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NEW GOVERNMENT DRY DOCK AT LAUZON, QUE.

DETAILS OF DESIGN, INCLUDING CAISSON STOPS, APPROACH, AND PUMPING EQUIPMENT, NOW UNDER CONSTRUCTION FOR THE DEPARTMENT OF PUBLIC WORKS.

THE new dry dock which the Department of Public Works of the Dominion Government has under construction at the village of Lauzon, two miles east of Levis, on the St. Lawrence River, opposite Quebec, will possess many features that will place it among the foremost of such structures. The proposed dry dock is to supplant one already in service at this point. The relative locations of the old and contemplated structures may be noted in Fig. 1, which shows also the general layout of the later development, including the approach slip to be built in conjunction with it.

The work has been under way since last season. The contract for the construction of the dock was let in July,

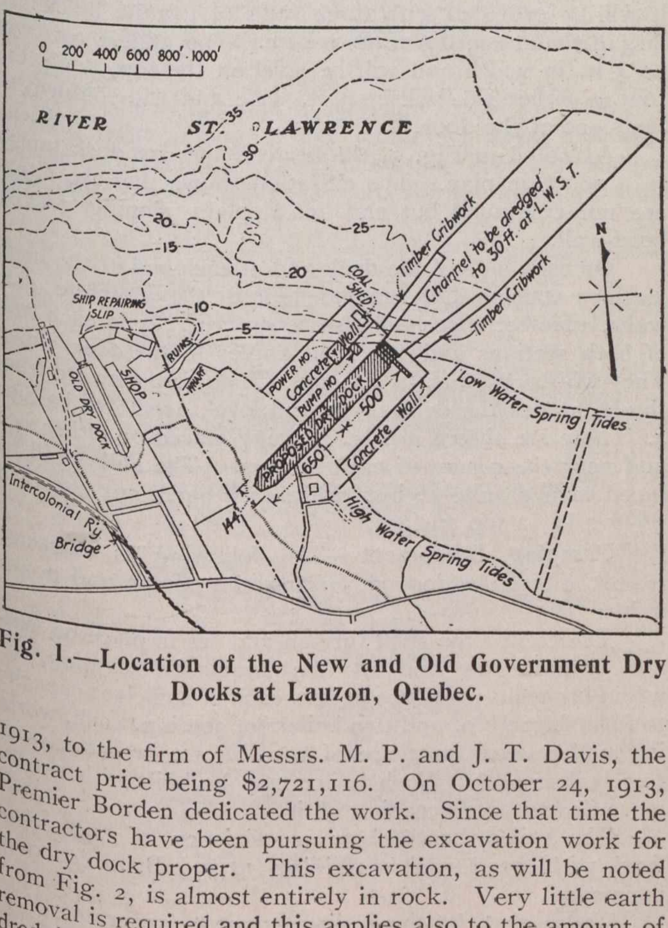


Fig. 1.—Location of the New and Old Government Dry Docks at Lauzon, Quebec.

1913, to the firm of Messrs. M. P. and J. T. Davis, the contract price being $2,721,116. On October 24, 1913, Premier Borden dedicated the work. Since that time the contractors have been pursuing the excavation work for the dry dock proper. This excavation, as will be noted from Fig. 2, is almost entirely in rock. Very little earth removal is required and this applies also to the amount of dredging necessary.

The dock will be 1,150 ft. in length from headwall to caisson stop. The width of the entrance is to be 120 ft., while the depth on the sill at ordinary high-water spring tide will be 40 ft. The dock will be divided into two parts, as shown in Fig. 3, general plan, the object of which is to be able to use the mid-caisson stop for smaller vessels. A steel rolling caisson, details of which are shown in Fig. 5, will be used to close the outer entrance, while a steel floating caisson, plan and sections of which are shown in Fig. 6, will be used to close the inner entrance, or, in cases of emergency, the outer entrance also.

Fig. 1 also shows the approach channel which is to be dredged to a depth of 30 ft. and to be guarded at the entrance to the dock by concrete walls supported by timber cribs. Between these guide piers and the rolling caisson a sill for the floating caisson is provided. It will be located 20 ft. from the face of the former and will enable it to be unwatered when repairs are necessary.

As shown in Fig. 3, the dry dock will be 144 ft. wide at the top of the coping and 120 ft. in width at the caisson seats. The width will be 120 ft. at the bottom. The depth is approximately 40 ft. below high-water at ordinary spring tide, the fluctuation being 18 ft. between tide levels. The cross-section shows the two solid concrete

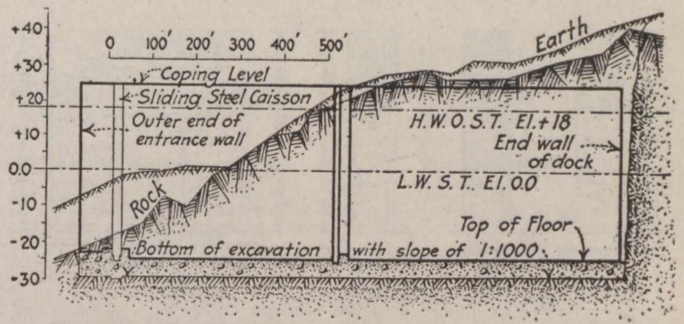


Fig. 2.—Profile Showing Excavation Necessary.

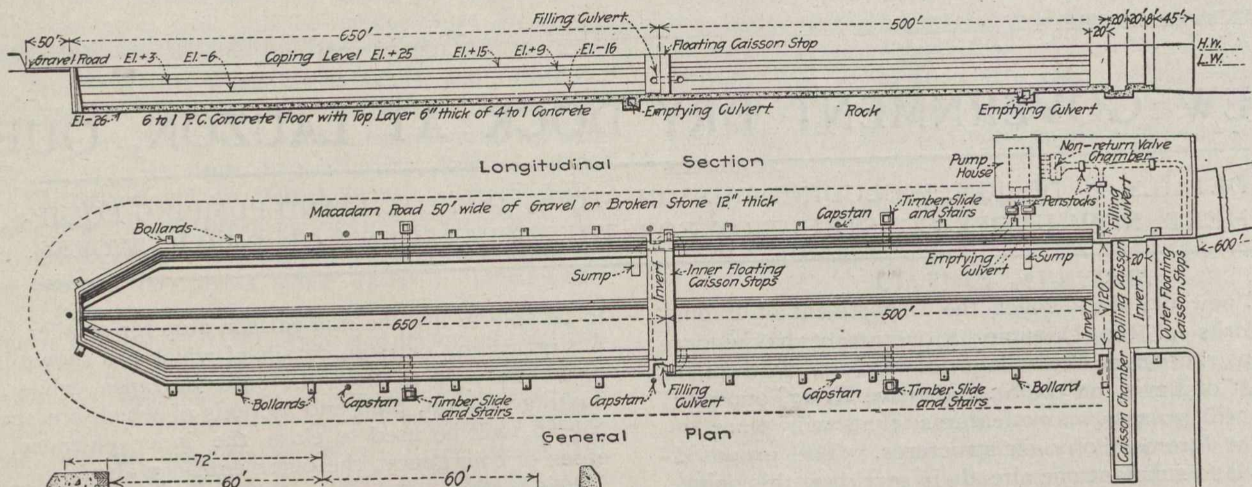
side walls integrally connected to the floor, which is also of concrete. The footings are on solid rock.

The excavation is being carried to a depth of 28½ ft. below the level of low-water spring tide, which is used as the datum line. This is the depth required at the inner end of the dock, the depth of rock varying, as shown in Fig. 1. The bottom of the excavation will have a slope of 1:1,000. It will be 122 ft. in width, sloping up to ground level on a 1:2½ batter. The slope of 1:1,000 mentioned above brings the forward end of the cutting approximately 29½ ft. below datum.

The solid concrete side walls of the dry dock are to be of gravity type in places where they have to support earth fill, such as at the entrance, where the rock bottom recedes considerably, otherwise, the concrete walls will line the rock face of the excavation, retaining on their inner face the same profile as the gravity walls. Where stepped, they will have an average wall thickness of about

5 ft. of concrete. Whenever the gravity walls are built higher than the natural surface of rock they will have a 6-foot thickness of backfill of puddled clay, behind which ordinary earth filling will be used. The coping at the top of the wall and on the altar levels will be of cut granite, in blocks 12 ins. thick and 3 ft. in width in the latter instance and in the form of granite slabs in the former.

The side walls are to be built in 30-ft. sections separated by a ¼-in. expansion joint. Each section will be finished with a V-joint 1 in. in depth. The flooring of the dock will be 5 ft. in thickness, the elevation at the centre being 6 ins. higher than at the sides and the slope toward the outer entrance of the dock being 1 ft. in 1,000. The sides will be drained by two 6x12-in. gutters. Underdrains, beneath the floor and behind the side walls will remove any seepage water. The floor will be built of plain concrete in sections similar to the walls, the interstices to be grouted on completion. One feature of the floor formation that deserves special mention is that it will be provided with three rows of granite blocks 18 ins. in thickness, down the centre. The middle row will be 4 ft. in width and will be level on the top, while the row on either side will be 3 ft. wide and will conform to the slope of the floor.



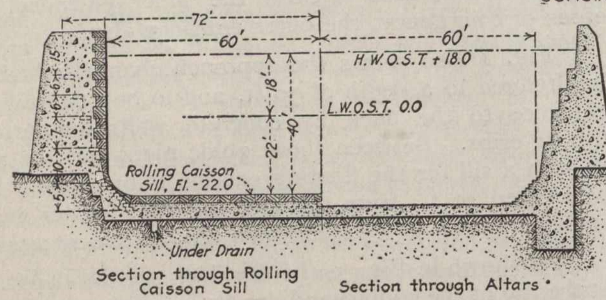


Fig. 3.—General Plan, Longitudinal and Horizontal Sections of Dry Dock.

As noted in Fig. 3, the head of the dry dock tapers to a point, in plan. The elevation shows that the altars are not continued but end in a plain sloping gravity head-wall.

On each side of the dock and at each end of the main sections stairs will be moulded into the concrete side walls. Timber slides will also be set centrally in each wall of both sections and at right angles to the dock walls. They will be 8x12 ft. in size and will slope backward from the bottom of the dock to ground level, as shown in Fig. 4. These are shown in Fig. 3, being placed on either side and near the centre of each section. The slides will be faced with granite 18 ins. thick, each block not less than 3½ x 4 ft. in top surface.

Pumping Equipment.—The following is extracted from the specifications governing the pumps and power units:

The contractor shall furnish and set in place on suitable foundations and at the required elevation, six wrought-steel water-tube boilers each of sufficient capacity to furnish 500 h.p. and two boilers of 300 h.p. each, working under steam pressure of 200 lb., set in batteries of two boilers each. Each boiler may be built with two or more drums not exceeding 48 in.

The boiler should show an efficiency of 75% when fired with good coal containing 12,500 B.t.u. or over per pound.

There shall be three direct-current generators, 550 volts, one of 1,500 kw., one of 750 kw. and one of 300 kw., each driven by steam turbines of the Westinghouse-Parsons type, or by triple-expansion reciprocating vertical engines capable of developing 25% overload. These generators shall be built so as to allow the connections in multiple when required. A lighting direct-current gen-

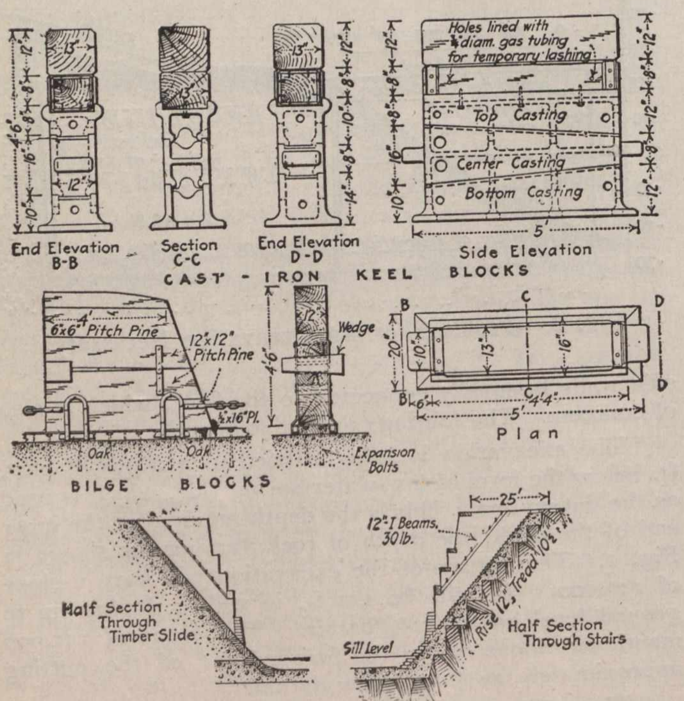


Fig. 4.—Details of Blocks and Block Slides, Also of Timber Slides.

erator shall also be installed of 100 kw. 220 volts to be driven by a vertical direct-connected compound engine mounted on same bed plate.

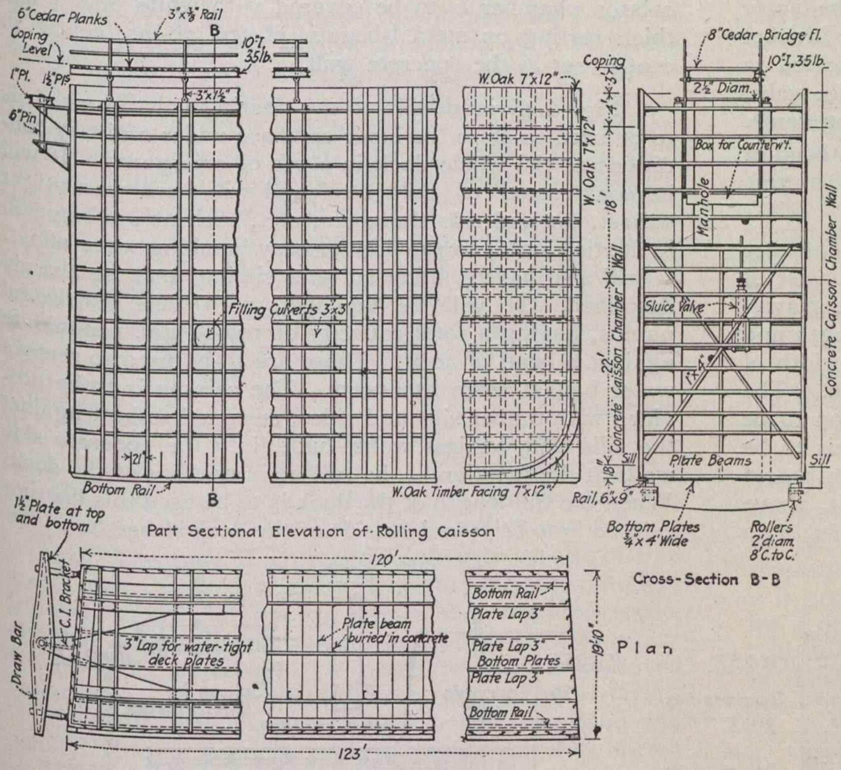


Fig. 5.—Elevation and Sections of Rolling Caisson.

The contractor shall furnish and install the following direct-current motors: three motors of 1,000 h.p. each for the main pumps, 550 volts of suitable speed for pumps; two motors of 125 h.p., 550 volts for the auxiliary drain pumps and of suitable speed; one motor of 125 h.p., 550 volts geared to worm operating the rolling caisson, speed, about 300 r.p.m. and reversible; one motor on rolling caisson, 15 h.p., 550 volts, with shaft extending on both sides and each end carrying three pinions and bevelled gear to operate the six caisson valves; four motors of 15 h.p. each 500 volts, provided with pinions and bevelled gear to operate the main culvert valves; two motors of 100 h.p. each on the floating caisson to operate the pump thereon; one motor of 10 h.p. with pinions and bevelled gear, fitted as specified for the motor on the rolling caisson to operate the sluice valves in the floating caisson. If required so to do, the contractor shall also install motors to operate any of the capstans to be placed on each side of the dock, in which case the motors shall be so installed as to be protected from dampness and rain and made detachable from their foundation.

The contractor shall furnish and install the undermentioned centrifugal pumps for the dock equipment, three main pumps of the vertical type to be placed in the pump house, each having a capacity of 60,000 Imp. gal. per minute, with suction and discharge pipe 58 in. diameter; the suction pipe to be provided with a bell-shaped extension; it shall be supported by angle irons riveted on the outside and fitted in the concrete floor of the pump house, the discharge pipe being solidly fitted in the wall of the non-return valve chamber.

These pumps to have cast-iron impellers, bronze shaft and cast-iron casing with two suitable bearings provided with forced oiling device and the shaft connected to the motors with flanges, all of which to be provided by the contractor and installed in perfect working order. These pumps shall show an efficiency of 72% when working against a head of 25 ft.

