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LARGEST REINFORCED CONCRETE ARCH BRIDGE IN THE WORLD.

There was built last year in Rome a bridge over the Tiber, which possesses special interest because of the fact that the span exceeds everything hitherto attempted in reinforced concrete construction. This bridge is called Ponte del Risorgimento.

The arch proper has a span of 333 ft. (100 m.), with a 33 ft. rise, (Fig. 1).* At the crown the thickness is reduced to the remarkable dimension of 8-in. (20 cm.), from this point it has been increased until it is 20-in. (50 cm.) at the springing lines. The bridge is materially strengthened by 8-in. thick stiffening ribs, which extend its whole length, and over the abutments. These consist of the above-mentioned ribs connected by cross walls and supported by concrete columns, (Fig. 2 and 3), constructed in the following manner.

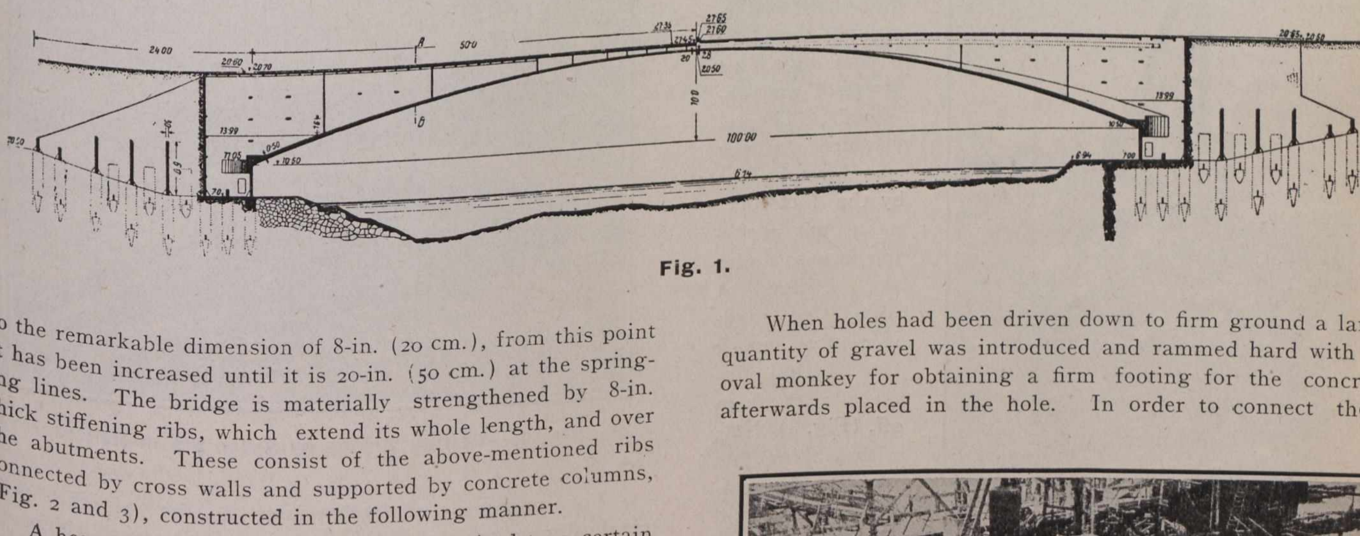

Fig. 1.

A heavy conical hammer, (Fig. 4), is raised to a certain height and is allowed to fall, so that it pierces to firm ground; this is, of course, obtained by repeated operations, similar to pile driving. The form of this hammer ensures the surrounding earth being firm and strong, so that even when driving through loose earth, the walls of the hole will remain standing.

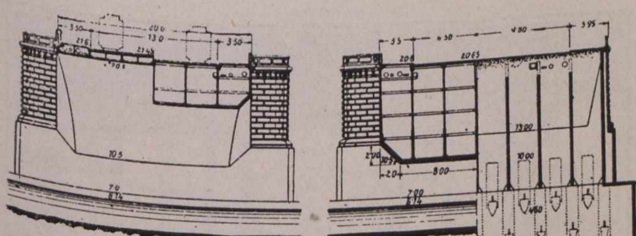

Fig. 2.

In cases where water percolated into the hole it was necessary to adopt some precaution to keep it dry, so as to obtain satisfactory concrete work. The manner of procedure was to introduce a quantity of clay which was compressed against the walls by the action of the rammer; in this way water was successfully kept from interfering with the concrete.

When holes had been driven down to firm ground a large quantity of gravel was introduced and rammed hard with an oval monkey for obtaining a firm footing for the concrete afterwards placed in the hole. In order to connect these concrete piles and the superstructure a number of vertical bars were embedded in the piles.

