\ .075 \text{ feet/sec.}$$

The velocity $s_e'$ corresponds to the flow in the surge tank at the time $t_e'$ of $q_e' = .075 \cdot 5380 = 404 \dfrac{\text{cu.ft.}}{\text{sec.}}$. For a spillway width of 65.7 feet and for $\mu = 0.6$, we get from the spillway formula $q \dfrac{\text{cu. ft.}}{\text{sec.}} = 208\, h' \sqrt{h'}$ and therefore for

$$u . q_e' = 282 \frac{\text{cu. ft.}}{\text{sec.}} \qquad (u = .7)$$

an overfall height of $h' = 1.22$ feet and a proportional factor $k = 3/2 . 208 . h_u^{1/2} = 345 \dfrac{\text{sq. ft.}}{\text{sec.}}$ and therefore as the distance of the ideal spillway crest from the static level $n — n$ because $e' =$ zero; $E = .410$ and with the results of case a for $z = E$

$$s_e = +\ .073 \text{ feet per second}$$

In order to determine which integral formula to use, we have

$$\frac{1}{(T_1')^2} = \frac{1}{T_1^2} + \frac{k}{2A}\left(\frac{1}{T_0} - \frac{k}{2A}\right) = -\frac{1}{34.6^2}$$

(therefore $\frac{1}{T_2^2} = -\frac{1}{(T^1)^2} = \frac{1}{(2\,T_0^1)^2} - \frac{1}{(T^1)^2}$ is positive)

which shows that we should use the third form of the general integral which is

$$y = \left(R_1 e^{+\frac{t}{T_2}} + R_2 e^{-\frac{t}{T_2}}\right) e^{-\frac{t}{2\,T_0^1}}$$

Further, $m = \dfrac{-E}{\dfrac{A\,T_0}{k\,T^2} + 1} = -.354$ feet

$T_0^1 = 14.3$ sec. $T^1 = 51$ sec. $T_2 = 34.6$ sec., so that

$$z = +.354 + \left[R_1 e^{+\frac{t}{34.6}} + R_2 e^{-\frac{t}{34.6}}\right] e^{-\frac{t}{28.6}}$$

$$= +.354 + R_1 e^{-\frac{t}{165}} + R_2 e^{-\frac{t}{15.65}}$$

$$s = \frac{dz}{dt} = -\frac{R_1}{165} e^{-\frac{t}{165}} - \frac{R_2}{15.65} e^{-\frac{t}{15.65}}$$ and for $t = o$

$+.410 = +.354 + R_1 + R_2$; $.073 = -\frac{R_1}{165} - \frac{R_2}{15.65}$;

therefore, $R_1 = 1.33$ feet and $R_2 = -1.27$ feet

$$z = +.354 + 1.33\,e^{-\frac{t}{165}} - 1.27\,e^{-\frac{t}{15.65}}$$

$s = -.00805\,e^{-\frac{t}{165}} + .0810\,e^{-\frac{t}{15.65}}$ which values give the following table:

| | | | | | |
|---|---|---|---|---|---|
| Seconds | $t = o$ | 50 | 100 | 150 | 200 |
| feet | $z = +.41$ | $+1.282$ | $+1.079$ | $+.881$ | $+.746$ |
| feet per sec. | $s = +.073$ | $-.00261$ | $-.0044$ | $-.0032$ | $-.0024$ |

The time of the highest elevation is determined with $s = o$ from equation $o = -.00805\,e^{-\frac{t_1}{165}} + .0810\,e^{-\frac{t_1}{15.65}}$ to $t_1 = 40$ seconds and $z$ max. follows:

$$z\ \text{max} = +.354 + 1.33\,e^{-\frac{40}{165}} - 1.27\,e^{-\frac{40}{15.65}} = 1.30\ \text{ft.}$$

This water level corresponds to an overflow quantity of 300 cubic feet per second. For the determination of the ideal overflow height and the factor of proportionality, we used the maximum overflow quantity of 282 cubic feet per second. It is therefore shown that the assumption made that $u = 0.7$ is correct. The duration of the overflow period follows from

$$.41 = +.354 + 1.33\,e^{-\frac{t}{165}} - 1.27\,e^{-\frac{t}{15.65}}$$

and is $t_x = 520$ seconds.