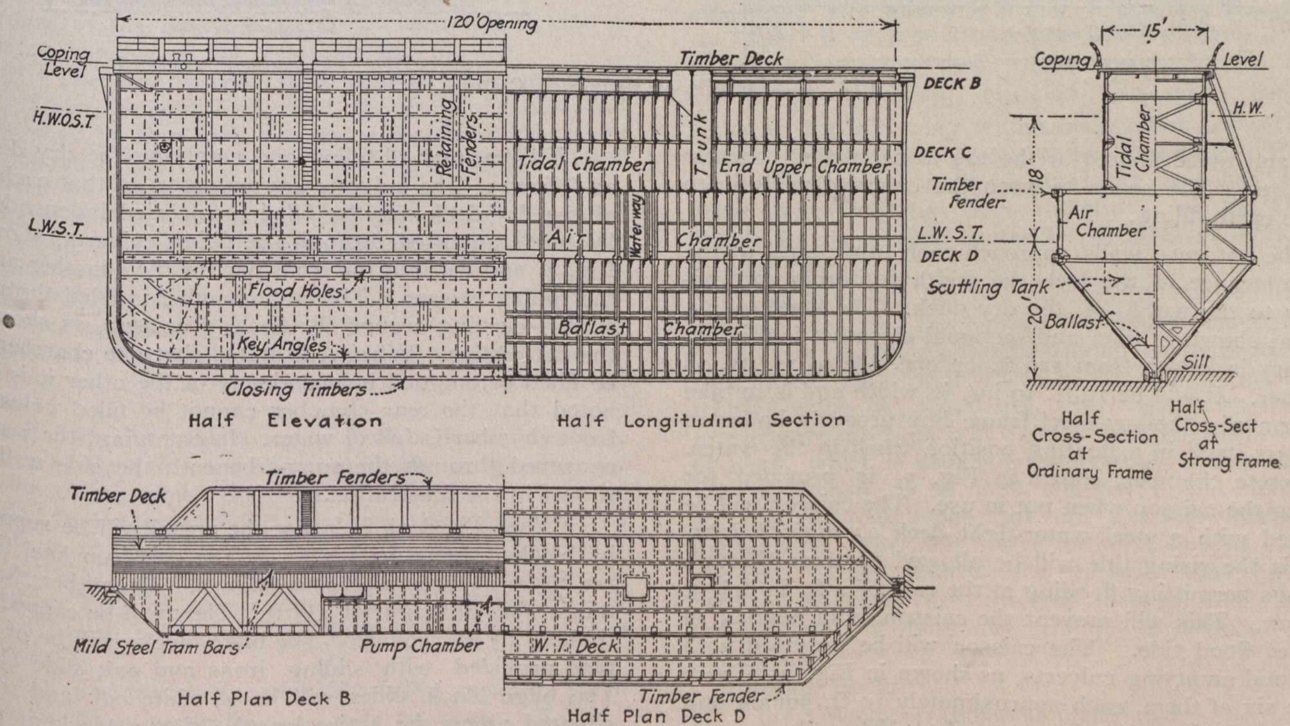


Fig. 6.—Elevation, Plan and Sections of Floating Caisson.

The contractor shall furnish and place in the pump house two drain centrifugal pumps of the vertical type with 18-in. suction and discharge pipes. The suction shall be provided with a bell-shape extension and foot valve; proper means shall also be provided to charge the pumps. These shall have cast-iron impellers fitted on bronze shafts which shall be flange connected to the motor shaft. The discharge pipes shall be supported on bracket fastened to the walls of the pump house and carried to the main emptying culvert of the dock. A sluice valve shall be provided in the discharge pipe for closing same.

These pumps are intended to work against a head of approximately 40 ft. and shall show an efficiency of 70% when working against that head.

Caisson Gates and Entrance Walls.—The entrance walls mentioned above, and shown in Fig. 7, consist of timber cribs supporting on the top a mass concrete gravity wall 18 ft. in height. They will be 600 ft. in length and funnel-shaped in plan, giving an outer entrance width of 300 ft. The walls are to be each 75 ft. in width. The type of construction consists of a stone foundation to be laid on the earth bottom for a depth of 4 ft., this to be covered by smaller stones to a depth of 1 ft. On top of this the timber is to be laid to an elevation of 6 ft. above low-water. The timber formation is to be filled with stone and to be floored at the top to carry the concrete structure. The space between the concrete walls is to receive earth filling.

The entrance walls approach each other until at the outer entrance of the lock the width conforms approximately to the width of the dry dock. The steel rolling caisson, shown in plan and sectional elevation in Fig. 5, will vary in length from 120 ft. on one side to 123 ft. on the other. It will be 19 ft. 10 ins. in width and is to take the form of a hollow steel frame box properly ballasted to adjust itself in a floating position when in the water. A concrete chamber, shown in Fig. 3, is provided for housing the caisson when not in use. The caisson will be provided with a steel water-tight deck 22 ft. in height. On this the rising tide will be allowed to enter through openings permitting flooding at the rate of 4 ft. in height per hour. This will prevent the caisson from floating in times of flood tide. The caisson will be provided with filling and emptying culverts, as shown in Fig. 2. There will be six of them, each approximately 10 ft. square and constructed of steel and water-tight. When the caisson is to be pulled out of its chamber and across the dock to form the closure its weight will be transferred on rollers by rails shown in the cross-section of Fig. 5. These rails are to be 6 x 9 ins. in section and to be of medium hard steel. The large sectional area is to prevent deflection at times when the caisson is undergoing repairs and there is no hydrostatic pressure underneath. The rollers are to be 2 ft. in diameter and placed 8 ft. centre to centre. The caisson chamber is to be covered with white pine 4 ins. thick resting on steel I-beams placed 30-ins. centre to centre, set in the concrete wall.

Fig. 6 gives details of the floating caisson which is to be used to close the inner entrance under ordinary conditions or the whole dock in cases of emergency. It will be constructed of mild steel and will have water-tight ballast, air and tide chambers, etc., such as are common to floating gates to provide for easy handling when afloat. It will also have 6 filling culverts similar to those already described. It will be equipped with two centrifugal pumps, having a total capacity of 10,000 gal. per minute against a head of 40 ft. These are to be used to remove water ballast when necessary. The caisson is to be provided with timber sills and sides, designed to butt against the sills and vertical walls built into the concrete side walls at the junction of the two main sections of the dock. When the full length of the dock is to be used this floating caisson is to be towed outside of the dock altogether.

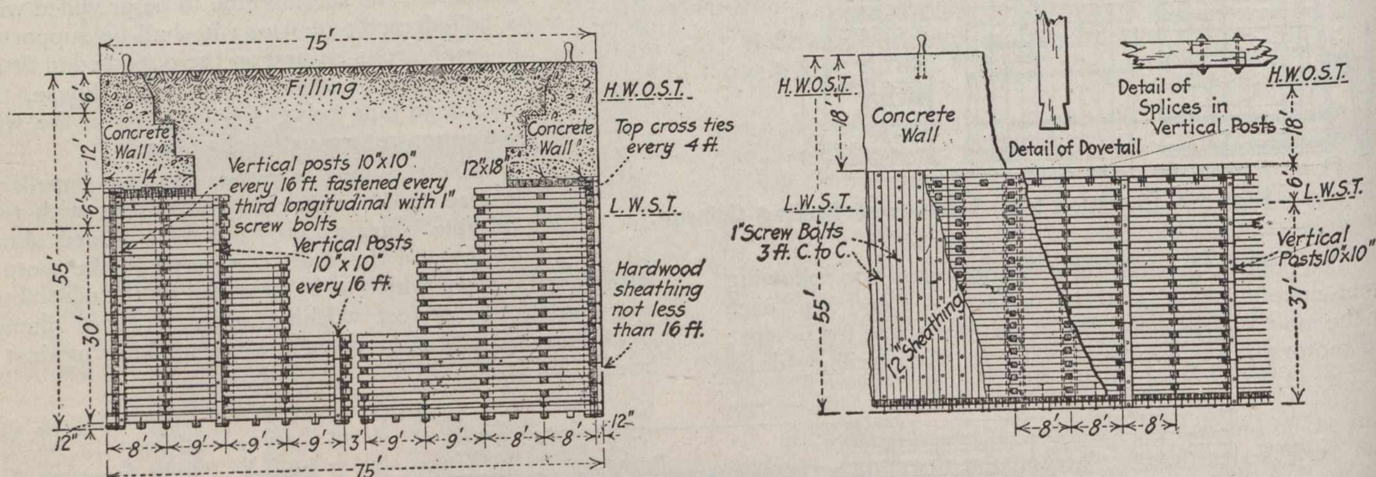


Fig. 7.—Details of Entrance Cribs.

The method of filling and emptying the dry dock is as follows: The culverts are arranged so that each part of the dry dock may be filled or emptied independently. Water is admitted through the filling culverts, shown in Fig. 2, and led into the front part of the chamber around the rolling caisson. The rear chamber is filled through a culvert curving around the floating caisson, as shown by the dotted line. When it is stated that one chamber may be filled or emptied independently of the other it is to be noted that the rear chamber cannot be filled unless the front chamber is full of water. In emptying, the water is conveyed through the sumps beneath the side walls, as shown in the illustration.

When the dock is in use the vessel will be supported by blocks, shown in Fig. 4. The cast-iron keel blocks are to be in three pieces, as shown. Altogether they attain a normal height of 4½ ft. They will be capped with timbers 13 ins. square. The bilge blocks will be of pitch pine provided with sliding irons and oak slide blocks. The bilge block slides will be of white oak and will be situated along the entire length of the dock at 16 ft. centre to centre.

The contract, as stated, was awarded to Messrs. M. P. and J. T. Davis, of Quebec, who are at present engaged upon the work. We are indebted to "Engineering News" for the drawings illustrating this article.

PETROGRAPHIC RANGE OF ROAD-BUILDING MATERIALS.

It frequently falls to the lot of a petrographer to classify stone which it is proposed to furnish for a special piece of work, and to give an opinion as to its fitness or its likelihood of meeting the requirements of specifications. In most cases these requirements are very far from being specific, in a petrographic sense, i.e., precise rock names are rarely used, whereas some general term or some phrase descriptive of the quality is common. The commonest term of all is "trap."

A few quotations copied from standard specifications covering regular contracts under various state and municipal departments, and bureaus of highways, are given as representative of this usage by Mr. Chas. P. Berkey, in the School of Mines Quarterly of Columbia University:—

(*a*) "Only broken stone . . . of a hard and compact texture and of uniform grain will be allowed . . . . Disintegrated and rotten stone . . . will not be accepted."

(*b*) "The trap rock shall be of satisfactory quality, equal to that used in . . . for macadam roads."

(*c*) "The mineral aggregate used shall consist of trap rock, newly broken, of uniform quality throughout, free from slaty and flat pieces, soft or disintegrated stone, dirt and other objectionable material."

(*d*) "The stone . . . must be trap or approved native rock. It must show a fresh, crystalline surface."

(*e*) "All stone must be . . . the same kind and quality, equally good in every particular as that shown in the Engineer's office."

(*f*) "Only good, solid stone shall be used. . . . Bidders will name the kind of stone they propose using in said work, also its location."

(*g*) " . . . shall consist of first quality trap rock. . . . Mineral aggregate shall be clean, crushed trap rock of approved quality."

(*h*) "Crushed stone shall have a coefficient of wear, according to the Duval test, of not less than 8, and a cementation value of not less than 50."

(*i*) "The first course shall consist of sound rock . . . Unless otherwise specified, the stone of the second course shall be trap rock. . . . For the third course other material than trap rock screenings may be used if approved by the Engineer."

(*j*) "Stone for macadam shall consist of approved local stone, trap rock, or a combination of local stone and trap rock . . ."

(*k*) "The crushed stone shall be trap or other suitable rock, satisfactory to the office in charge."

(*l*) "The macadam shall be of limestone of approved quality. . . . The stone must be of good and uniform texture."

(*m*) "All stone for concrete shall be hard limestone, sandstone, trap, furnace slag, quartzite, or granite, acceptable to the Chief Engineer. Broken stone must be quarried from massive ledge, and any stone which shows a tendency to break into flat, thin pieces will be rejected."

(*n*) "The broken stone shall be trap, granite, or limestone, or such other stone taken from the line of work as shall be satisfactory in the judgment of the Engineer."

Such a summary is probably fairly typical. From it two or three generalizations may be made. For example: (1) The standard, so far as there is a standard, with which all rocks are compared in highway work, is "trap." (2) Trap is usually specified by name wherever there is any reasonable hope of furnishing it for the contract. (3) Wherever substitutes are encouraged they are either indicated by name, or are described in efficiency terms, or the responsibility is placed directly on the engineer in charge.

It is the general opinion, based on experience, that the "traps" are pre-eminently satisfactory for highway uses. But trap is not a very definite petrographic term. In a very broad way this means that the basic igneous rocks of massive structure, and having a tendency to diabasic or closely interlocked habit of the mineral constituents, are the best road material. The acid igneous rocks are not so successful, especially when there is heavy traffic sufficient to test the toughness of the rock. The metamorphic rocks, as a class, are not regarded with much favor. The clastic or fragmental rocks, as a rule, are not recommended, but limestones are very serviceable where hardness is not a prime essential. In every large class of rocks there are special types which prove to be of acceptable grade, but no large class compares with the basic igneous rocks for general efficiency under the most exacting conditions.

In spite of this apparent reduction to such simple terms in the matter of range of rock types regarded as acceptable, as a matter of fact, a great variety of rocks are actually used and are quite worthy of serious consideration. Many factors enter into the question of choice; it is not always a simple problem. There is little excuse for a community to demand trap in any except the most critical cases, unless there are trap ledges in the vicinity or somewhere near its borders. It may well happen, in many cases, that the increased efficiency is more than counterbalanced by the extra cost over local stone. In the average case, local stones everywhere merit serious consideration, and a little judicious discrimination will usually discover an acceptable one.

It is in this connection that critical knowledge of rock variation will be found useful. Names of rocks alone are not so useful as might at first appear, because all types vary greatly in minor points of texture, structure, chemical and dynamic modification, and consequent efficiency. No amount of mere classification can take the place of careful discrimination of structural variety within the principal types themselves.

It may be useful, however, to consider briefly the range of types coming within observation for such uses, and to indicate their petrographic grouping. Probably no publication on rock for highway uses has given a fuller list of varieties than Bulletin 44 of the Office of Public Roads, United States Department of Agriculture, Washington.

The following list has been compiled from this and other sources, and the terms are classified under the commonly used headings familiar to all students of natural rock materials. In it there is no attempt to indicate relative value for actual use. For reasons suggested in an earlier paragraph it is certain that particular varieties of a type which is usually considered of poor quality may very well prove to be much superior to the more faulty varieties of rock types that are generally regarded as high-grade. The descriptive terms following some of the rock names indicate the varieties that have been used; the terms are inserted just as they occur in the literature, without any attempt to reduce them to uniformity:—

I. Igneous Rocks:

(*a*) Volcanic fragmental materials:

1. Volcanic ash.
2. Volcanic breccias.
3. Rhyolite tuff.
4. Andesite tuff.
5. Basalt tuff.

(*b*) Surface flows (crystalline lavas, felsitic, and slightly porphyritic in texture and showing flowage structure):
6. Rhyolite and rhyolite breccia.
7. Felsite and brecciated felsite.
8. Trachyte.
9. Andesites: Augite; Hornblende; Andesite breccia.
10. Basalt: Vitreous; Olivine; Chloritized.

(*c*) Intrusive masses (dikes, sills, etc.; strongly porphyritic or intimately interlocked in texture):
11. Granite porphry.
12. Syenite porphry.
13. Camptonite.
14. Diabase ("trap" of highest grade): Hypersthene; Uralitic; Olivine; Augite; Gabbro; Meta-diabase.
15. Diabase porphry.
16. Peridotite.
17. Pegmatite.

(*d*) Plutonic masses (deep-seated in origin; granitoid in texture and massive structure):
18. Granite: Hornblende; Porphyritic; Muscovite; Micro-granite; Gneissoid.
19. Syenite: Augite; Quartz.
20. Granodiorite.
21. Diorite: Quartz; Augite; Basic; Porphyritic.
22. Gabbro: Hornblende; Hypersthene; Uralitic.

In the above grouping, the field relations are indicated in the sub-headings, and under each the rock types of which the names have been found mentioned in road tests, or rock lists for such purpose, have been arranged approximately in order from the more acid to the more basic in composition.

II. Sedimentary (clastic) rocks and associated organic accumulations and aqueous precipitates, together with special modifications:

(*e*) Simple sediments (arranged from fine to coarse grain):
23. Shale: Clay; Ferruginous; Carbonaceous; Calcareous.
24. Sandstone: Argillaceous; Calcareous; Ferruginous; Chloritic; Feldspathic; Arkose; Kaolinized; Biotite; Indurated; Metamorphosed; Conglomeritic.
25. Conglomerate.

(*f*) Organic in origin, with or without sedimentary intermixture, and usually with some modification:
26. Limestone: Shell; Fossiliferous; Clay; Argillaceous; Bituminous; Siliceous; Nodular; Oolitic; Cherty; Dolomitic.
27. Dolomite: Argillaceous; Arenaceous; Siliceous.