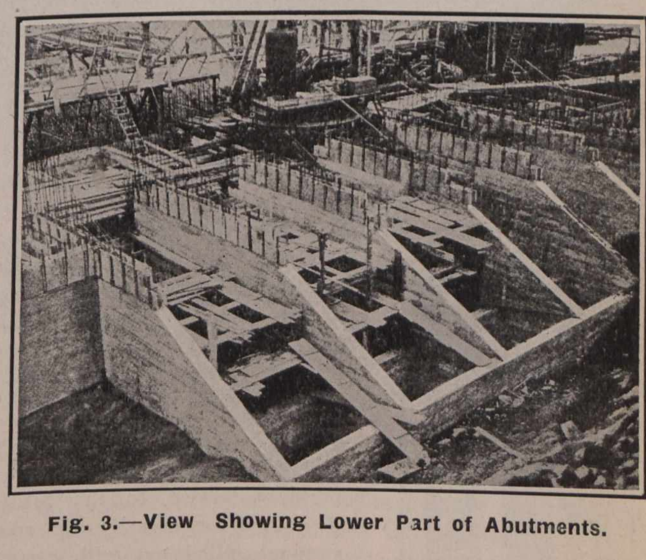

Fig. 3.—View Showing Lower Part of Abutments.

The foundation work was done between the months of January and July, and there were frequent interruptions due to highwater in the river.

* The total width of the dredge between the triangle is 64 ft., of which the roadway is 44 ft. and the sidewalk on each side 10 ft.

At one end of the bridge a wall of rock formed a strong natural protection and prevents any damage being done by the water to the abutments; at the other end of the bridge this protection is obtained by reinforced concrete sheet piling, connected together by tongue and groove joints. These piles were sunk in position by the use of a water jet, the water being brought to the end of the piles under a head of 70 ft.

In the reinforcement of the bridge only two sizes of bars were used,* the unusual section of these bars is shown in Fig. 5, and is the design of Mr. Porchedder, (Turin), the head of the contracting firm who undertook the work.

The whole design is based on a live load of 100 lbs. per sq. ft., or 3 steam rollers weighing 33,000 lbs. each, placed in the most dangerous position.

A remarkable feature in connection with this bridge was the use of reinforced concrete scaffolding, (Fig. 6 and 7). This was of such a nature, that very little resistance was offered to the flow of the water, and at the same time great strength was obtained. The resistance power was brought out by the fact that a steamer in trying to pass under the bridge at high tide inadvertently struck two of the piles and broke them off, (Fig. 8). Notwithstanding this accident the scaffolding was still able to support the recently placed concrete.

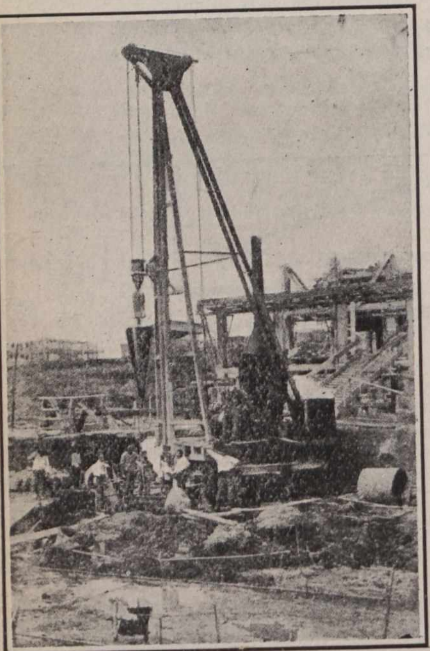

Fig. 4.

The scaffolding was built up so that each row of columns rested on 16 concrete piles placed in two rows and connected above the water-line by a beam, (Fig. 9); each group of piles constitutes a support for reinforced concrete columns, which are again framed together by a second cross beam, on which were laid wedges and wood beams for the forms.

The columns and beams for this scaffolding were constructed separately, floated to the bridge and joined together by the reinforcement, filled out with cement mortar. The erection thus occupied a very short space of time.

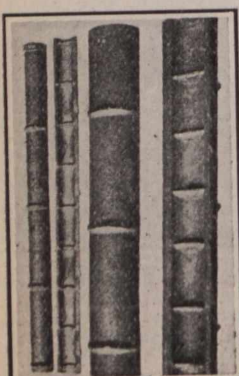

Fig. 5.

*With sectional areas of .175 and .61 sq. in. respectively.

A concrete mixture of 500 lbs. of cement per cubic yard was used, and the consistency was very wet.