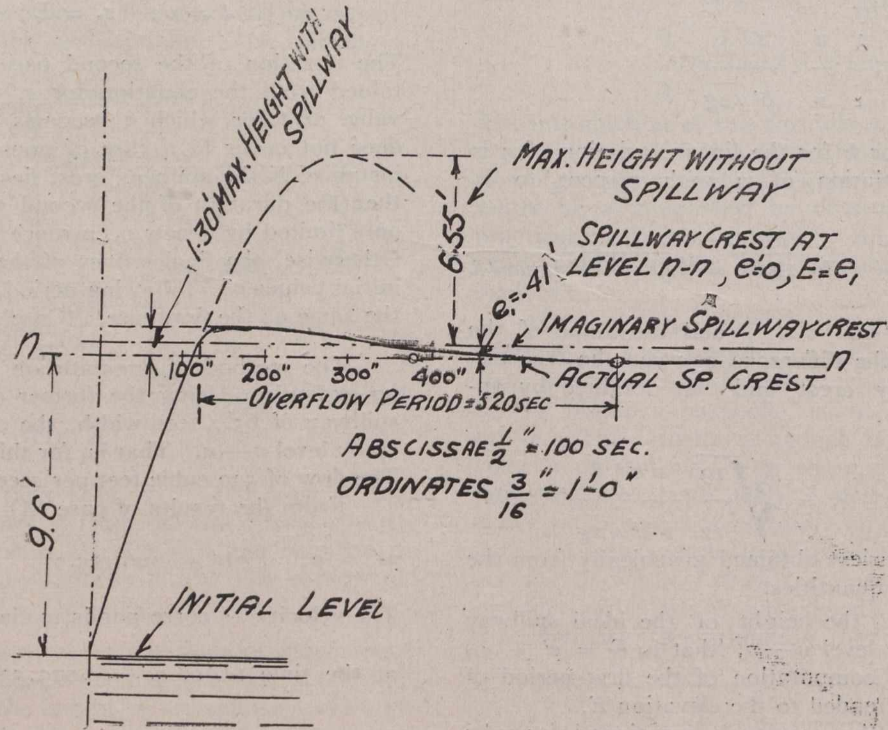



Fig. 9.

And therefore the velocity $s_x$ with which the water level reaches the ideal overflow elevation is:

$$s_x = -.00805\, e^{-\frac{520}{165}} + .0810\, e^{-\frac{520}{15.65}} = -.000346 \frac{\text{feet}}{\text{sec.}}$$

With these initial values the movement in the third period may be determined. Because we assumed that the spillway crest is at the elevation of the static level $n-n$, the overflow period goes further but with smaller fluctuations of water level and overflow quantities.

If the spillway is built not in the surge tank, but in the main conduit, the principal equation requires a supplement. According to Fig. 10, a shaft at the distance $L'$ from the beginning of the conduit is driven down to the conduit with a section $A'$, through which water from the conduit goes over a spillway whose ideal overflow crest is as before the distance $E$ from the static level $n-n$. At the distance $L''$ is the surge tank with the section $A''$. In the hydraulic equilibrium with $Q_1$ cubic feet per second discharge through the penstocks, the water surface in the overflow shaft will be below the static level $n-n$ by the distance $h_1' = n'.v_1$; in the surge tank by $h_1''$ $(n' + n'')\, v_1$. $v_1$ is the velocity in the conduit of the area $a$ which corresponds to the discharge $Q_1$. $n'$ and $n''$ are the function coefficients corresponding to the distances $L'$ and $L''$. For flow fluctuations the distance $z_1$ and $z_2$ from the static level $n-n$ at the velocities $v_1'$ and $v_1''$ and the water surfaces in shaft and surge tank will have different levels and there will be overflow in the shaft as soon as the water surface reaches the spillway crest. It is sufficient to carry through the solution of the principal equation for the latter period and to handle the first period as a special case of it.