(*g*) Precipitates:
28. Travertine (tufaceous limestone).
29. Gypsum.

(*h*) Special segregations, etc.:
30. Quartz.
31. Chert: Calcareous; Oolomitic.
32. Flint.
33. Nematite.
34. Phosphate rock.

III. Dynamic fragmental materials:

(*i*) 35. Breccia: Quartz; Quartzite; Brecciated felsite.

IV. Metamorphic rocks (that have been recrystallized and have lost most of their original structural habit and in part their mineralogic habit. As a rule they have a foliate structure and break much more readily in one direction than in others):

(*j*) Fine-grained types (with good rock cleavage):
36. Slate or argillite: Clay; Siliceous; Calcareous; Indurated slate.

(*k*) Medium grained (rather massive and comparatively little foliate habit):
37. Quartzite: Calcareous; Sericitic; Feldspathic; Chloritic; Pyroxene; Epidote; Hornblende; Micaceous.
38. Graywacke.

(*l*) Strongly foliated and usually of medium grain (commonly of abnormal composition; i.e., some mineral other than feldspar in excess):
39. Schist: Quartzite; Mica; Biotite; Quartz-mica; Hornblende; Mica-hornblende; Hornblende-mica; Chlorite; Hornblende-chlorite; Garnet-hornblende; Quartz-hornblende; Tremolite; Talc schist (soapstone).

(*m*) Foliated structure, medium to coarse grain, sometimes banded and of normal composition (i.e., the usual feldspathic mineral makeup):
40. Gneiss of unstated relations: Quartz; Sericite; Hornblende; Arkose; Chlorite; Muscovite; Biotite; Pyroxene.
41. Granite gneiss.
42. Syenite gneiss.
43. Diorite gneiss.
44. Gabbro gneiss.

(*n*) Massive types:
45. Marble: Dolomite marble.
46. Serpentine: Hornblende serpentine.
47. Amphibolite.
48. Eclogite: Mica eclogite.
49. Epidosite.

This list represents in reality a very wide range. It is certain that many of them are of very low efficiency, but in spite of that they have been found worthy of consideration and test. Nos. 10, 13, 14, 15 and 21 are the prominent "trap" representatives. Diabase, No. 14, is the type usually meant when the term is used in specifications. But it is not a closely defined petrographic term and is often more loosely used.

The fact that these rock names appear as having been considered worthy of attention for road-building purposes does not necessarily indicate special fitness of all these types. Many of them are doubtless very poor grade compared with trap, but they may in spite of that be superior to the only other materials warranting practical comparison in a given case. Furthermore, the fact that any one of these has been used successfully cannot be taken as evidence that every occurrence of the rock of the same petrographic classification would be acceptable, since so much depends on the physical condition, freedom from decay, texture and special structural factors of each occurrence—to say nothing of other factors of control lying outside of the present line of discussion—such as availability of other competing materials, transportation difficulties, allowable cost, uses to which the road is to be put, etc.

No doubt it would be a great convenience for highway engineers if a special classification, in which the prominent efficiency factors were given chief place, could be devised. The chief difficulties with such a scheme are:

(1) That it is an attempt to simplify data that are essentially not simple.

(2) That its basis could not coincide at all with that of any other rock classification; and, therefore,

(3) That the terms used in classification could not agree closely with those in common use.

The result would be, it seems to me, that we should have another classification to become familiar with instead of accomplishing a simplification. On the whole, there is as yet no better suggestion than that the commonly used terms for description and naming should be thoroughly mastered, and that the nature of the structural and textural basis of difference in quality should be fully understood, and that the geological and petrographic principles underlying the history of rocks should be a part of ones professional equipment.

ELECTRO-THERMIC MANUFACTURE OF STEEL.

This is a comparatively new industry, dating from about the year 1900. The advantages of heat produced electrically, for the manufacture of steel, over that produced by chemical reaction through the combustion of fuels are four in number. It is obvious that almost any temperature within reason can be obtained, and consequently slags rich in lime, and with a strong affinity for sulphur and phosphorus, can be smelted whose melting point is too high for the ordinary methods employed. It is also possible to deal with the titaniferous ores, which make the furnace charge too infusible for coke smelting. Alloys can likewise be produced which are too infusible to be formed in fuel-heated furnaces, such as ferro-titanium, ferro-tungsten, ferro-chrome, or ferro-silicon, which are richer than usual in the alloying element.

A second advantage is that an exactness and nicety in the control of temperature can be obtained, giving increased facility to the control of chemical reactions within the furnace, so that certain combinations of elements in the iron are made possible and the temperature at which the steel is finished and cast may be more exactly regulated. The metal obtained is also free from contamination by impurities contained in the fuel, the chief of which is sulphur, which is always present in the coke. Another point which has to be taken into consideration is that electric power for smelting purposes can often be obtained from some watercourse adjacent to the ores and fluxes, in situations where gas, oil, coal, or coke could be procured with difficulty.

GAS PLANTS AND MACHINERY.

The president of the Institution of Gas Engineers in England was reported recently as stating that with the exception of the method of heat purification, there has not been any striking change in either plant or machinery in the gas industry for some time past. The problem of carbonization is receiving close attention, but it is to be regretted that the committee appointed by the institution has not yet been able to arrange for the comparative tests being awaited by the industry as a whole. Of late, increasing attention has been given to questions of scrubbing and condensation in order to remove deleterious substances from crude gas in such a way as not to impoverish the finished product, and in such a way as to ensure that nothing remains that will impose an unnecessary burden on the purifiers, or interfere, or tend to interfere, with the value of gas as an illuminant and a heating agent.

WATER AND SEWAGE INSTALLATION AT ASSINIBOIA, MAN.

The water and sewer systems around Deer Lodge, in Assiniboia, the western suburb of Winnipeg, were officially opened on August 12th. If the plans of the Assiniboia council are compassed, water and sewer main connection will be carried from the Winnipeg city limits to Sturgeon Creek. The plans have been made and are being carried out with the end in view that, when the time comes to connect up with the Greater Winnipeg Water District scheme, the connection will be ready and easily completed. The new system has, moreover, been constructed so as to afford a means of protection against fire.

Under supervision of G. W. Rogers, A.M.I.C.E., the municipal engineer, the new system has been installed with most creditable speed. Work was started last November, and since that time nearly 7 miles of sewers and water mains have been laid. The work, when complete, will cost approximately $200,000.

The water is obtained from an artesian well, 365 feet deep; and a small pumping station 52 x 30 feet in dimensions, has been erected.

The pumping plant is complete in every detail and has a capacity of 12,000 gallons an hour. It will supply a population of 2,000. All the machinery is in duplicate, so that in the event of a breakdown the water supply will not be shut off for a single instant. The electrical equipment consisting of two 25-h.p. units, together with the arrangement of switch board and all the electrical apparatus, was installed under the direction of R. Lynn, the municipal electrician. There is a 70-pound pressure at the head of the pumps. The building and solid concrete foundations upon which all the machinery and storage tanks rest were erected by the Progress Construction Co. The entire machinery plant was put in by the Refrigeration and General Engineering Co., of Winnipeg; which firm, in addition to installing the plant, put in a complete system of fire hydrants, which are distributed all over the district.

In the pumping station, probably the most important installation is that of 2 steel tanks, the combined capacity of which is 36,000 gallons. There will always be this amount of water in reserve in addition to that around the well. Outside the building there is a concrete tank, the top of which is flush with the ground. This tank is 13 feet deep, 12 feet in diameter, and has a capacity of 5,000 gallons.

The system employed at the new plant is to pump the water from the well to this outside tank with 2 air compressors. It is then pumped into the 2 steel tanks within, and from there into the mains under air pressure. In this manner the water is aerated to a certain extent. The plant is so arranged that water can be pumped directly into the mains in case of fire. The system of laying the water mains is such that in case of a leak it will only be necessary to shut off a small area until excavations are made and the repairs attended to. This sewage is discharged directly into the Assiniboine River by gravitation, the high water-mark being much lower than the residential district.

The figures contained in the report of the superintendent of Mines for the Province of Quebec show that in the course of the last fiscal year, the mines of Quebec yielded a production of 13,119,811, or nearly 2,000,000 more than in 1912. As usual, asbestos leads all mineral products, the quantities extracted reaching the value of $3,839,504. Quebec Province alone produces 80 per cent. of the world's consumption.

THE EVOLUTION OF RAILWAY MOTOR GEARING.*

By W. G. Carey.

THE design of the gear equipment of the first small electric railway motors was adapted from established practice in the construction of gear trains in stationary apparatus. Abundant space was available for adequate cast iron gears. With increase in size of motors it became convenient to substitute cast steel for cast iron in order to secure increased strength while conserving interchangeability on existing trucks; and thereafter for many years cast steel gears with machine steel pinions continued to be used in universal practice. The speed reductions from the armature shaft to the axle ranged from about 3 to 1 to 4.78 to 1, and pinions and gears wore out in about these ratios. The obvious advantage of increasing the life of the pinion to approximately that of the gear in order to improve average conditions of mesh and to reduce the cost of frequent renewal of pinions led to early experiments in case-hardening of pinions. In applying this process, practice satisfactory in other arts was followed and little attempt was made to modify, for the special conditions, the process as usually carried out. The first case-hardened pinions exhibited consequently a considerable measure of warping from the heat treatment, which fact involved high cost in rejections in manufacture. Also, this warping and other results of the treatment caused in many cases destructive wear of the companion gear, and the net results were such that no really great interest in any form of heat treatment of gear-

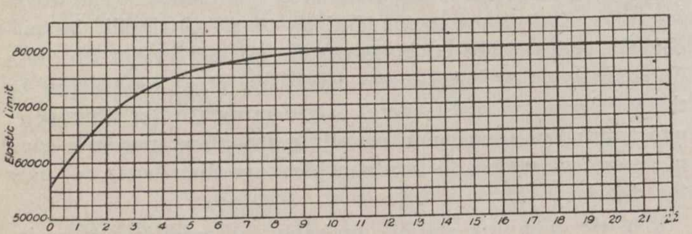


Fig. 1.

ing was felt until increased size of motors, for which an active demand was arising, made imperative an increase in the strength of materials. The pitch of teeth and width of gear face had been increased to the limit allowed by available space on the trucks, and the strongest cast steel practicable for machine operations was found inadequate; therefore, to meet the severest conditions resort was had to alloy steels, with partial success in keeping equipments in service. Experiment to determine the alloy steels best suited for the purpose required, however, a long time and involved heavy expense, and heat-treated carbon steels tried out at the same time afforded excellent results. Painstaking study by manufacturers of railway apparatus, aided by the broadminded co-operation of operating engineers, soon resulted in the determination of suitable material and the development of methods in heat treatment adequate for the severest conditions in present normal practice.

Incidentally, the modification of the material and its heat treatment, together with increased strength, produced considerable increased hardness, and, at least for city service where the strength of untreated gears was still adequate, the old idea of a pinion harder than the gear, tending to equalize the life of the two, was in a measure realized, and within a very short time the untreated pinion was entirely discarded, even for service in which the strength of the heat-treated steels was entirely unnecessary.

Only experiment could determine certainly the effect of the hard pinion on the untreated cast gear, and some curious results developed in special cases. In one of the first installations on a considerable scale the hardened pinions wore out completely in about half the life of the old untreated machine steel pinions, and this proved to be due to the presence in the gear grease of considerable quantities of very hard sand prevalent in the neighborhood, which, getting into the gear case, became embedded in the surface of the soft gear teeth, forming a lap for the rapid destruction of the pinion teeth. On the whole, however, with good methods of lubrication and maintenance of equipment, heat-treated pinions having a hardness not exceeding approximately 300 in the Brinnell scale appear to afford greatly increased life without measureable reduction in the life of an untreated companion gear.

Continued experiment in case-hardening developed means of avoiding most, if not all, of the original trouble of warping in treatment, and the process was applied experimentally on a considerable scale to the cast gears as well as to pinions; and increased life, altogether out of proportion to the increased cost, was immediately obtained. Split gear castings, however, still gave some trouble from warping on account of their irregular sections. At that time split gears were in considerable demand, although the use of solid gears had already commended itself strongly for many reasons. Split gear bolts had always given trouble and it was easier to obtain sound castings in the more regular sections in the solid gear, and these considerations had begun to have a considerable influence in hastening the provision, in repair shops and inspection barns, of wheel presses and other facilities for handling solid gear equipments. In the present state of the art of case-hardening pieces of such size and shape as motor gears, this matter of warping is not so serious a matter, as its control has been greatly improved; but at that time a general readiness to substitute solid gears greatly facilitated the trial of case-hardened gearing on an extensive scale in service.

This material is essentially a low carbon steel with the surface impregnated with additional carbon and heat-treated. The usual practice is to shroud portions not required to be hardened so that only the tooth surfaces are exposed to the "cementing" process, as the incorporation of additional carbon is called. Therefore, only the carburized portion hardens in quenching. It is usual practice to carry the depth of impregnation of carbon in the tooth surface to about the limit of allowable wear, which, in three-pitch gearing, is approximately 1/10 in. This, however, is subject to very definite control and is varied within limits for various conditions.

The surface of case-hardened gear and pinion teeth shows hardness about 95 in the scale of the Shore schleroscope. It is not practicable to measure this material with the Brinnell instrument for the reason that the uncemented core will not stand up under the pressure necessary to effect an indentation, and such pressure also causes deformation of the pressure ball. The schleroscope is also to some extent misleading, as different conditions, such as size of parts tested or method of their support in test, give rise to considerable inaccuracies. In experienced hands the most reliable comparison of hardness of specimens of materials of this class is a file test, though this may be entirely misleading in comparison of different alloy

*From the General Electric Review.

steels. Modern case-hardened carbon steel which gives a schleroscope reading of 95 can just be scratched with a very fine Swiss file.

This class of gearing, because of the price at which it could be marketed, was manifestly a great improvement in economy of operation, wherever it might be found sufficiently strong to withstand the shocks of service. No test, other than that of service, has been devised for determining its resistance to service stresses, but that the limit of its strength is below the requirements of the heaviest modern service appeared probable and has since been demonstrated. In the first days of its use much virtue was attributed to the toughness of the low carbon core, but this toughness cannot manifest itself under stresses on the whole tooth, and a tooth strained beyond its strength breaks short. It is evident that substantially the entire tooth strength must be found in the hardened case, and the factor of safety, even with the enormous elastic limit of this high carbon case, promised to be too low for safety in the heaviest equipments throughout the very long period of its probable service. Although this gearing has been used very conservatively on motors of

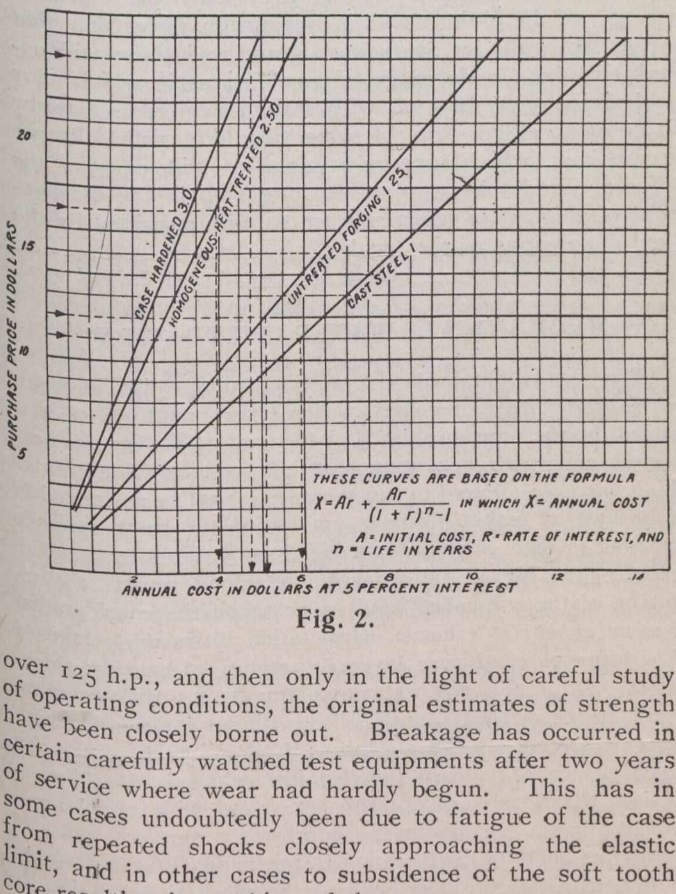


Fig. 2.

over 125 h.p., and then only in the light of careful study of operating conditions, the original estimates of strength have been closely borne out. Breakage has occurred in certain carefully watched test equipments after two years of service where wear had hardly begun. This has in some cases undoubtedly been due to fatigue of the case from repeated shocks closely approaching the elastic limit, and in other cases to subsidence of the soft tooth core resulting in cracking of the case.

It is therefore known to-day that, while with motors of less than about 100 h.p. this type of gearing is sufficiently strong to resist fatigue until worn out in service, its application with heavier equipments can only be advised in the light of a very definite understanding of the conditions of operation. With such heavier equipments, especially in high speed service with rapid acceleration and liability to abnormal shocks such as are produced by commutator flash-overs or line breaks at the collector, the case-hardened gearing appeared and has already been proved to have an inadequate factor of safety.