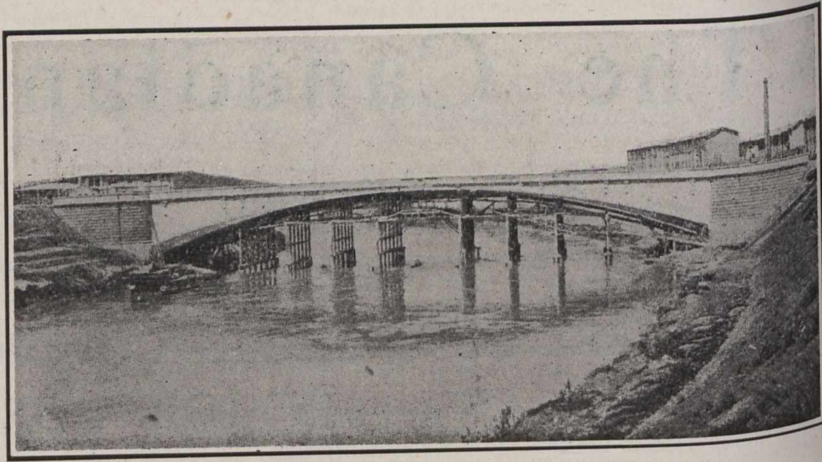

Fig. 6.

The contract price for the bridge was about $200,000.

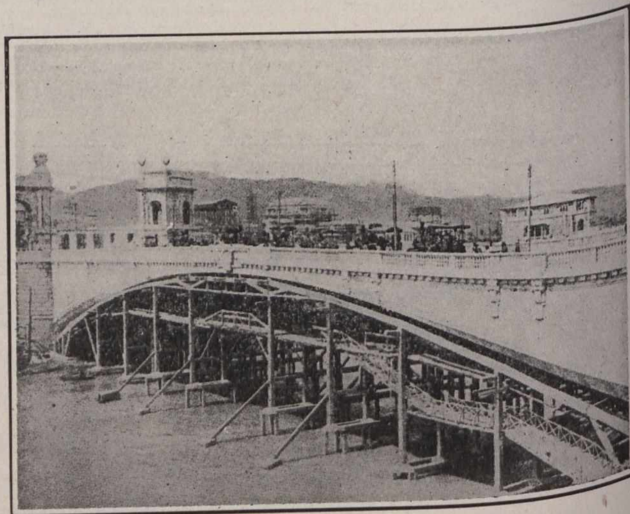

Fig. 7.—Testing Bridge by Seven Steam Rollers.

For purposes of comparison a list of the principal dimensions of some other large arch bridges is given in the table on the following page.

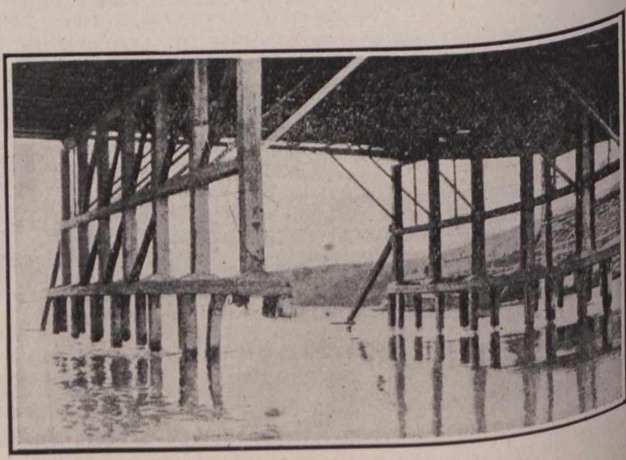

Fig. 8.

On page 847 of this issue of *The Canadian Engineer* will be found an article by Mr. Henry G. Tyrrell entitled "American Impressions of the Risorgimento Bridge at

Rome." This article, read in conjunction with the foregoing description will be of interest to our readers.

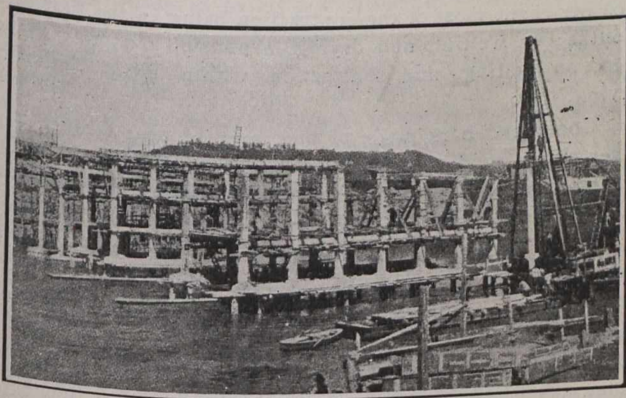

Fig. 9.