For the purpose of simplifying the work, we consider only the case of sudden total shut-down. For both parts of the conduit, we get the following movement equations:

$$\frac{L'\, dv_1'}{g\, dt} + z_1 + n'.v_1' = o$$

$$\frac{L''\, .dv_1''}{g.dt} + (z_2 - z_1) + n''\, v_1'' = o \qquad - \quad (86)$$

The equations which express continuity follow from the consideration that from the upper conduit in a unit of time $dt$, a quantity of water must flow into the shaft which is equal to the algebraic sum of—

1st—the quantity which flows away in the lower conduit, which is equal to $a.v_1''.dt$.

2nd—the simultaneous filling of the shaft with the quantity $A'.v_1'.dt$.

3rd—the simultaneous overflow quantity $k\,(z_1 - E)\, dt$. But the water quantity which flows through the lower conduit in the time $dt$ is also equal to the simultaneous filling $A''\, v_1''$ dt in the surge tank. The following two equations express, therefore, the continuity

$$a.v_1' = a.v_1'' + A'\, s_1 + k\,(z_1 - E)$$

and

$$a v_1'' = A'' s_2 \qquad - \quad - \quad - \quad - \quad (87)$$

The motion equations and the second equation for continuity reach their values before as well as after the overflow on the spillway. The second equation for continuity is correct for $k = o$, for periods without any overflow. If we consider that $s_1 = \frac{dz_1}{dt}$ and $s_2 = \frac{dz_2}{dt}$ we may, with the aid of the continuity equations, eliminate the velocities $v_1'$, $v_1''$ and their derivations. We get then two simultaneous differential equations of the second order, from which we eliminate again $z_1$ and its derivations, whereas for the determination of $z_2$ we get a linear differential equation of the fourth degree with constant coefficients, the integration of which does not involve any great difficulty.

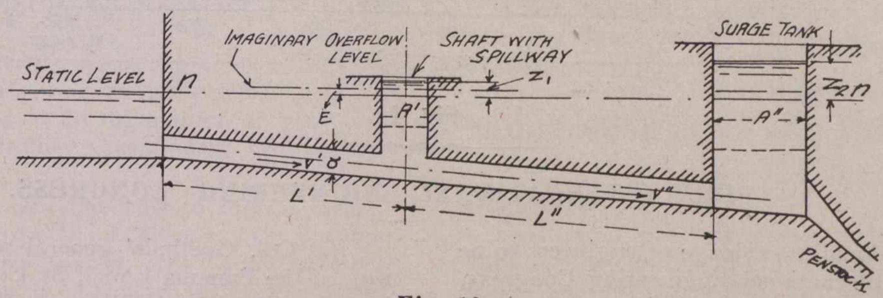



**Fig. 10.**

In order to make the spillway especially efficient, we manage it so that the spillway crest lies below the static level $n-n$, and this in a distance which is equal to or a little less than $h_1' = n'.v_1$. In this case, after the shut-down is finished, a very rapid overflow will occur in the spillway and will continue, and finally there exists a constant flow over the spillway, whereby naturally as much flows through the upper conduit as goes away over the spillway and where the water level in the shaft, as well as in the surge tank lies at a distance under $n-n$, which corresponds to the hydraulic slope necessary for the flow through the upper conduit.

If in this case $A'$ and the spillway widths are small enough with reference to the hydraulic slope, to keep the preceding fluctuations so near the static level of the water surface in the shaft, that the variation of the inflow to the shaft may be neglected, the problem becomes simplified, because the first motion equation drops out and in the first equation for continuity, the values $a.v_1'$ become constant and equal to $q$.