Attention was then turned to a modification of the homogeneous heat-treated gearing with a view to increasing its hardness to attain increased life and a greater elastic limit, which was essential in order to defer fatigue beyond the extended limit of wear. The physical characteristics of heat-treated steels depend upon a considerable number of variable factors in the constitution of the steel, the manner in which it is worked, and methods of treatment. The constitution of the material can only be definitely controlled within certain limits which are well recognized in steel manufacture, and variations in the constitution affect final physical characteristics, though the variations may be corrected in a measure by corresponding variations in treatment. Such methods, if carried to too great a refinement, are prohibitively expensive, and the development of the desired new type of gearing involved a method of analysis and an adjustment of treatment which would be commercially practicable.

The type of heat-treated gearing which had become recognized as a heavy service standard showed elastic limit varying in regular production from eighty to ninety thousand pounds per square inch, although occasionally specimens showed still higher values and certain other specimens with elastic limit varying down to 70,000 lb. per square inch were put into service in the earlier days of this development. Throughout several years a record was kept of mileage and physical characteristics of all specimens broken in a service of known character, and the curve in Fig. 1 shows relation between elastic limit of broken specimens and the time required for fatigue to the breaking point in normal service.

This shows that maximum stresses on the gear teeth, which could be determined in no other way, are equivalent to about 70,000 lb. per square inch in the teeth, since all specimens broken early in service show approximately this value. Higher values are shown to afford longer life, until the specimens broken toward the limit of wear invariably show an elastic limit of approximately 80,000 lb. per square inch, and in no cases have specimens showing higher values broken in service.

With a lower ductility, it was assumed—and it is in all probability true—that a larger factor of safety would be necessary to defer fatigue beyond the limit of wear, and a composition was selected and methods of working and treatment determined which would give an elastic limit of 140,000 to 150,000 lb. This steel shows a hardness approximately 500 in the Brinnell scale, and, while no very definite comparison with hardness of case-hardened gearing is possible, such rough comparison of the Brinnell and schleroscope scales as is possible and the file test indicate the hardness to be approximately 85 per cent. of that of case-hardened gearing.

Commercial application of this type of gearing has been made with the greatest care, and it has not yet been trusted in the heaviest service, although since its first commercial use two years ago about 7,000 equipments of this gearing have been installed with motors of all power up to 150 h.p. and there is no record of breakage of a single tooth within the limit of wear.

It has been pointed out that various factors had contributed to a marked tendency to substitute solid for split gears. This tendency was manifest in all classes of service, and its wide spread made possible the realization of an old idea of using forged blanks in place of castings for axle gears.

The manifest advantage of forgings in entirely eliminating shrink strains and other faults not altogether avoidable in castings was important, but not all of the desired end. It was practicable to machine steel of a higher carbon content, and the strength and toughness could be greatly enhanced by the operation of forging the blank. The very great diversity of combinations of shape and dimension required involved an enormously expensive development cost and it is probable that this would have long deferred the general substitution of forged for cast solid gears, were it not for the fact that the development of the homogeneous heat-treated types absolutely required forgings, since the desired physical characteristics were unattainable in castings. The cost of manufacture is so far a little higher, but the difference would probably be justified by the certain and invariable integrity of the blank, even with the same life factor. In addition, however, the untreated forged gear shows approximately 20 per cent. higher elastic limit and nearly 25 per cent. greater hardness, and these characteristics afford an increased life approximately proportional.

There are then available in the art to-day three modern types of gearing, each of which may have its appropriate field, although there may be some difference of opinion as to where and to what extent these fields overlap. The first essential in the selection of a type is adequate strength for positive assurance against breakage within the limit of wear.

There are thousands of motors in operation which are destined to be superseded by more modern machines within the expected life of heat-treated gearing, and in such cases no advantage can be gained by the use, at higher cost, of a type which cannot be worn out within the life of the apparatus; and therefore the untreated forging is clearly the only type to be considered.

Also, many important systems have been completely equipped with case-hardened gearing, and the problem of changing over to another type, unless the two types can be successfully operated together, is a difficult one, and such a change must be effected gradually. Both of these considerations must be taken into account, although in the end practice will be standardized on the basis, first, of safety and then of annual cost of maintenance.

In the meantime, in substituting complete gear equipments of the modern heat-treated steels for untreated gears with heat-treated pinions having hardness of about 250 to 300 in the Brinnell scale, it is evident that some trouble will be involved in attempting to maintain the proper combinations, and the result of combining gears and pinions of widely differing hardness under all service conditions is very uncertain. While occasional instances of successful operation of even case-hardened pinions with untreated gears are reported, it is certain that such combinations will generally result in reduced life of the softer member, and in effecting changes in their practice most operators are taking the trouble to provide pinions of only moderate hardness for use with their untreated gears and meshing all new gears of more modern types with pinions of the same types.

For the purpose of estimate of maintenance cost, life factors of different types must be assumed and the following are based upon records of service under widely varying conditions.

Grade.	Life factor.
Untreated cast steel	1
Untreated forged steel	1.25
Homogeneous heat treated	2.25
Case-hardened	3

These estimated life factors, with cast steel taken as 1, are about proportional to the relative hardness of the respective types, which factor should, and apparently does, reflect fairly closely the average life in service. Based upon these factors and an assumption of 5 per cent. interest on investment, the curves in Fig. 3 show a comparison of the respective maintenance costs of the four types here considered, at the prevailing market prices of a representative gear for city service.

The market prices of this gear in the four different types are, respectively: cast steel, $11; untreated forging, $12; homogeneous heat-treated, $17; and case-hardened, $24. Following the dotted lines as indicated by arrows from these purchase prices in the ordinates, the respective annual costs will be found to be $5.90 for untreated casting; $5.10 for untreated forging; $3.95 for homogeneous heat-treated, and $4.75 for case-hardened gears.

It has been said that the heat-treated carbon steels now available have proved adequate for the severest conditions in present normal practice. It is known, however, that we are already near the limit of strength of this material, and the added demands of apparatus already projected, and of at least one existing application of somewhat special character, call for an additional factor of safety to maintain strength requisite for service to the limit of wear. Experiment on an extensive scale is being conducted with various alloy steels and various treatments, and encouraging results are promised, particularly with chrome-vanadium. Owing to its narrower base, the strength of the pinion tooth is measurably lower than that of the teeth of its companion gear, and there will undoubtedly be a wide range of applications in which alloy steel pinions may be used with carbon steel gears, and by virtue of an elastic limit of something like 170,000 lb. per square inch, which appears attainable, will equalize the difference and take us another long step in the development of this art in which we are so circumscribed by the fixed dimensions of the trucks.

MECHANICAL WATER FILTRATION.

The results obtained with mechanical filtration of water that is badly discolored and carries large quantities of suspended matter are highly satisfactory. Waterworks engineers may with advantage consider whether flood water which has been allowed to run to waste cannot be so treated as to become of value. Where gravitation works have been designed to take only a portion of flood water it is possible, according to Mr. T. Molyneaux, to extend greatly the resources of the watershed, and so postpone the consideration of some expensive scheme. Gravitation filters are composed of a layer of sand over layers of stones of varying thicknesses, and really are water strainers only. High-pressure filters are cylindrical vessels filled with sand through which water is forced at high pressure. One gallon in every 300 which passes is required for cleaning, which is done by reversing the filter and agitating the sand with radial arms provided in the casing for the purpose.

Before mechanical filtration is taken up on a large scale some amount of consideration must be given to the design of the plant. It has been pointed out that the unit commonly in use is 8 ft. in diameter, and capable of dealing with some 150,000 gallons of water daily; but there seems no reason why a larger plant should not be used. The obstacles in the way would appear to be only mechanical, and as such can be overcome without great difficulty. There is a plant in course of construction in which the units are of 9 ft. diameter, and it will shortly be seen how superior this is to the existing designs.

Mechanically-filtered water would be further improved if it were passed into a service reservoir before being sent into the mains, in order to allow a secondary deposition of matter in suspension, which no ordinary laboratory analysis shows, but which is undoubtedly present.

WARFARE AND THE ENGINEERING PRESS

VIEWS FROM ABROAD OF THE EFFECT OF THE EUROPEAN TROUBLE ON THE PROGRESS OF ENGINEERING.

THE effect of the outbreak and magnitude of European hostilities upon engineers and engineering has been reviewed with a general feeling of confidence by the engineering press. The first expressions of concern, while naturally reflecting retrenchment in constructional activities and readjustment of many factors influencing engineering, exhibit no trace of forebodings of a panicky nature. Even in England, where, according to the daily press, one might expect engineering and industrial work to cease, except that for the production of military supplies, the industries are active, the unemployed are comparatively few, and the British manufacturer has already set to work upon the task of preparing to secure as large a share as possible of the export trade which will be set a-begging when peace has again been secured.

The following editorial observations, which appeared in various engineering papers of England and the United States, should be read carefully by Canadian engineers. There is substantial argument to uphold the belief that the arrest by war of engineering work will not be long drawn out, and that it will be succeeded by greater activity than has been experienced of late:—

We can all perceive the ugly features of the war. Let us note a few of the consolations. Plant to the value of some hundreds of thousands of pounds must be re-ordered in this country. Against the factories which will run on reduced time must be set several others which have already started overtime. We heard yesterday of an electrical manufacturing firm who were compelled to work all through the last two week-ends. But we are not thinking so much of electrical works proper as of other industries which buy from us. For instance, the big armament firms are working day and night, the electrical equipment of ships has been accelerated, the Reading biscuit firms are on overtime, so are the army clothing establishments, the arsenals and certain dockyard departments.

So that, without wishing to argue that the war is, on balance, a benefit—it is obviously an immense evil altogether—there is not the least occasion for despondency. Our home trade is immensely greater than our foreign trade, and our trade with the affected countries was largely an importation of manufactured goods in exchange for our coal and semi-manufactured products The very considerable imports from Germany and Austria will not simply be dispensed with, to a large extent they must be replaced.

As the Government insure the safety of ocean traffic, America and the Colonies will not be deterred by war risks. Shipping will be continued, after some initial check, with Canada, United States, Africa, Australia, and the East. British manufacturers stand to replace German and Austrian competitors on a large scale, and for many years to come; now is their opportunity. They should supplant them, not only in our home market, but in such neutral ones as South America, an immense purchaser. These firms partly importing and partly manufacturing in this country will probably decide to increase their British works, though not immediately. What we cannot produce ourselves, or get from Europe, we can probably obtain from America or elsewhere. Even the greatest of calamities bring good to somebody or other; the present upheaval will probably divert our trade to different channels. But we sincerely hope and believe that our trade does not, like that of Germany, incur any risk of crushing, or even of arrest, taken as a whole. What, it may be asked, of our sales to Germany? Assuming their stoppage for a long period after the war, it must be remembered by way of consolation that Russia, one of Germany's very best customers, and afflicted with some sentiment in her temperament, will go elsewhere for her manufactured goods. England, France and America can no doubt oblige. Beyond hazarding these few guesses as to the probable tendency of events, it is early as yet to discuss the precise developments. The general summary is that things might have been very much worse. The public are accepting the calamity with unexpected calm, things wear their normal aspect, trams and trains run much as before, the shops are all doing good business, there are really few signs of the upheaval, apart from the placards and the scarcity of London general omnibuses.—*The Electrical Times*, London, August 6th, 1914.

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It is needless to take an alarmist view; on the other hand, it is wise to be fully prepared for the fortunes of war. The municipal engineer has at all times a great responsibility, but in time of war this responsibility is surely increased. To consider one of the many works for which he is responsible—the water supply. The greater the work, the greater is its vulnerability; one man with a spade could easily start a burst in an earthen dam, and one small cartridge might wreck the conduit which supplies a city. How soon might the most perfect pumping machinery be put out of gear or utterly ruined. Again, one may imagine how easily a great sewer might be blocked or even wrecked, and how seriously this might, under certain conditions, affect the district served. The same applies to power and electricity stations, to bridges and to docks. In the case of dock basins the malicious bursting of a wall might easily lead to the wrecking of a large number of vessels, while injury to dock-gates and caissons would be followed by the most serious consequences. It is idle to enumerate or to suggest the various ways in which harm might be done; every engineer knows only too well how easily the greatest works could be injured or wrecked, seeing that they have been designed and constructed for the purposes of peace, and not to withstand malicious attack.

Bearing these facts in mind it is clearly the duty of the municipal engineer at the present time to take every possible precaution against the possibilities mentioned. Reservoirs certainly ought to be watched and guarded where the supply of large communities is dependent upon them; similarly, long, exposed pipe lines ought to be watched. At present it would not be difficult for our country's enemies to damage aqueducts or reservoirs. It is a case in which the municipal engineer should carefully consider what works under his control are sufficiently important and vulnerable to require special guarding, and next he would do well to see that they are efficiently watched. If his own staff of workmen are insufficient, as may well be the case, it is his duty to call attention to the fact, and the help of the police, military, and territorials may well be required. There will be a very large number of persons ready and willing to serve their country at the present time. These might be employed in guarding municipal works, but such service will be useless unless it is first directed by the municipal engineer.. There are other dangers incident to a state of war. The bridges and highways may need special protection. Excessive loads may come upon them, and it is the duty of the municipal engineer to see that these are strong enough to sustain the loads, and where necessary to make provision for temporarily strengthening them. We do not wish to adopt any alarmist attitude; happily the risk of actual invasion is extremely remote. There are, nevertheless, other chances of trouble which should not be overlooked, and the proper guarding of municipal works at the present time is a duty which should be brought prominently forward, seeing how vitally the well-being of every citizen is affected.—*The Surveyor*, London, August 7th, 1914.

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The entire world must suffer on account of the terrible European situation, if not directly in loss of life and property, at least in temporary financial embarrassment. American financiers, however, and the Government are fully equal to the emergency as it affects this country. The closure of the stock and produce exchanges throughout the country, the preparation to issue emergency currency under the Aldrich-Vreeland act, the placing of clearing houses on a certificate basis and the enforcement in some States of the sixty-day-notice clause for withdrawals of savings deposits will all tend to prevent the panic which, with the absence of these measures, would undoubtedly ensue. A temporary curtailment of export trade, with its stimulating effect, must be expected; but even with Great Britain in the conflict naval strategists feel that the ocean lanes will be kept open, enabling us to dispose of our farm products, with which we are now unusually well supplied. There is every reason, therefore, for citizens of the United States to remain calm. No other country is so well prepared to meet the emergency. In a short time, probably, things will assume a settled condition and business will proceed almost as briskly as though there were no unusual disturbance abroad. There is ample cause for gratification, therefore, at the favorable situation of the Union in so terrible a season.—*The Engineering Record*, New York, August 8th, 1914.

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The calm and steady way in which London—speaking principally for the City and its financial organizations—has withstood the shock of the crisis is rational ground for assuming that no new alarm is likely further to unsettle it. The people who are laying in supplies of flour, of sugar, of condensed milk and so on, are in a large minority. Prices will rise, have already done so, in fact: but they are not likely to advance exorbitantly. Out of the evil, good will come. Canada and the United States, for example, may find their financial salvation by reason of the present grave condition of affairs. Afterwards there will arise such activity in trade, in metals, in stocks and shares as few can remember. These, however, are for the future. The immediate outlook is too serious to be illumined by more than hope, but that hope is fortified and cheered by the steadfast way in which the financial institutions of the City of London, and the people whom they affect, have met a situation that might have precipitated a panic which nobody could have called surprising.—*The Electrical Review*, London, August 7th, 1914.

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One of the most certain results of a great European war will be a world-wide scarcity of investment capital and a consequent rise in the ruling rate of interest. Indeed, such a rise has already taken place, partly as a result of the wars fought during the last dozen years and even more of the preparations for war on an enormous scale which the European nations have made. About the close of the 19th century, prior to the Boer War in South Africa and the Spanish-American war, the market value of investment funds in the highest-class securities was not far from 3 per cent. During the past year or more the average price has been probably 4 to 4½ per cent. Where the price of capital will go to in the event of a general European war, long continued, can only be conjectured. Such a war would destroy to a large extent the great reservoirs of investment capital in the principal European nations, to which all the rest of the world has resorted for the funds with which to carry on economic and industrial development. It may easily be that a year hence 5 per cent. or 6 per cent. or even 7 per cent. may be the ruling price for investment funds of the highest class. The rate on funds invested in ordinary enterprises, involving more or less risk, such as attaches to almost every private enterprise, must, of course, be correspondingly higher.

The far-reaching results of such a change in the value of capital it is impossible to foresee in full detail. It would have, of course, a vast effect upon the prices of commodities of every sort and of real estate. It will greatly limit the carrying out of works of permanent improvement, in which engineers are so largely concerned, since capital will be difficult to obtain and can only be secured at a high price. It will mean the cancellation of a great number of new enterprises because the reservoirs of capital that were to have sustained them will be dried up.

Of especial interest to many engineers is the question, What is to be done concerning the half-dozen great international engineering congresses which were scheduled for next year?