Table of Long Concrete Arches.

NAME	Used for	Built in	Span ft.	Rise ft.	Crown-thickness in.	Thickness at springing lines, in.	Material
Bridge over the Petursse-Tal, Luxembourg........	Street ..	1900/03	240	55	57	86	Sandstone
Bridge over the Adda Line Colico-Sondrio, Italy.....	Railway	1902/04	233	34	60	88	Granite
Bridge over the Steyrling Line Wienera - Triest. Austria..................	Railway	1903/04	233	52	80	136	Granite
Bridge over the Isar, Munich.................	Street ..	1903/04	233	42	32	36	Reinforced Concrete
Bridge over the Tsonzo Line Triest-Klagenfurt, Austria..................	Railway	1904/05	284	73	84	140	Limestone
Walnut Lane Bridge in Fairmount Park, Philadelphia..................	Street	1906/08	237	72	67	116	Concrete
Bridge at Teufen, Schwizelaw..................	Street ..	1908	263	88	48	85	Reinforced Concrete
Bridge over the Valserine, France.................	Railway	1908/09	268	66	60	100	Limestone
Grafton Bridge in Auckland, Australia.........	Street ..	1907/10	320	86	67	73	Reinforced Concrete
Bridge in Cleveland (Ohio)	Street ..	1908/10	284	81	73	134	Concrete
Bridge in Milwaukee (Wis.)	Street ..	1909	256	58	48	96	Reinforced Concrete
Bridge in Spokane (Wash.)	Street ..	1909/11	285	117	82	226	Concrete
Bridge in Constantine (France)..................	Street ..	1910/11	233	83	60	60	Concrete

STADACONA HYDRAULIC COMPANY.

Announcement has been made at Quebec of the organization of the Stadacona Hydraulic Company, which is undertaking the development of the power at Seven Falls, back of Ste. Anne de Beaupre. The falls, which have a head of over 400 feet, will at present enable the company to obtain an initial development of 10,000 horse-power. The company is backed by a group of Montreal, Quebec and foreign capitalists, and the arrangements concluded, it is said, will result in the company being able to deliver power by the end of the present year. Among the interests identified with the company are: President, Hon. L. P. Pelletier, postmaster-general of Canada; Sir Rodolphe Forget, M.P.; Neuville Belleau, banker, Quebec; Hon. C. E. Dubord, Quebec, member of the Legislative Council of the Province of Quebec; Mr. D. O. Lesperance, banker, Quebec; Mr. Alfred Bouvier, Brussels; Mr. H. J. Bierman, Shawinigan Falls; and Mr. Andre de la Mornerie, France.

DESTRUCTION OF CEMENT MORTARS AND CONCRETE THROUGH EXPANSION AND CONTRACTION.

One of the most important of the standard tests for Portland cement is that for "Constancy of Volume"—a lulling title which carries with it the implication that our cements are actually constant in volume. It requires no very keen observer to find numerous instances where the implication has not been justified. Cracked copings and walls, sidewalks warped and split, and stucco dropping from houses, are sights which are so frequent as to force upon the observer the feeling that the phenomena must be due to some property characteristic of many if not all concretes which are exposed to the weather.

Professor A. H. White, of the University of Wisconsin, gave the results of his investigation of the subject in a paper before the American Society for Testing Materials. The paper in abstract form, as here given, is most interesting.

The change in volume of concrete due to temperature change has been determined with considerable accuracy to be for unit length 0.0000055, or 0.00055 per cent., per degree Fahrenheit. There are, however, other changes due to the chemical processes of setting and hardening which are barely mentioned in even the more important treatises, and other variations due to the wetting and drying of the concrete whose very existence is practically unknown. It is with these two latter classes of changes that this paper will deal.

The following pages show especially the effect of alternately wetting and drying bars of neat cement and sand mortar. There are also included the behavior of various bars of neat cement kept continuously in water and in air. These are included not only because more data on the subject are desirable, but because the Portland cement now being used is a different material from that tested by the European investigators, who undoubtedly worked with cements made in the old vertical kilns. The modern American cement made in rotary kilns differ from the older not only in method of manufacture but also in chemical composition, and is worthy of separate study.

Experimental Method.—The method of making and measuring the expansion bars was that of Campbell and White. The dimensions of the bars are approximately 1 by 1 by 4 ins., and they contain bevelled glass plates cast into the end to ensure a smooth surface for the micrometric measurements. The Portland cements used were all commercial samples which passed successfully the standard tests for soundness. Standard methods were used in proportioning the water and in mixing. The initial measurement was made after the bar had stood 24 hours in the damp box.