Considering that $s_1 = \frac{dz_1}{dt}$ and $s_2 = \frac{dz_2}{dt}$, we get from the first equation of continuity (87)

$$A'' \cdot \frac{dz_2}{dt} + A' \frac{dz_1}{dt} + k\,(z_1 + E) = q. \qquad (88)$$

and the second motion equation becomes zero.

$$\frac{L''}{g} A'' \frac{d^2 z_2}{dt^2} + r_2 A'' \frac{dz_2}{dt} + a\,(z_2 - z_1) = o \qquad (89)$$

From this last equation, $z_1$ and its derivative may be determined and substituted in equation 30c. For the solution of $z_2$ we get a linear differential equation of the third degree which may readily be integrated. The results of such an investigation are apparent in Fig. 11; we see that at the time of the highest water elevation in the surge tank the height of water flowing over the spillway is directly proportional to the height of the water in the surge tank above the static level, but the quantity of water is greater during the time the level in the surge tank is falling and continues until the level in the surge tank has reached its lowest elevation. The extent of the fluctuations is not only dependent upon the conduit, surge tank and spillway dimensions, but, naturally, also depends upon the area $A'$. The complete computation of the case would exceed the space available here.

(To be continued.)

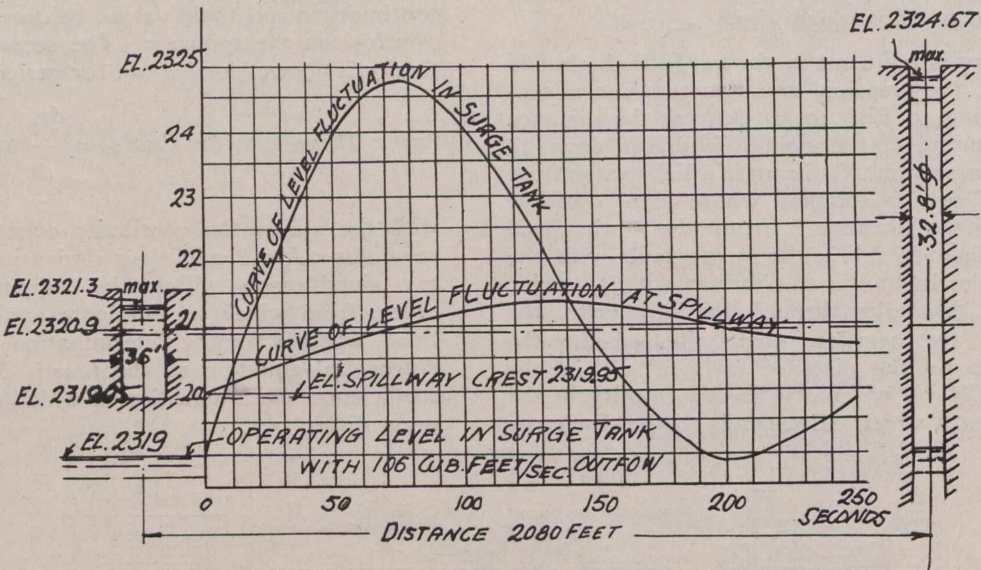



**Fig. 11.**

## FIRST INTERNATIONAL ENGINEERING CONGRESS.

The first international assemblage of engineers to be known as the International Engineering Congress, and to be held at the Panama-Pacific International Exposition, San Francisco, from September 20-25, 1915, will be presided over by Col. George W. Goethals, who has accepted the office of honorary president. The sessions will be held in the new $1,000,000 auditorium now being constructed in the civic centre of San Francisco, the main hall of which has a seating capacity of 10,000. Section meetings will be held in the eleven minor halls in the great convention building.

The International Engineering Congress is to be conducted under the auspices of five national associations, viz.: the American Society of Civil Engineers, the American Institute of Mining Engineers, and the Society of Naval Architects and Marine Engineers, assisted by a committee of eighteen of the foremost engineers of California.