Besides the great international engineering congress to be held in San Francisco, together with numerous other international congresses relating to many branches of science and industry arranged for there, the International Railway Congress was to assemble next year at Berlin, the International Society for Testing Materials at St. Petersburg, the International Navigation Congress at Stockholm, and the Congress of Mining and Metallurgy at London. Doubtless all these congresses will have to be indefinitely postponed. It has been suggested that the American engineers might offer to welcome these various congresses in the United States. But even if it were attempted to hold the meetings here, the attempt could hardly result otherwise than in failure. With the great nations of the world at each other's throats, it is not to be expected that their representatives, many of them government officials, could be brought together in peaceful and friendly conference only a few months hence. Indeed, who is wise enough to foresee the profound changes in nations, in politics, in policies, in races, which may grow out of this terrific conflict? It sounds like a mockery, the circular before us regarding an international exhibition of art and civilization to be held at Dusseldorf next year. But that is only one of several such international events, including our own great exposition at San Francisco, which must be either abandoned, or, if held, must do without exhibits from the chief industrial nations of Europe.

The best that may be hoped from the present terrible conflict is that when it is ended by peace, it may be a peace accompanied by universal disarmament, a peace that shall relieve the nations from those crushing burdens of preparation for war and leave them free to solve those problems of social readjustment which are the pressing problems of this century.—*The Engineering News*, New York, August 6th, 1914.

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Whilst the engineer gives place to none in the detestation of war and in efforts to avert it, to him it has an interest which it cannot have for the layman. The engineer was originally a soldier, the maker and destroyer of fortresses, the maker and user of cannons, and to him war has never meant merely the victory and defeat of opposing armies. With philosophic detachment he sees it as a scientific test of painfully wrought theories, of new materials and new offensive and defensive engines. Time has not lessened but greatly increased his influence on the art of war. Even in the short interval that has elapsed since the South African campaign he has given to the Army and Navy many new things, and if he could stand wholly apart from the horrors of the gigantic conflict with which he is now face to face he would look on the trials to which the material he has devised and made is to be put with an interest as lively and as dispassionate as that of the astronomer who seizes the rare eclipses of the sun to test his theories and new apparatus.

So far our great ships of war have had no chance of showing what value is to be placed on new designs, but now that war is declared we shall learn if the lessons of the proving ground and the theories of the study are well founded. We shall know at last if the gun is really better than the armor; we shall learn if the 13½-in. gun is indeed superior to the 12-in.; we shall learn if the 4-in. quick-firer is efficient to ward off the attacks of destroyers. The problem of the submarine will be solved. Whether she is really as dangerous as the subtlety and secrecy of her attack have led us to suppose will be found out. We shall discover, too, if the torpedo itself is as formidable as it seems, and whether the immense improvements in it, which it owes to the engineer, have really made it the most fearful and deadly of naval arms. It is possible, too, that the greatest of all naval problems may be set at rest. Perchance some pre-Dreadnought ships may find themselves in conflict with the latest warships of the world, and we shall discover if the theory of the all-big-gun ship is well founded. Amongst other works of the engineer that will be put to the test of war between first-rate Powers the turbine must be mentioned. Whether it will endure the rough handling as well as the old reciprocating engines, whether it will be as faithful and dependable in its duty, is a question the answer to which all Admiralties and all engineers await with anxiety. Whilst the test of naval material of war is still in doubt, land material is already undergoing probation. Here the engineer has a host of new things to watch with interest. Our war in South Africa taught us many things about field artillery, and those lessons have been embodied in our 18-lb. field piece, which we believe is better than any in the world, though the new French field gun, a mysterious weapon about which little is known, may be superior to it. It is believed that the Germans, just as they have remained true to a smaller calibre naval gun, have also adhered to a smaller field gun; it is reported to throw a 15-lb. shell. Whether it makes up in muzzle velocity for what it lacks in weight remains to be seen. But it is not only in the guns themselves, but in their carriages, that much that is new has to run the gauntlet of war. The old form of carriage that recoiled with the gun is now a thing of the past. The modern field gun-carriage is an elaborate structure with recoil cylinders and running-out springs. The gun runs back with but little movement of the carriage and the rapidity of fire is greatly increased. No one yet knows what effect such a highly developed weapon may have upon the issue of a battle. Again, mechanical transport is almost a new thing which has hardly been tested on the actual theatre of a war on a large scale. Many excellences must be developed, many faults found. Those who are responsible for its design, no less than the engineers all over Europe, who have carried out the desiderata of their war offices, can hope for nothing better than that it should not be found wanting under the crucial test. Coming to still greater novelties, we have to learn how the aeroplane and seaplane comport themselves, whilst the value of the airship must be decided once and for all. With the purely military value of aeronautics the engineer is but little concerned. Whether the fact that the enemy can watch from the sky every step an army makes and report it by wireless telegraphy to headquarters, is to cause, as some aver, a great modification of tactics, is a matter of secondary importance to him from the professional standpoint. What he does want to know is that the machines he has developed with such infinite trouble and at the cost of many brave lives are capable of performing trustworthily the duties assigned to them. He has brought into war a new factor of enormous moment—a factor of which many in England think we have been too slow to take advantage of.

Besides the few obvious things we have mentioned, there are hundreds of others in which the engineer is directly interested. Every ship is full of small items which change with every new vessel as some new invention or development of an old one is brought forward. Take, for example, the range finder, of which the accuracy is now so great that it will tell the distance of an object correct within 25 yards in 10,000; the new uses to which electricity has been put; the development of wireless signalling; the new system of laying mines, and so on and so on. On every side the hand of the engineer is seen, and no one in Europe will watch the progress of arms in the greatest conflict the world has ever seen with more keenness than he.—*The Engineer*, London, August 6th, 1914.

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Municipal bonds have naturally felt the effect of the war in Europe, along with all other securities. During the first six days of this month ten or more cities received no bids for bonds offered and two thought it advisable to postpone advertised sales. But this is not to be wondered at nor should cities become alarmed thereby as to their future finances. During July the market for municipal bonds was better than ever, many selling on a basis of 3.71 per cent. to 4.40 per cent.; and the war situation can certainly have no effect on the stability of the finances of United States cities.

Railroad and industrial securities might be affected in their actual as well as their market value by the effect of the war upon commerce; but the only effect upon municipal bonds would seem to be the general withdrawal of money from investment, and this will be but temporary, in the judgment of financiers. When money again seeks investments, in a few days or weeks, the municipals will, it would seem, be still more favorably considered than during the past few months.

We advise cities, therefore, not to rashly close down work or postpone projects indefinitely, thus throwing many citizens out of employment, but to act on the assumption that in a very few weeks they can raise money on terms at least as favorable as a year ago and possibly as those of this spring. On the other hand, however, every effort should be made to avoid selling at high rates of interest long-term bonds which will commit the city to the payment of such interest for many years to come. —*Municipal Journal*, New York, August 13th, 1914.

* * * *

The forces of war are powerful, with their perfection of death-dealing mechanisms and their high development of strategical plans for circumventing the enemy. But the present-day forces of peace—the forces of commerce, of education, of brotherhood, of mutual tolerance and good feeling—are still more powerful, and will, we are confident, prevail before too many lives have been lost or too much of the material prosperity of the belligerent peoples has been destroyed.

It has been one of the incongruities of the recent upheaval that some of the delegates to a peace conference in one of the European countries had to turn back home because of the beginnings of war. But this incident is worthy of more than a grim smile. The feelings which prompted the calling of the peace conference are still in the breasts of the people and will demand a cessation of hostilities.

While most of the nations of the world are, from a military standpoint, better prepared for war than they ever were before, these same war organizations are considered by the rank and file of citizens as relics of a former age. The organization of present-day governments is very little along the lines of offensive and defensive warfare, and very much along the lines of building up peaceful lines of industry for the welfare of their citizens. The nations of the world are on a far-reaching, interdependent commercial basis which will not long brook the interference of war.

The present has been accused of being a severely commercial age; but in a crisis of this kind it is this strong commercial tendency which will prove one of our bulwarks of safety and will insist on a speedy return to a peace basis.

From the standpoint of the contractors' interests, we are sufficiently optimistic to believe that the first scare is the worst, and that business can very rapidly get back on to a most satisfactory basis. It is true that some municipal bonds have not found ready buyers within the past few days; but capital will gradually come out from under cover as it sees business assuming its normal aspect, and will be ready to finance legitimate enterprises as usual. The dealer in machinery and equipment, too, will find that an even greater export market has been opened up to him.—*The Contractor*, Chicago, August 15th, 1914.

An increase of 125,732 tons in the unfilled orders on the books of the United States Steel Corporation was reported in the corporation's monthly statement issued at New York on August 10. This is the fourth month in which increases in the unfilled tonnage have been reported after the long period of almost uninterrupted decline in unfilled orders, which began in January, 1913. The orders now on the books of the Steel Corporation amount to 4,158,589 tons, compared with 3,998,160 at the end of May. A year ago at this time the Corporation's unfilled contracts amounted to 5,959,079 tons.

UNITED STATES COAL OUTPUT IN 1913.

According to a statement recently issued by the United States Geological Survey, based upon figures compiled by Dr. Edward W. Parker, the production of coal in the United States during 1913 was the highest on record, the total being 570,048,125 net tons (2,000 lbs.). This shows an increase of 35,581,545 net tons, or nearly 7 per cent., on the output of the previous year. It is considerably more than double the output of 1900, and more than eight times the production of 1880. The value of the coal mined in 1913 is stated at $760,488,785, as compared with $695,606,071 in 1912. The increased activity indicated by these figures was well distributed throughout the 29 coal-producing States, 23 of which showed increases and only 6 decreased production, the decrease in one of these, Colorado, being due solely to labor troubles. Twelve of the States showing increases made record yields.

Pennsylvania mined more coal in 1913, both anthracite and bituminous, than in any previous year in the history of the industry. The production reached the total of 265,306,139 net tons, valued at the mines at $388,220,933, and which is one-fifth of the world's output. Of this 91,524,927 tons were anthracite, valued at $195,181,127, and 173,781,217 tons were bituminous, valued at $193,039,806. The total tonnage broke the previous record for 1912 by 19,079,053 net tons, or nearly 8 per cent., the proportionate increase being about the same for both anthracite and bituminous. The gain in the value of anthracite, however, was $17,558,501, or about 10 per cent., over 1912, and in bituminous coal $23,669,309, or 14 per cent. The total gain over 1912 was $41,227,810, or nearly 12 per cent.

STEEL PLANT CLOSING.

Relative to the closing of the Dominion Steel plant at Sydney, N.S., an official of the company stated that the action was taken due to the stop to all industrial activity caused by the war. The Steel company has its yards full of wholly or partly manufactured material. It has 20,000 tons of rails which cannot be delivered. On the whole the company has well over two million dollars' worth of material unsold, or sold and not yet delivered. With regard to the order for 10,000 tons of rails recently received by the company, the specifications would involve starting up a blast furnace; and the order would only give work for a short time. It seemed better to hold this order as a nucleus until others can be added to it, so as to make work, when begun, fairly continuous. There is business in sight for bar steel to keep the mill running for some little time. The officials hope that it will not be many weeks before they will have enough business to justify recommencing in such a way as to keep running for a reasonable time.

The output of the Dominion Coal Company, Glace Bay, N.S., for June, 1914, amounted to 452,270 tons, which is to be compared with the largest previous output of 438,272 tons produced in October, 1913. It is stated, moreover, that the output for June would have been 50,000 tons greater, had it been possible to work the mines to full capacity. The production of the Dominion Coal Company for the first half of 1914 was 2,254,043 tons from the Glace Bay mines and 199,961 from the Springhill mines, comparing with 2,295,082 tons from Glace Bay and 193,797 from Springhill in the first half of 1913. There is, therefore, only a difference of 34,000 tons between the two half-years.

A High Surge-Tank.—A surge-tank on the differential principle has been constructed at the hydro-electric plant of the Salmon River Power Company, Altmar, N.Y. The structure is 180 feet high to the top edge of the tank, which has a height of 80 feet and a diameter of 50 feet, and stands on a base built up of ten lattice columns. The tank has to take care of surges from a column of water 9,625 feet long and 12 feet in diameter. A 12-foot riser connects the bowl-shaped bottom of the tank with the pipe-line. Inside the tank is a 10-foot vertical pipe tapered from 10 feet 8 inches diameter at the bottom end to 15 feet at the upper end. The annular space between the mouth of the 12-foot riser and that of the 10-foot 8-inch pipe allows part of the water to flow straight out into the tank, while the rest passes up the 10-foot pipe. The effect is to throttle the surges very considerably.

ELECTRIFICATION OF THE BUTTE, ANACONDA AND PACIFIC RAILWAY.

THE Butte, Anaconda and Pacific Railway has been entirely under electrical operation for the past six months. The installation is most interesting everywhere as it marks a new departure in electrification. Prior to it, railway electrification for the most part was influenced largely by the demand for rapid suburban and interurban service, by the frequency of that service and by other considerations, such as smoke abatement in cities. The above electrification is the first on record however, to have been made for the express purpose of securing greater economy. Further, as the first road to use 2,400-volt direct current, it is likewise worthy of note.

The first electric locomotives were put in service about June 1, 1913, and set to hauling ore. By January 1, 1914, according to information furnished by the General Electric Company, they had hauled nearly 2½ million tons of ore and had travelled approximately 201,000 miles. The change from steam to electric haulage was made without any change in the personnel of the train crews and without any delays or alterations in the schedule.

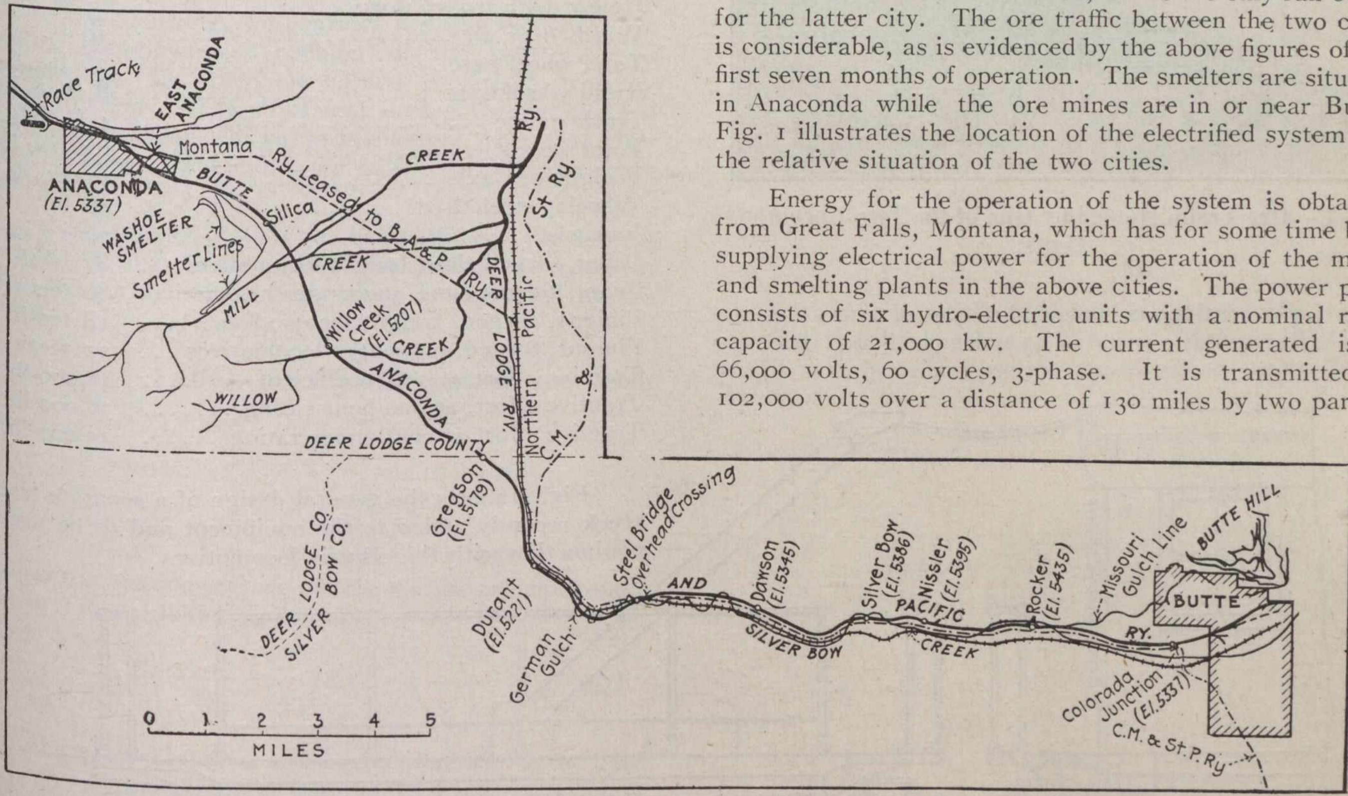

Fig. 1.—Route of the Butte, Anaconda and Pacific Railway.