The vast scope of the congress is indicated by the fact that it will be divided into eleven groups of sub-congresses, the reports of which it is calculated will fill eleven large volumes. Chief among these branches will be that dealing exhaustively with the problems worked out in the construction of the Panama Canal, and the influence of the canal on world commerce, commercial trade routes and general transportation problems. Colonel Goethals will have charge of the presentation of all canal topics, and his papers and discussion will carry with them the authority and value of official reports. Aside from general engineering topics, the section devoted to the canal will be treated under 22 heads, as follows:

(1) Col. Goethals' general report; (2) Dry Excavation of the Panama Canal, by Col. Goethals; (3) Dredging the Canal; (4) Terminal Works, Dry Docks and Wharves of the Canal; (5) Meteorology and Hydrology of the Zone; (8) Designs of Locks, Dams and Regulating Works; (9) Methods of Construction of Same on the Atlantic Side; (10) Same on the Pacific Side; (11) Designs of Locks, Walls and Valves; (12) Spillways; (13) Gates of the Canal; (14) Electrical and Mechanical Installation; (15) Emergency Dams Above Locks; (16) Municipal Engineering and Domestic Water Supply in the Zone; (17) Reconstruction of the Panama Railroad; (18) Aids to Navigation of the Canal; (19) Geology of the Canal Zone; (20) The Working Force of the Canal; (21) Sanitation in the Zone; (22) Purchase of Supplies for the Canal.

Following Colonel Goethals' personal reports, each of these topics will be treated by the heads of departments or other attachés who were responsible for that part of the canal construction. These addresses and papers will constitute practically the official technical record of that great engineering feat. It will be published, forming the only printed record of its kind, and for this compilation, interesting to the layman no less than to engineers, credit is due to the exposition congress. Programmes for the other ten sections of the congress are in course of preparation.

Subscriptions are being received daily by local organizations which will act as hosts for this great body, a large proportion of these being from foreign bodies and foreign engineers. The most noted experts of the world in all departments of engineering work are availing themselves of this opportunity to pass through the canal en route.

## PERSONAL.

C. J. GIBSON has received the appointment of town engineer of Bowmanville, Ont.

D. F. McLEOD, former city engineer of New Glasgow, N.S., has become city manager of Lakefield, Fla.

R. C. HARRIS has received the appointment of resident engineer for the Alberta Division of the C.P.R., with office at Calgary.

R. L. HAYCOCK is in temporary charge of the Civic Waterworks and Sewerage Department at Ottawa, in succession to A. N. Beer.

J. D. EVANS, recently chief engineer of the Central Ontario Railway, has been appointed division engineer of the Ottawa Division of the C.N.R.

T. J. BROWN has been appointed a resident engineer and bridge and building master for the C.P.R. company, his office centre to be Cranbrook, Alta.

T. S. LOWE, road foreman of engines for the C.N.R. at Limoilou, Que., has been promoted to master mechanic of the Lake St. John Division, with office at Limoilou.

T. C. HUDSON, formerly master mechanic of the C.N.R. Company at Joliette, Que., has been appointed division master mechanic of the Quebec Grand Division of that system, with office at Joliette.

R. L. DOBBIN, formerly resident engineer on the Moose Jaw water supply scheme during the construction period of 2 years, has been selected to fill the position of waterworks superintendent for the Utilities Commission, Peterborough, Ont.

ARTHUR J. HILLS was appointed in August, general superintendent of the Ontario Grand Division of the Canadian Northern Ontario Railway system, with headquarters at Toronto. Mr. Hills is now in charge of operation, maintenance of way and motive power. He was a graduate of the University of Toronto in 1899.

R. W. McCONNELL, for many years a member of the geological survey staff of the Dominion Government, has been appointed to succeed R. W. Brock, recently resigned, in the office of Director of the geological Survey and Deputy Minister of Mines. Since the resignation of Mr. Brock, Mr. McConnell has been occupying the position of Acting Deputy Minister of Mines.

GEORGE COLLINS, from 1906 general manager and secretary of the Central Ontario Railway, and also from 1903 a director of the same road, has been appointed recently superintendent of the Ottawa division of the Canadian Northern Railway, with headquarters at Trenton, Ont. The former system was taken over this year by the C.N.R., and from 1882 up to that time, Mr. Collins has risen in continuous service with the Central Ontario system.

WILLIAM C. TOMKINS, who received in August the appointment of assistant to the vice-president of the Grand Trunk and Grand Trunk Pacific Railway companies, and who succeeded in that office Martin M. Reynolds, deceased in June, 1914, has been connected with the staff of the G.T.R. system since 1885. Following upon his first position as auditor of pay-rolls came the office of general manager. The next promotion was to the immediate staff of the president, where he became in 1908 secretary to the late Mr. Reynolds, vice-president in charge of finance and accounting. Mr. Tomkins received his recent appointment on August 1, 1914.

B. B. KELLIHER has resigned from his position as chief engineer of the G.T.P. Railway system, due to ill-health. For 30 years Mr. Kelliher has been engaged in railway construction, and has achieved the rank of one of the foremost mountain engineers of his generation; for the last 10 years, he has been actively engaged upon the construction of the G.T.P. railroad; and for 9 years of this latter period, he has been engineer in charge of this great engineering scheme. Mr. Kelliher was a native of Ireland and a student of Dublin University. After serving as an apprentice to a civil engineer in Dublin and being engaged on the surveys for the Mitchellstown and Fermoy and the Galway and Clifton roads, he went to the United States. From 1886 to 1890 he was employed with the Union Pacific Railway; and from 1890 to 1896, was assistant engineer of the Northern Pacific Road on the Cascade and Pacific Divisions. After further experience as division engineer of the Oregon Short Line, he was chosen for the difficult task of locating a line through the mountains of Colorado from Denver to Salt Lake City for the Denver, Northwestern and Pacific Railway, and joined the Grand Trunk Pacific staff on the completion of this work as division engineer at Winnipeg.

## OBITUARY.

Mr. John Middleton, a member of a C.N.R. survey party, met death near Lytton, B.C., where he was killed by falling a distance of 70 feet from a ledge of rock.

The death occurred recently of Murdock Lloyd of Toronto, a mining engineer employed at the Tough Oaks Mines, Swastika, Ont. Mr. Lloyd was fatally injured in a boiler explosion.

## McGILL GRADUATES AND THE WAR SITUATION.

The following letter has been sent to every McGill graduate:—

At a time like the present, when the destiny of the Empire is at stake, McGill University and its graduates should come forward and do everything in their power to help the common cause. The individual graduate probably does not fully realize the influence the graduates as a whole have in Canadian affairs. Over 5,000 educated men, holding important positions all over the Dominion and elsewhere, are a tremendous power and influence, particularly if their efforts are concentrated on certain fixed objects.

It was felt by the Executive of the Graduates' Society and by the Committee in charge of the Reunion, which it had been proposed to hold in the fall of 1915, that in the present crisis in the Empire something should be done; and it was decided to write a letter to every graduate, asking him to use all his influence towards patriotic ends.

In order to make our influence felt in a definite way it was thought that a fund should be started to which EVERY graduate of the university would contribute. The contribution of each individual would be for the nominal amount of one dollar, which would represent his patriotic vote and the signification of his intention to do everything possible to assist Canada in the responsibility and duty created by the war.

The vote of the McGill graduates will be deposited in cash form to the credit of the Canadian National Patriotic Fund.

You are, therefore, invited to send your cheque, or to enclose one dollar in some other form, to the Treasurer of the fund, Geo. C. McDonald, 179 St. James Street, Montreal.

An immediate response is necessary if this action is to have all the effect that is hoped for from it.

For the Executive,
JOHN L. TODD, President.
WILLIAM STEWART, Secretary.

## NEW ENGLAND WATERWORKS CONVENTION PROGRAM.

Of particular interest on the program which has been arranged for the thirty-third annual convention of the New England Waterworks Association, to be held at Boston, Mass., from September 15th to September 18th, will be the report by Chairman George C. Whipple, of the committee on statistics of filter operation. This will be the first of its kind in the history of waterworks conventions in America. Other papers of interest will be those read by Frank A. McInnes and Clarence Goldsmith, of Boston, on lessons to be learned from the great Salem fire.

At the "superintendents' sessions" there will be papers by many eminent men of foremost authority on the operation of waterworks plants; while additional committee reports will be given by Frank A. McInnes on "Standard Specifications for Cast-Iron Pipe," by Allen Hazen on "Meter Rates," and by Frederic P. Stearns on "Low Water Yields."