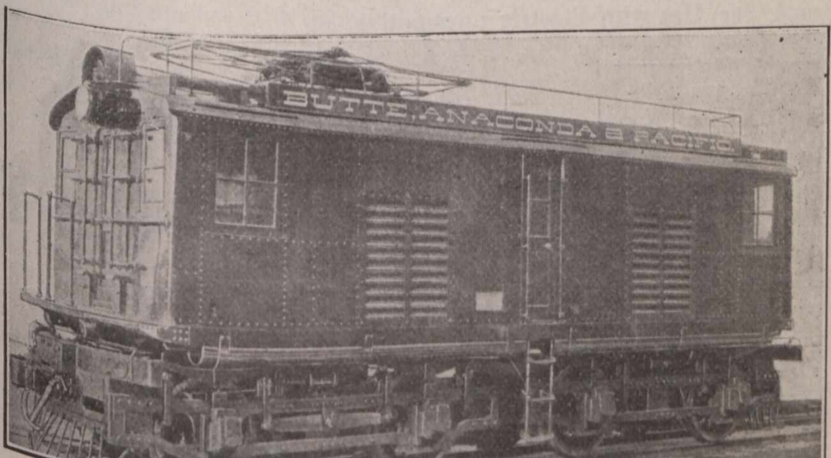

Fig. 2.—One of the 2,400-volt Direct Current Freight Locomotives.

Prior to the installation, the Butte, Anaconda and Pacific Railway was a single track main line about 30 miles in length with about 85 miles of sidings, yards, etc. There is a maximum grade of 0.3% against loaded cars and of 1% against empties. The heaviest train has been 50 loaded ore cars, approximately 3,400 tons. The line extends from Butte, where connection is made with several trunk lines to Anaconda, and is the only rail outlet for the latter city. The ore traffic between the two cities is considerable, as is evidenced by the above figures of the first seven months of operation. The smelters are situated in Anaconda while the ore mines are in or near Butte. Fig. 1 illustrates the location of the electrified system and the relative situation of the two cities.

Energy for the operation of the system is obtained from Great Falls, Montana, which has for some time been supplying electrical power for the operation of the mines and smelting plants in the above cities. The power plant consists of six hydro-electric units with a nominal rated capacity of 21,000 kw. The current generated is of 66,000 volts, 60 cycles, 3-phase. It is transmitted at 102,000 volts over a distance of 130 miles by two parallel lines to the sub-station at Butte. Another transmission line carries power at 60,000 volts to the Anaconda sub-station, 26 miles distant. These two sub-stations are equipped with 2,400-volt motor-generators. Each set consists of a 3-phase, 60-cycle, 720 r.p.m. synchronous motor direct connected to two 500-kw., 1,200-volt direct connected generators arranged to operate in series for 2,400 volts.

The overhead construction was especially designed to give the flexibility necessary for the satisfactory operation of the pantograph trolley used on the locomotives. The trolley used over all tracks is of copper and is supported by an 11-point catenary suspension from a stranded steel messenger cable. The trolley wire is reinforced between the sub-stations with two copper cables tapped to the trolley at intervals of 1,000 ft. The rails are connected by No. 0000 bonds at every joint.

The locomotive equipment consists of seventeen 80-ton units, two for passenger service and fifteen for freight. The ore trains are being hauled by two coupled units. The locomotives are of an articulated double-truck type, with all the weight on the drivers. The double unit, 160-ton locomotives for freight purposes are capable

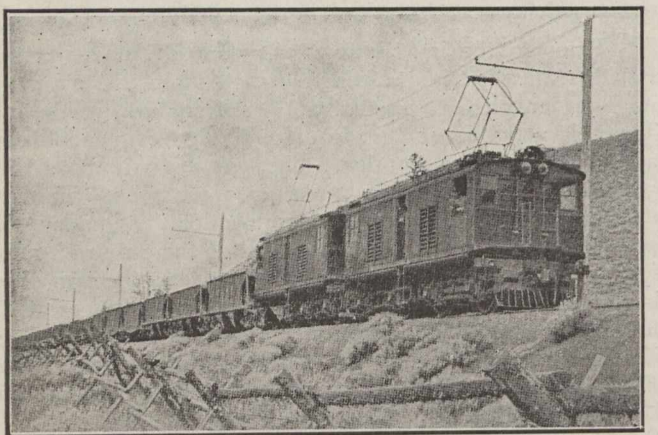

Fig. 3.—Ore Train, Hauled by One of the Two-Locomotive Units.

of giving a continuous sustained output of 2,100 h.p. and have a free-running speed of 35 miles per hour. They are geared for slow speed also. The passenger locomotives, on the other hand, are geared for a free-running speed of 55 miles per hour, or 45 miles per hour with three passenger cars. Curves as sharp as 20° occur on portions of the line, although the average curvature is from 6° to 10°. The locomotives are designed with sufficient flexibility to operate on a curve of 31° at slow speed.

The following information respecting the construction of the locomotives may be of interest:

Length inside of knuckles	37 ft. 4 in.
Length over cab	31 ft.
Height over cab	12 ft. 10 in.
Height with trolley down	15 ft. 6 in.
Width over all	10 ft.
Total wheel base	26 ft.
Rigid wheel base	8 ft. 8 in.
Track gauge	4 ft. 8½ in.
Total weight	160,000 lb.
Weight per axle	40,000 lb.
Wheels, steel tired	46 in.
Journals	6 x 13 in.
Gears, forged rims, freight locomotives	87 teeth
Gears, forged rims, passenger locomotives	80 teeth
Pinions, forged, freight locomotives	18 teeth
Pinions, forged, passenger locomotives	25 teeth
Tractive effort at 30% coefficient	48,000 lb.
Tractive effort, at one hour rating	30,000 lb.
Tractive effort at continuous rating	25,000 lb.

Fig. 4 shows the general design of a separate tractor truck recently added to the equipment and to be used in conjunction with the electric locomotives.

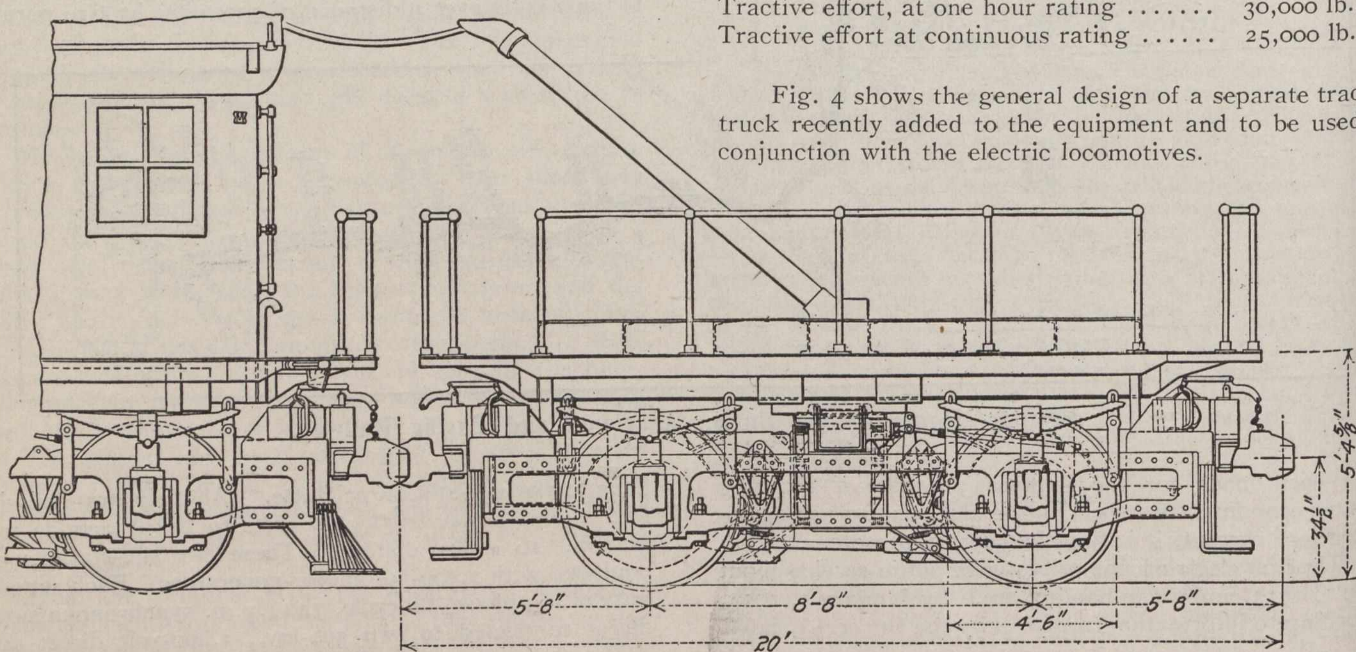

Fig. 4.—Separate Tractor Truck, for Use with Electric Locomotive.

RAILROAD SLEEPERS FOR SCOTLAND.

In view of the fact that an increased and more direct steamship service is anticipated between British Columbia and Glasgow, when the Panama canal is open, the Glasgow authorities have announced what specifications are required for railroad sleepers, or ties, in that market. At present the trade is for the most part with the Baltic for sleepers made from what is known as red wood.

The blocks from which the sleepers are to be cut should be of good sound timber, straight, free from shakes, large or loose knots, or other blemishes, and reasonably free from sapwood, water and dirt.

The sleepers should be cut from blocks not less than 8 feet 11 inches long, each block being sawn up the middle so as to form two sleepers. The blocks should be of such transverse dimensions that at least 90 per cent. of the sleepers shall be, after sawing, 10 inches broad and not less than 4⅞ inches thick, with a flat surface on the upper side not less than 7 inches in width throughout the entire length of the sleeper. The remainder, which must not exceed 10 per cent. of the total quantity, should be, after sawing, 10 inches broad, and not less than 4¾ inches thick, with a flat surface on the upper side not less than 6½ inches in width throughout the entire length of the sleeper.

The sleepers should be accurately gauged, and all those which do not comply with the requirements specified above should be rejected. Some buyers do the sawing of the blocks in Glasgow. Other details would be a matter of correspondence between buyer and seller.

SURGE TANK PROBLEMS III.

ANALYSIS AND GRAPHICAL REPRESENTATION OF PROBLEMS DUE TO CONDITIONS OF VARYING OUTFLOW TO PARTIAL OR COMPLETE SHUT-DOWN OR OPENING.

By PROF. FRANZ PRASIL.

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

Case C.—Variable Outflow.

In the following, we consider first the influence of a gradual shut-down and opening of the penstock, and secondly the case when the outflow is variable with respect to time. The movement during the period of a gradual shut-down will be quite different from that after the shut-down. Therefore, we must consider both cases separately.

(1) Movement During the Shut-down.—We assume that the closing occurs so that the outflow decreases in direct proportion to the time which is expressed by the formula:

$$q = Q_1 \left(1 - \frac{t}{\mathrm{T}}\right) \quad (56); \qquad \mathrm{T} = \text{time for complete shut-down}$$

Therefore,

$$c = c_1 \left(1 - \frac{t}{\mathrm{T}}\right) \qquad \frac{dc}{dt} = -\frac{c_1}{\mathrm{T}}$$

Similar to equation (23) we get the special principal equation (57) in the following form:

$$\frac{d^2z}{dt^2} + \frac{1}{T_0} \cdot \frac{dz}{dt} + \frac{z}{T^2} + \frac{c_1}{T_0}\left(1 - \frac{t}{\mathrm{T}}\right) - \frac{c_1}{\mathrm{T}} = o \qquad (57)$$

The general integral of this equation may be obtained by means of the theory of linear differential equations of the second order.

The general member is $z_1 = R\,e^{-\frac{t}{2T_0}} \sin\left(\beta + \frac{t}{T_1}\right)$

The particular integral $z_2 = b_1 + b_2 . t$ when b_1 and b_2 may be determined by inserting the value of z_2, also $\frac{dz}{dt} = b_2$ and $\frac{d^2z}{dt^2} = o$ in equation 57.

Therefore,

$$\frac{b_2}{T_0} + \frac{b_1}{T^2} + \frac{b_2 t}{T^2} + \frac{c_1}{T_0} - \frac{c_1 t}{T_0 \mathrm{T}} - \frac{c_1}{\mathrm{T}} = o \qquad (58)$$

As the conditions of this equation must be fulfilled for all values of t the two equations follow:

$$\frac{b_2}{T_0} + \frac{b_1}{T^2} + \frac{c_1}{T_0} - \frac{c_1}{\mathrm{T}} = o; \qquad \frac{b_2}{T^2} - \frac{c_1}{T_0 \mathrm{T}} = o \qquad (59)$$

As $h_1 = \frac{c_1 T^2}{T_0}$ $\quad b_1 = h_1 \left[\frac{T_0}{\mathrm{T}}\left(1 - \frac{T^2}{T_0^2}\right) - 1\right]$ $\quad b_2 = \frac{h_1}{\mathrm{T}}$

The general integral is obtained by the form $z = z_1 + z_2$.

Therefore,

$$z = R.e^{-t/2T_0} \sin(\beta + t/T_1) + b_1 + b_2 t \qquad (60)$$

And with differentiation with respect to t $\left(tg\,\gamma = \frac{2\,T_0}{T_1}\right)$

$$s = \frac{R}{T} e^{-t/2T_0} \sin(\gamma - \beta - t/T_1) + b_2 \qquad (61)$$

In order to obtain the constant for the integration, consider that for $t = o$, $z = z_0 = -h_1$, as in case (*A*), but that $s = s_0 = o$, because the shut-down occurs gradually. Therefore:

$$R \sin\beta = -h_1 \frac{T_0}{\mathrm{T}} \left[1 - \frac{T^2}{T_0^2}\right]$$

$$R \cos\beta = -h_1 \frac{T_1}{2\mathrm{T}} \left[3 - \frac{T^2}{T_0^2}\right]$$

$$R = h_1 . \frac{T_0}{\mathrm{T}} . \frac{T_1}{T} \quad (62) \qquad tg\,\beta = 2\,\frac{1 - \frac{T^2}{T_0^2}}{3 - \frac{T^2}{T_0^2}} . \frac{T_0}{T_1} \quad (63)$$

For the graphical demonstration of these functions we may separate them into three equations. For instance, the z — function into

$$r = R\,e^{-t/2T_0\,\phi}; \quad z_1 = r \sin(\beta + \phi); \quad z_2 = b_1 + (b_2 T_1)\,\phi. \qquad (64)$$

The value of r determines again a logarithmic spiral with the slope $tg\,\alpha = -\frac{T_1}{2\,T_0}$ with the initial vectors r_0 and β.

z_1 is obtained in the rectangular co-ordinate system by projection from the polar system as in the former cases. z_2 in the same rectangular co-ordinate system is a straight line which intersects the ordinate axis at the distance b_1 from the initial point and whose inclination to the axis of abscissæ is fixed by the direction constant $b_2 . T_1$. The algebraic sum of $z_1 + z_2$ gives z. (See Fig. 5.) But only that part of the curve which lies between the values of the abscissæ o and T is of practical importance because at the time T the complete shut-down has already occurred (as we assumed).

(2) Movement After Completed Shut-down.—After the shut-down has occurred, the movement of the water

surface continues as described in case (*A*). Therefore, from this moment the following equations are effective:

$$z = R_1 e^{-t/2T_0} \sin(\beta_1 + t/T_1) \qquad (65)$$

$$s = \frac{R_1}{T} e^{-t/2T_0} \sin(\gamma - \beta_1 - t/T_1) \qquad (66)$$ (see equations 32 and 35).

$$R_1 \sin\beta_1 = z_T$$

$$R_1 \cos\beta_1 = \left(s_T + \frac{z_T}{2T_0}\right)$$

where z_T and s_T are limiting values of the first period.

The demonstration of the movement may be developed according to the same method as in case (*A*). For the computation of the value of the most practical importance (the maximum elevation), we get

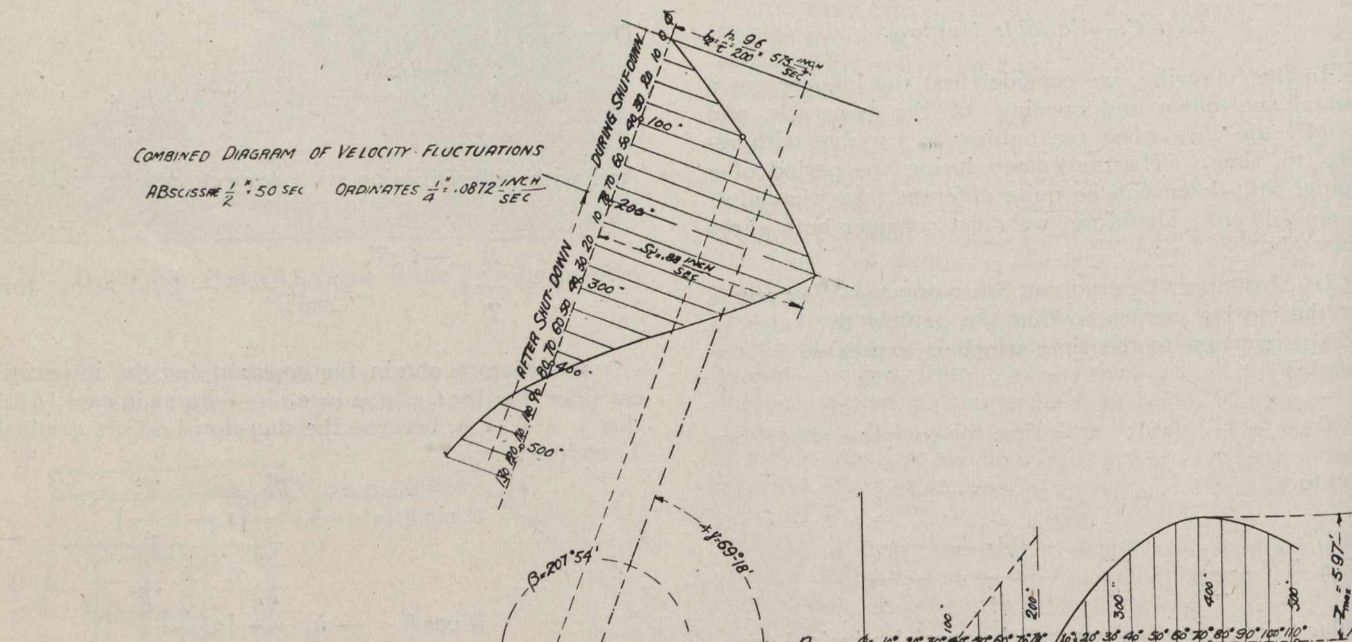

Fig. 5.

Where $tg\,\gamma = \frac{2T_0}{T_1}$

The constants R_1 and β_1 have to be determined from the value of z and s computed for $t = T$. In order to obtain an easier computation, we measure the time for the second period from the moment of the completed shut-down, so that the following equations for the determination of the constants R_1 and β_1 are in effect:

$$z\,\max = R_1 e^{-\frac{T_1}{2T_0}(\gamma - \beta_1)} \sin\gamma \qquad (67)$$

(3) Practical Example.—The computation in connection with the preceding example follows for a shut-down in 10, 100 and 200 seconds, with a discharge of 530 cubic feet per second.

With $T = 137.5$ seconds, $T_0 = 194.5$ seconds, $T_1 = 147$ seconds, $h_1 = 9.6$ feet, we get the following table:

for T =	10 sec.	100 sec.	200 sec.
$b_1 = h_1 \left[\frac{T_0}{\mathrm{T}}\left(1 - \frac{T^2}{T_0^2}\right) - 1\right] =$	+83.3 feet	—.264 feet	— 4.93 feet
$b_2 = \frac{h_1}{\mathrm{T}} =$	.96 $\frac{\text{feet}}{\text{sec.}}$	.096 $\frac{\text{feet}}{\text{sec.}}$	.048 $\frac{\text{feet}}{\text{sec.}}$
$R = h_1 \cdot \frac{T_0}{\mathrm{T}} \cdot \frac{T_1}{T} =$	200 feet	20 feet	10 feet
$tg\beta = \dfrac{2\left(1 - \frac{T^2}{T_0^2}\right) T_0}{\left(3 - \frac{T^2}{T_0^2}\right) T_1} =$	·530	·530	·530
	$\beta = 207^\circ\ 54'$	arc $\beta = 3.628$	$\gamma = 69^\circ\ 18'$; arc $\gamma = 1.210$
z_{T} =	—9.10 feet	—4.85 feet	—1.05 feet
s_{T} =	.097 $\frac{\text{feet}}{\text{sec.}}$	.091 $\frac{\text{feet}}{\text{sec.}}$	.0735 $\frac{\text{feet}}{\text{sec.}}$
$R_1 \sin \beta_1$ =	—9.10 feet	—4.85 feet	—1.05 feet
$R_1 \cos \beta_1$ =	+11.05 feet	+11.6 feet	+10.4 feet
R_1 =	14.30 feet	12.55 feet	10.45 feet
β_1 negative =	—39° 30′	—22° 44′	—5° 46′
arc β_1 =	—.6894	—.3968	—.1006
z max =	+6.53 feet	+6.40 feet	+5.97 feet

From the graphical demonstration (Fig. 4)* we see that the period of shut-down up to 100 seconds influences the maximum elevation a very small amount indeed. The explanation for this is that during this period the velocity of flow in the main conduit decreases very little. For the determination of the dimensions of the surge tank, we have, therefore, to consider the results of the limiting case, that is, the sudden shut-down. The computation for that condition is a much simpler one, (case A). For a gradual opening, the same relations exist. The lowering of the level $n - n$ occurs to the same extent and for the same duration as the rise above the initial level in the case already computed.

Of special interest is the case of an outflow, which is variable in the sense that the outflow increases considerably during a certain time and decreases afterwards to the same amount as before or to some other amount, (for instance, in a plant for railway operation).

1. Analytical Investigation.—We assume now, that under circumstances similar to those above mentioned, the following law of outflow is effective:

$$q = \epsilon . Q_1 (1 + f \sin t/\mathrm{T})$$

so that for the time

$t = o;\quad t = \frac{\pi . \mathrm{T}}{2};\quad t = \pi \mathrm{T}$ q becomes resp. $= \epsilon Q_1;$

$\epsilon Q_1 (1 + f);\ \epsilon Q_1$ - - (68)

after the time $t = \pi . \mathrm{T}$ the outflow may be constant again. ϵ and f are natural numbers. f is the proportion of the maximum increase of the outflow to the normal outflow. So that

$$c = \frac{q}{A} = \epsilon c_1 \left(1 + f \sin \frac{t}{\mathrm{T}}\right) \qquad \frac{dc}{dt} = \epsilon . f . \frac{c_1}{\mathrm{T}} \cos \frac{t}{\mathrm{T}}$$

Equation 23 may then be written:

$$\frac{d^2z}{dt^2} + \frac{1}{T_0} . \frac{dz}{dt} + \frac{z}{T^2} + \frac{\epsilon . c_1}{T_0} + \frac{\epsilon . f . c_1}{T_0} \sin \frac{t}{\mathrm{T}} + \frac{\epsilon . f . c_1}{\mathrm{T}} \cos \frac{t}{\mathrm{T}} = o \quad (69)$$

If we introduce

$$z = y - \frac{\epsilon c_1 T^2}{T_0} = y - \epsilon h_1;\ \frac{dz}{dt} = \frac{dy}{dt};\ \frac{d^2z}{dt^2} = \frac{d^2y}{dt^2} \quad (70)$$

and further,

$$\epsilon . f . c_1 \left[\frac{1}{T_0} \sin \frac{t}{\mathrm{T}} + \frac{1}{\mathrm{T}} \cos \frac{t}{\mathrm{T}}\right] = \epsilon . f . c_1 \sqrt{\frac{1}{T_0^2} + \frac{1}{\mathrm{T}^2}} \sin \left(\phi + \frac{t}{\mathrm{T}}\right) \quad (71)$$

with $tg\,\phi = \frac{T_0}{\mathrm{T}}$ then the equation 69 transposes to

$$\frac{d^2y}{dt^2} + \frac{1}{T_0} \frac{dy}{dt} + \frac{y}{T^2} + \epsilon . f . c_1 \sqrt{\frac{1}{T_0^2} + \frac{1}{\mathrm{T}^2}} \sin \left(\phi + \frac{t}{\mathrm{T}}\right) = o \quad (72)$$

*See *The Canadian Engineer* August 27th, Page 370.

and it then follows again from the theory of differential equations of the second order that $y = y_1 + y_2$, that is,

$$y_1 = R.e^{-t/2T_0} \sin(\beta + t/T_1) \text{ general integral} \quad (73)$$

$$y_2 = b \sin\left(\psi + \frac{t}{\mathrm{T}}\right) \text{ particular integral} \quad (73)$$

The latter may also be written

$$y_2 = b.\sin\psi \cos\frac{t}{\mathrm{T}} + b\cos\psi \sin\frac{t}{\mathrm{T}} \quad (74)$$

The integration constants R and β may be obtained from the initial phase and the constants b and ψ by forming the equations

$$\frac{dy_2}{dt} = \frac{b}{\mathrm{T}}\cos\left(\psi + \frac{t}{\mathrm{T}}\right) = \frac{b}{\mathrm{T}}\cos\psi\cos\frac{t}{\mathrm{T}} - \frac{b}{\mathrm{T}}\sin\psi\sin\frac{t}{\mathrm{T}}$$

$$\frac{d^2y_2}{dt^2} = -\frac{b}{\mathrm{T}^2}\sin\left(\psi+\frac{t}{\mathrm{T}}\right) = -\frac{b}{\mathrm{T}^2}\sin\psi\cos\frac{t}{\mathrm{T}} - \frac{b}{\mathrm{T}^2}\cos\psi\sin\frac{t}{\mathrm{T}}$$

We then introduce these values in the differential equation and combine the members containing $\cos t/\mathrm{T}$ and $\sin t/\mathrm{T}$

$$\left[-\frac{b}{\mathrm{T}^2}\sin\psi + \frac{b}{\mathrm{T}T_0}\cos\psi + \frac{b}{T^2}\sin\psi + \epsilon.f.c_1\sqrt{\frac{1}{T_0^2} + \frac{1}{\mathrm{T}^2}}.\sin\phi\right]\cos\frac{t}{\mathrm{T}} +$$

$$\left[-\frac{b}{\mathrm{T}^2}\cos\psi - \frac{b}{\mathrm{T}T_0}\sin\psi + \frac{b}{T^2}\cos\psi + \epsilon.f.c_1\sqrt{\frac{1}{T_0^2} + \frac{1}{\mathrm{T}^2}}.\cos\phi\right]\sin\frac{t}{\mathrm{T}} = 0$$

and as these equations hold good for all values of t, the terms in both parentheses must become 0. One thus obtains two equations with the unknowns b and ψ and considering that $tg\phi = \frac{T_0}{\mathrm{T}}$ and $h_1 = \frac{c_1 T^2}{T_0}$, it follows

$$b = -\epsilon.f.h_1 \frac{\sqrt{1 + \frac{T_0^2}{\mathrm{T}^2}\left[-\frac{T^2}{\mathrm{T}^2} + \frac{T^2}{T_0^2} - 1\right]^2}}{1 + \frac{T^2}{\mathrm{T}^2}\left[-\frac{T^2}{\mathrm{T}^2} + \frac{T^2}{T_0^2} - 2\right]} \quad (75)$$

$$tg\,\psi = -\frac{T_0}{\mathrm{T}}.\left[-\frac{T^2}{\mathrm{T}^2} + \frac{T^2}{T_0^2} - 1\right]$$

For the determination of the integration constants R and β, it must be considered that for

$$t = 0; \quad z = -\epsilon h_1; \quad y = 0; \quad s = 0.$$

We obtain for this case the equations

$$R.\sin\beta = -b.\sin\psi$$

$$R.\cos\beta = -b\left[-\frac{T_1}{\mathrm{T}}\cos\psi + \frac{T_1}{2T_0}\sin\psi\right] \quad (76)$$

During the variation of the outflow the following equations are effective:

$$\left.\begin{aligned} z &= \epsilon.h_1 + R e^{-\frac{t}{2T_0}}\sin\left(\beta + \frac{t}{T_1}\right) + b\sin\left(\psi + \frac{t}{\mathrm{T}}\right) \\ s &= -\frac{R}{T}e^{-\frac{t}{2T_0}}\sin\left(\gamma - \beta - \frac{t}{T_1}\right) + \frac{b}{\mathrm{T}}\cos\left(\psi + \frac{t}{\mathrm{T}}\right)\end{aligned}\right\} \text{ with } tg\,\gamma = \frac{2T_0}{T_1}$$

ψ amounts generally to about $\frac{3\pi}{2}$ which relation simplifies the computation of R and β.

The variation ceases (as we assumed) after the time $t = \pi.\mathrm{T}$. The values which correspond to the elevation of the water surface and velocity at that time are obtained by the formulæ:

$$z_{\mathrm{T}} = -\epsilon h_1 + R e^{-\frac{\mathrm{T}}{2T_0}}\sin\left(\beta + \pi\frac{\mathrm{T}}{T_1}\right) - b.\sin\psi$$

$$s_{\mathrm{T}} = -\frac{R}{T}e^{-\frac{\mathrm{T}}{2T_0}}\sin\left(\gamma - \beta - \pi\frac{\mathrm{T}}{T_1}\right) - \frac{b}{\mathrm{T}}\cos\psi \quad (77)$$

For further investigation, the formulæ of case (A) may be applied. In order to simplify matters, in the determination of the further movement, we measure the time from the instant of the beginning of the constant outflow and logically we must use the limiting values of the preceding phase for the determination of the integration constants R_1 and β_1.

If we do not hinder the variation of the outflow but maintain the law $\epsilon Q_1\left(1 + f\sin\frac{t}{\mathrm{T}}\right)$, we see that the movement of the water surface in the surge tank takes the form of a forced oscillation; where the influence of the first member decreases with the increase of t and this the quicker the larger the value of $\frac{T_1}{2T_0}$ becomes in the member

$$e^{-\frac{t}{2T_0}} = e^{-\frac{T_1}{2T_0}.\frac{t}{T_1}}$$

The movement of the level of the water surface is merely that of a harmonic oscillation. In such cases it is well known that the phenomenon of resonance may occur, if the period of the actuating influence has the same duration as the swinging bodies' own period, that is to say, if, in the case mentioned $\mathrm{T} = T$. The value of the amplitude of the forced oscillation is then

$$b = -\epsilon f h_1 \frac{\sqrt{1 + \frac{T^2}{T_0^2}}}{T^2/T_0^2} = -\epsilon f h_1\sqrt{\frac{T_0^2}{T^2} + 1}\,.\,\frac{T_0}{T} \quad (78)$$

We obtain the angle ψ from $tg\,\psi = -\frac{T}{T_0} = -\frac{1}{tg\,\phi}$ (79)

because $\frac{T_0}{\tau} = tg\,\phi$ and $\tau = T$.

According to the theory of the phenomena of resonance, the amplitude of the forced oscillation becomes of infinite value when the damping force is infinitely small. The latter would be the case, using our terms, when T_0 = infinite with which value the amplitude of the abovementioned equation also becomes infinite. The phase difference between force and movement has thereby to be

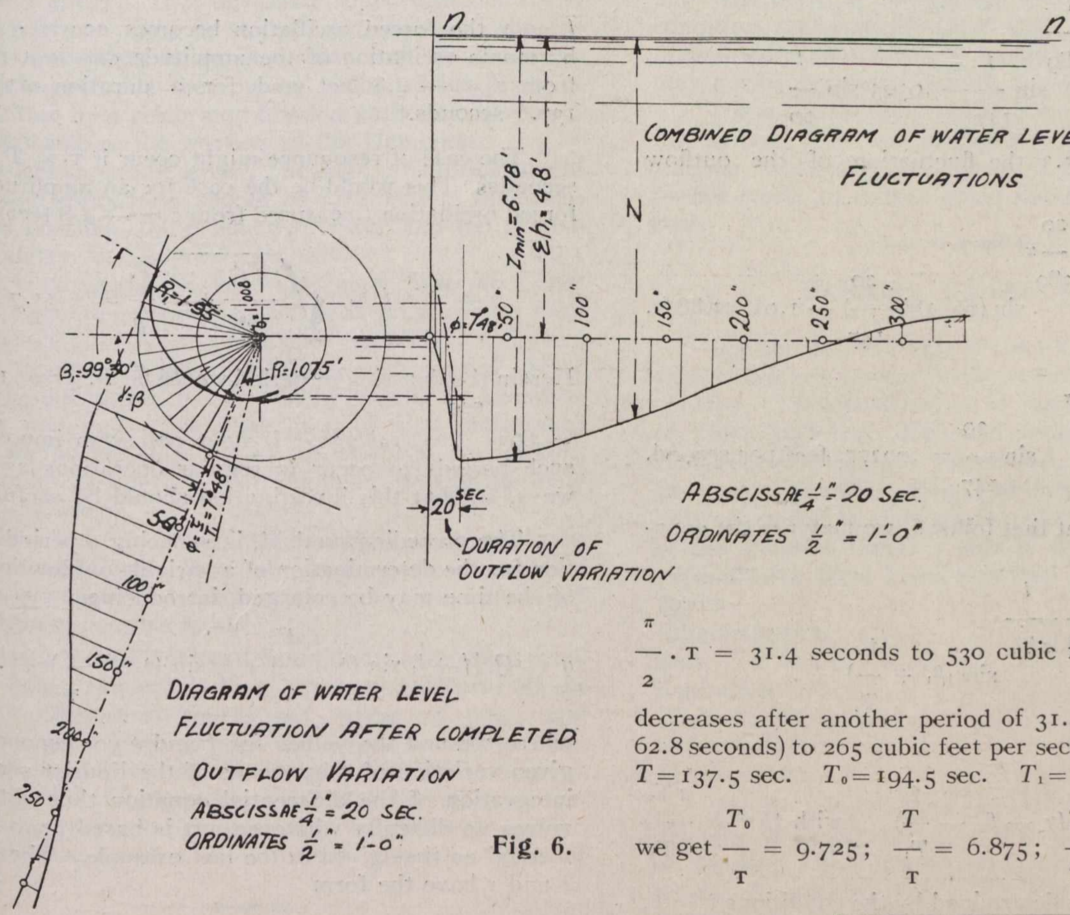

Fig. 6.

equal to $\frac{\pi}{2}$, which also finds its expression in this equation (79).