## SECOND INTERNATIONAL CONGRESS OF MUNICIPAL EXECUTIVES, 1915.

At the First International Congress of Municipal Executives, London, Eng., it was resolved to grant the request of the American Commission of Municipal Executives, assembled by the Southern Commercial Congress, that the second assemblage of the Congress be held under the auspices of the commission at Washington, D.C., in September, 1915. Senator Duncan U. Fletcher of Florida, president of the Southern Commercial Congress, and chairman Clarence J. Owens of Maryland, managing director of the Southern Commercial Congress and director-general of the American Commission, will have charge of this second international congress, and have already commenced the arrangement of plans to make it the greatest convention of civic leaders municipal officials ever held.

## JOINT CONVENTION.

A joint convention is to be held by the American Road Builders' Association and the American Highway Association in 1915, either at San Francisco or at Oakland, Cal., during the Panama-Pacific Exposition, the exact date not yet being determined.

## RECENT ELECTION MADE BY THE INTERNATIONAL ASSOCIATION OF TESTING MATERIALS.

The council of the International Association of Testing Materials has elected as members of Commission No. 58 on "Standardization of Methods of Testing and Nomenclature of Road and Paving Materials," Prevost Hubbard, Assoc. Am. Soc. C.E., in charge of the division of roads and pavements for the Institute of Industrial Research, Washington, and lecturer in highway engineering chemistry at Columbia University, New York; and Arthur H. Blanchard, M. Am. Soc. C.E., consulting highway engineer, and professor in charge of the graduate course in highway engineering at Columbia University.

At the recent convention of the Canadian Union of Municipalities, which was held at Sherbrooke, Que., a resolution was unanimously adopted to the effect that Victoria, B.C., should be the centre at which the 1915 assembly of the union should convene.

## INTERNATIONAL IRRIGATION CONGRESS.

The Twenty-first International Irrigation Congress will be held at Calgary, Alta., October 5th to 9th, 1914.

## COMING MEETINGS.

NEW ENGLAND WATERWORKS ASSOCIATION.—Secretary, Willard Kent, Narragansett Pier, R.I. Annual convention to be held at Boston, Mass., September 15th to 18th.

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

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

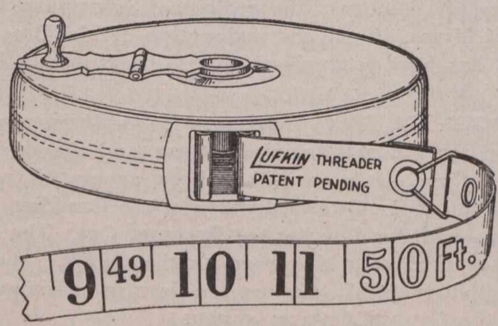
AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—Charles Carroll Brown, Secretary, Indianapolis, Ind. Meets at Somerset Hotel, Boston, Mass., October 21st, 22nd and 23rd.

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

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

## METALLIC TAPE "THREADER."

The Lufkin Rule Co. of Canada, Limited, Windsor, Ontario, has just put out a patented measuring tape attachment known as a Threader. It is a loop and stud arrangement, by means of which the tape, though securely fastened to the winding drum of the case when in use, can yet be readily detached from it and a new tape as readily attached, no manipulation of the case, case screw or drum being required to do this. Woven tapes are sometimes torn by accident or through long use often become soiled and worn in such a




way that they must be replaced while the case is yet in very fair condition. The case not receiving the same hard use as the tape line usually outwears it, and representing approximately half the value of the outfit it is of considerable importance that it be a simple matter for anyone to insert a new tape in the old case as often as necessary and thus get the fullest measure of use out of the case as well as the tape. Metallic tapes without cases are quite generally stocked by hardware houses, etc., and can always be easily obtained. The attaching is perfectly and easily accomplished by means of the Threader, which will hereafter be furnished with the company's metallic woven tapes without extra charge.