2. Graphical Demonstration.—The graphical demonstration of the movement of the first phase is not difficult. The demonstration of the values

$$z_1 = R\,e^{-\frac{t}{2T_0}} \sin\left(\beta + \frac{t}{T_1}\right)$$

may be carried out in the same form as before by means of the projection of the logarithmic spiral. The demonstration of

$$z_2 = b \,.\, \sin\left(\psi + \frac{t}{\tau}\right) = b \sin\left(\psi + \frac{T_1}{\tau} \,.\, \frac{t}{T_1}\right)$$

is obtained by projection of a circle, constructed with the radius b in the polar system, where the initial vector is inclined against the axis of abscissæ with an angle ψ.

In this case a rotation of the initial vector of z_1 by an amount of 2π corresponds to a rotation of the initial vector of z_2 by an amount equal to $\frac{T_1}{\tau} 2\pi$. (See Fig. 6.)

3. Analytical Example.—We use the same conduit and surge tank dimensions and assume the same friction conditions. As before, we take $\epsilon = 0.5$; with $f = 1$ and for $\tau = 20$ seconds we have an initial flow of 265 cubic feet per second which increases during the time $\frac{\pi}{2} \,.\, \tau = 31.4$ seconds to 530 cubic feet per second, and decreases after another period of 31.4 seconds (a total of 62.8 seconds) to 265 cubic feet per second. Therefore, with $T = 137.5$ sec. $T_0 = 194.5$ sec. $T_1 = 147$ sec. $h_1 = 9.6$ ft.

we get $\frac{T_0}{\tau} = 9.725$; $\frac{T}{\tau} = 6.875$; $\frac{T}{T_0} = .707$

$$b = -\epsilon f h_1 \frac{\sqrt{1 + \frac{T_0^2}{\tau^2}\left[\frac{T^2}{\tau^2} + \frac{T^2}{T_0^2} - 1\right]^2}}{1 + \frac{T^2}{\tau^2}\left[\frac{T^2}{\tau^2} + \frac{T^2}{T_0^2} - 2\right]} = -1.008 \text{ feet}$$

$$tg\,\psi = -\frac{T_0}{\tau}\frac{T^2}{\tau^2}\left[\frac{T^2}{\tau^2} + \frac{T^2}{T_0^2} - 1\right] = -457.1$$

ψ lies in the fourth quadrant and is equal to 270° 7′ 50″, which is practically 270°. With the latter value $\sin\psi$ becomes -1 and $\cos\psi = 0$. We get

$$R \sin\beta = +b \qquad R\cos\beta = +\frac{T_1}{2T_0}$$

and therefore

$$tg\,\beta = \frac{2T_0}{T_1} = tg\,\gamma \qquad \beta = \gamma = 69^\circ\ 18'$$

$$R = b \sqrt{1 + \frac{T_1^2}{(2\,T_0)^2}} = b \,.\, T_1 \sqrt{\frac{1}{T_1^2} + \frac{1}{(2\,T_0)^2}} =$$

$$b \,.\, \frac{T_1}{T} = -\,1.008 \,.\, \frac{147}{137.5}$$

$R = -\,1.075$ feet, therefore

$$z = -\,4.8 - 1{,}075 \cdot e^{-\frac{t}{389}} \sin\left[69^\circ\,18' + \frac{t}{147}\right] + 1.008 \cos\frac{t}{20}$$

$$v = +\,.00782\, e^{-\frac{t}{389}} \sin\frac{t}{147} - .0503 \sin\frac{t}{20}$$

If at the time $t = \pi . T$ the fluctuation of the outflow ceases it follows that

$$z_T = -4.8 - 1.075\, e^{-\frac{20}{389}\pi} \sin\left(69^\circ\,18' + \frac{20}{147}\right) - 1.01 = 2.88 \text{ ft.}$$

$$v_T = .00782\, e^{-\frac{20}{389}\pi} \sin\frac{20}{147} = .00275 \text{ feet per second.}$$

For the movement that follows, we may use the equations (32) and (35)

$$z = -\,\epsilon h_1 + R_1\, e^{-\frac{t}{2\,T_0}} \sin\left(\beta_1 + \frac{t}{T_1}\right)$$

$$s = -\frac{R_1}{T} e^{-\frac{t}{2\,T_0}} \sin\left(\gamma - \beta_1 - \frac{t}{T_1}\right) \quad \text{with } tg\,\gamma = \frac{2\,T_0}{T_1}$$

and R_1 and β_1 may be determined by the conditions $t = o$, $z = z_T$, $s = s_T$. We obtain

$R_1 \,.\, \sin\beta_1 = -\,9.6 + 2.88 + 4.8 = -\,1.92$ feet

$R_1 \,.\, \cos\beta_1 = .00275 \,.\, 147 - 1.92\,\frac{147}{389} = -\,.321$ feet

$R_1 = 1.95$ feet; β_1 lies in the third quadrant, i.e., negative.

$tg\,\beta_1 = 5.98975$ $\quad \beta_1 = -\,99^\circ\,30'$ $\quad$ Arc $\beta_1 = -\,1.737$

$\gamma = 68^\circ\,18'$ $\quad$ arc $\gamma = 1{,}210$

$$z = -\,4.8 + 1.95\, e^{-\frac{t}{389}} \,.\, \sin\left[-\,99^\circ\,30' + \frac{t}{147}\right]$$

$$s = -\,.0142\, e^{-\frac{t}{389}} \,.\, \sin\left[11^\circ\,12' + \frac{t}{147}\right]$$

Since at the time $t = o$ the velocity s is positive, a maximum first occurs. The time from the beginning of that maximum until the beginning of the second phase is $t_1 = 147\,(\gamma - \beta_1) = 433$ seconds.

$$z_1 \text{ min} = -\,4.8 + 1.95\, e^{-\frac{433}{389}} \sin\gamma = -\,4.19 \text{ feet}$$

The general course of the movement may be seen in Fig. 6.

In case of a continuous fluctuation of flow, expressed by the law $q = \epsilon Q_1 \left(1 + f \sin\frac{t}{T}\right)$ with $\epsilon = .5$ and $f = 1$ the forced oscillation becomes nearly a constant harmonic oscillation of the amplitude one foot measured from $z = -\,4.8$ feet and for a duration of period of 137.6 seconds.

The case of resonance might occur if $T = T = 137.5$ seconds. This would be the case for an amplitude of the forced oscillation (measured from $z = -\,4.8$ feet) equal to

$$b = \pm\, \epsilon . f . h_1 \sqrt{\frac{T_0^2}{T^2} + 1 \,.\, \frac{T_0}{T}} = \pm\, 11.7 \text{ feet.}$$

Herein the duration of period would be $T \,.\, 2\pi = 137.5 \cdot 2 \cdot \pi$ sec $= 863 = 14'\,23''$. It does not seem impossible for such periods to occur in regular operations as for railways, so that this investigation should be useful.

The preceding method, introducing a periodical function for the determination of a variable outflow in function of the time may be enlarged, introducing

$$q = \epsilon Q_1 \left[f_0 + f_1 \sin\left(\phi_1 + \frac{t}{T}\right) + f_2 \sin\left(\phi_2 + 2\,\frac{t}{T}\right) + \ldots\right] \quad (80)$$

where we find the values for f and ϕ corresponding to a given variation of q by means of the Fourier series. The integration of the differential equation thus obtained involves no difficulty whatever. It is based upon the same method as that given in the last example. The values of z and s have the form

$$z = z_0 + R . e^{-\frac{t}{2\,T_0}} \sin\left(\beta + \frac{t}{T_1}\right) + \Sigma\, k_n \sin\left(\psi_n + n\frac{t}{T}\right)$$

$$s = s_0 + \frac{R}{T} e^{-\frac{t}{2\,T_0}} \sin\left(\gamma - \beta + \frac{t}{T_1}\right) + \Sigma\, \frac{n . s_n}{T} \cos\left(\psi_n + n\frac{t}{T}\right) \quad (81)$$

Naturally the computation requires great care. The graphical demonstration is obtained by superposition of the projections obtained from the polar system with logarithmic spirals $r = R\, e^{-\frac{T_1}{2\,T_0} . \frac{t}{T_1}}$ and the circles with the radii k.

(To be continued.)

Editorial

"Business as Usual"

ORDERS AND CONFIDENCE.

The opinion was expressed in these columns recently that the government authorities of Canada should do all in their power to continue public works in progress and to commence others. An announcement has come from Ottawa since then that the Dominion government will follow that policy. It is obviously sound economics. If the national machinery is stopped entirely—and the engineering profession is an important cog—only disaster can be brought upon the country. The advice given to Great Britain by a celebrated London authority is exceedingly applicable to the workers of the Dominion.

"Orders should be given," he says, "factories should be run, and everything should be arranged to maintain, as far as possible, the productive power and the income of the country.

"At such a time it is of the greatest importance that every one should endeavor to act as if great events were not impending. Were confidence seriously disturbed business would come practically to an end and our ability to face the difficulties that may be in front of us would be seriously impaired. Therefore, it is of vital importance that as far as possible, the events that are now taking place should not interfere with the daily life and the daily work of the nation.

"Every one, according to his ability, must endeavor to work hard in order that individual incomes and therefore the income of the whole nation, may be maintained at the highest possible level."

These are excellent sentiments and carried into practice will help considerably to overcome the adverse effects of war. Engineers, buyers and sellers of plant and machinery must give to the national situation at least their individual share of confidence and a share of business, even if it is somewhat reduced. To withdraw entirely both orders and confidence is inimical not only to their own interests but also to the general welfare of Canada.

THE COST OF NOISE.

Have the efficiency engineers about whose work we have heard much in recent years, given attention to the factor of noise in the engineering field and in machine plants generally? There is an enormous waste of labor and energy apparent in large works and in big factories, as a result of noise. To the engineer, it is as cumbersome in the final analysis, as so-called hustle is to the American business man. In a recent conversation reported in Metallurgical and Chemical Engineering the superintendent of a large stamp-mill made the observation that "noise costs money." The reporter goes on to say:

"We have been discussing the use of stamps as crushing machines and the comparative merits of various devices for crushing ore. One of the arguments advanced by this superintendent against the use of stamps was the tremendous and never-ending noise produced by the falling weights. In his opinion the din was responsible for many misunderstood directions and orders to employees, resulting in confusion, loss of time, and expensive mistakes. The point is readily perceived. The average mill employee is anxious to give the impression that he understands the boss's orders, and rather than ask a question for further information he will sometimes pretend to understand and then go and seek advice from a fellow workman. The order may be wrongly executed or not at all. The noise of the stamps contributes greatly to this condition, makes it difficult to give and receive orders, and undoubtedly causes many mistakes. The cost of noise may not be estimated exactly, but it is a real factor."

These are excellent contentions. It would be interesting to hear from the efficiency engineers operating in Canada, what they are doing in the course of their effective work, to reduce noise and consequently its heavy cost.

PANAMA CANAL OPENED.

The opening to traffic of the Panama Canal on August 15th was a great event in the commercial and engineering spheres. The construction of the Canal, various phases of which have been described from time to time in *The Canadian Engineer*, is considered, and justly, one of the greatest engineering events of modern days. There has been expended to date on the purchase and construction of the Panama Canal a sum of $360,173,375.33 These expenditures have been classified as follows to May 1, 1914:—

Administration	$ 7,004,684
Law	60,109
Sanitation	17,208,154
Construction	206,117,831
General items	90,167,566
Fortifications	6,200,505

For the benefit of commerce, it comes into being when shipping is disorganized by war. It follows the opening of the Kiel Canal, which was built largely for war purposes. A peaceful vessel, the Panama Railway steamer Ancon, was the first to pass through the famous Canal from the Atlantic to the Pacific. The battleships of belligerent nations may be among the earliest visitors to the great waterway. Their passage through the Canal is governed by regulations which were formulated in times of peace. They may not remain in the Canal for more than twenty-four hours, unless specially permitted. A war vessel of one nation must not follow the exit, from the Canal, of one of another nation, until after the expiration of twenty-four hours. The Canal has been opened at an inauspicious time. Rival battle-fleets are intent on serious gunnery. Commercial fleets are idle, lame or stealthy. But better times are in store. They may have come when President Wilson, in March, 1915, presides at the international celebration which will mark the official opening of the Canal.

A boat can make in eleven hours a trip through the Canal which otherwise would have taken thirty days. That is something the world's shipping will appreciate in due course. Europe is engaged at present in work of destruction. America, in the meantime, has completed one of the greatest engineering works of construction.

PERSONAL.

MESSRS. T. T. WILSON, J. B. PHILLIPS, W. YOUNGMAN, R. WHITSIDE, and F. MINNVILLE, are engineers recently appointed to positions on the staff of the Manitoba Highway Commission.

G. GORDON GALE, since 1907 connected as a superintendent with the Hull Electric Company, has recently been promoted to the general managership of the company. Mr. Gale graduated from McGill University; and, previous to his connection with the Hull Electric Company, he was assistant engineer of the electric plant of the Canadian Rubber Company. His positions as superintendent with the former company during the past seven years have been superintendent of power, acting superintendent, and for five years, general superintendent.

J. A. RUDDICK, chief engineer of the Dominion Coal Company, Sydney, N.S., has resigned his position to accept a similar one in Canada. While in charge of the construction department of the Dominion Coal Company during the past two years, Mr. Ruddick supervised the building of the new pier for the I.C.R., the coal-washer at Whitney pier—the only one of its type in Canada—as well as several large structures in connection with the company's different collieries. No details have been announced relative to Mr. Ruddick's new appointment.

M. A. LYONS, a graduate of 1910 from the Massachusetts Institute of Technology, has been appointed to the office of Chief Engineer to the Highway Commission of Manitoba. Mr. Lyons is to have general supervision of survey, design and construction of roads and bridges under the recent "Good Roads Act" in that province. His headquarters will be in the Parliament Building, Winnipeg. In 1911, Mr. Lyons became assistant engineer for the Canadian Pacific Railway in the irrigation department; in 1912, drainage district engineer for the Manitoba department of public works; and since 1913, bridge engineer for the latter department.

OBITUARY.

The death occurred on August 25th of Roderick J. MacDonald Parke, consulting electrical engineer, member of the Canadian Society of Civil Engineers as well as of the Canadian Society of Electrical Engineers, member of the Board of Trade, and at the time of his death managing director of the Automatic Electric Cook Co., Limited, Toronto. Mr. Parke is noted as the designer of the first long distance transmission plant in Canada, viz., from the Ragged Rapids, on the Severn River, to Orillia. He was chosen by Mr. Urquhart, former mayor of Toronto, to report upon the cost of distributing electricity throughout the city; and this report was used in part when the design now in operation was being prepared. He prepared plans for the Dominion Government and supervised the lighting construction of the old Welland Canal. He was formerly head of the firm of Parke & Leith, an agency for the British Aluminum Company, Limited; and, as a result of his labors in this industry, he founded the Canada Wire and Cable Company, Limited. The firm with which Mr. Parke was connected at the time of his death was promoted to exploit a patent invented by the deceased.

ADVANCE PROGRAM FOR NATIONAL PAVING BRICK MANUFACTURERS' ASSOCIATION.

Part of the program to be undertaken at the annual meeting at Buffalo, N.Y., September 9th, 10th and 11th, of the National Paving Brick Manufacturers' Association, has been given out by W. P. Blair, secretary of the association. Sept. 9th will be utilized by the members for their business meeting. A discussion with the brick committee of the American Society of Municipal Improvements over specification questions will be held on the evening of the 9th. The itinerary and program on the 10th will include a trip through the city and out into the country over the older as well as the newer highways, observing those under construction. On September 11th a trip will be taken over the Niagara Boulevard to Fort Niagara. Details may be obtained from W. P. Blair, secretary, Brotherhood of Locomotive Engineers Building, Cleveland, O.

FORT WILLIAM CONVENTIONS CANCELLED.

Notice has been received from Fort William, Ont., to the effect that, due to the unsettled conditions caused by the European war, it has been necessary to cancel the annual meeting of the Canadian Public Health Association, which was to have been held in that city during the month of September.

Due to the same cause, the 1914 convention of the Associated Boards of Trade of Western Canada, which was arranged to convene at Fort William on September 8th, 9th and 10th, has been postponed for an indefinite period.

CONVENTION POSTPONED.

The convention of the Union of New Brunswick Municipalities, to be held at St. John, N.B., has been postponed until November 17th and 18th.

COMING MEETINGS.

INTERNATIONAL WATER-POWER CONGRESS.—Under the auspices of the Ministers of Public Roads and Agriculture. Second international congress, Lyons, France, September 7th to 10th.

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

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