Illustrations from Actual Practice.—It may be urged that the tests were all made on small bars manufactured in the laboratory and that such large values might not be obtained in actual practice.

Bar 156 A is made from a part of the cement sidewalk on the north side of the campus of the University of Michigan. It was laid in 1890 from imported German cement by the University workmen who were paid by the day and under no temptation to slight the work or skimp cement. Most of the slabs of this walk are now warped slightly so that shallow puddles of water stand in them after rain, and even after twenty years the expansion is still occasionally causing adjacent blocks to heave and form an inverted "V." The top layer is split from the bottom in many places and it was from one of these pieces of the top coat that bar 156 A was sawed. An examination of its lower surface shows that the split was not due to faulty bonding, for the break has occurred not at the exact junction of the top coat and base, but just below the upper surface of the base. The top coat carries with it a thin layer of the base. This bar became dampened in the sawing process and was therefore put into water and allowed to become saturated and fully expanded before the measurement recorded as the initial was made. It then contracted slowly for 14 days in the air, the total shrinkage being 0.05 per cent., and on putting it into water it expanded to practically its initial volume in 4 days. When removed from water it contracted again as before.

Another instance to which attention is called is bar 156 E, cut from a piece of cement stucco which came loose from a brick porch after only two years' service. The stucco is well mixed, has a good ring and is hard. The brand of cement used and the proportions are unknown, but it is certainly a rich mixture, probably as high as 1:1. The stucco in coming off did not split off from the brick but in almost all instances carried a thin skin of the brick adhering to it, showing that the fault did not lie in failure to bond the materials together. The behavior of a bar sawed from this stucco is shown in the curves for 156 E. It was sawed to shape without moistening, and when placed in water for 24 hours it expanded 0.07 per cent. and reached 0.08 per cent. after 4 days in water. On drying in air is slowly returned to its original volume. It is not to be wondered at that a stucco which expands practically 1 in. in 100 ft. whenever it gets thoroughly wet, should fail.

Another instance of change of volume in material which has been in use many years is afforded by the study of a section of cement sidewalk which was taken up in good condition after 20 years' service. From this was sawed a bar approximately 1 by 2 by 4 ins., consisting of the top coat 1 by ¾ by 4 ins. on a section of the bottom portion 1 by 1¼ by 4 ins. This bar (156 B) is, therefore, similar in many ways to the compound bars of neat cement and 1:3 mixture before referred to. It showed the usual expansion of both layers in water and the contraction in air which was expected. When placed in water the bottom layer expanded practically its whole amount (0.033 per cent.) in 15 minutes, while the richer top layer expanded in the same time only 0.010 per cent. At the end of 24 hours the top portion had expanded 0.028 per cent., and after 3 days had become practically constant with almost the identical expansion 0.035 per cent., which the bottom showed. This is interesting partly because of the evidence of alternate bending stress in the concrete due to the more rapid expansion of the lower layer and partly because of the ultimate agreement in expansion of the top and bottom portion. Note that this cement sidewalk was in good condition after 20 years' service. It is possible that its satisfactory condition is due to this agreement in coefficient of expansion of the two layers.

Summary of Experimental Data.—In the foregoing there have been presented data on the sadly neglected subject of expansion and contraction of hydraulic cements as they age in water and in air and as they are alternately wet and dry. It should be emphasized, however, that the number of experiments is entirely inadequate to make it proper to quote them as average results. They are to be regarded merely as illustrations of how some acceptable commercial cements have behaved. It is, however, permissible to summarize the extremes to show the range of fluctuation.

Neat cement bars hardening under water.—After 1 year, expansion 0.07 to 0.15 per cent.; 1 year to 4 years almost no change; on drying after 3 years in water, contraction 0.13 to 0.15 per cent.; on wetting again, expansion 0.13 to 0.17 per cent.

Neat cement bars hardening in air.—Contraction after 3 months, 0.14 to 0.28 per cent., after 1 year, 0.18 to 0.34 per cent., with slight increase to 4 years.

Cement-sand bars, 1:3.—Hardening under water, expansion 0.01 to 0.05 per cent., the greatest changes being in the first few weeks; hardening in air, contraction 0.06 to 0.09 per cent., most of the contraction being in the first three months; on wetting and drying, expansion 0.04 to 0.09 per cent. on wetting, and contraction within same limits on drying.

Compound bars made of one layer of neat cement on a layer of 1:3 sand expand and contract together but at different rates and to different degrees. The differential expansion varies from 0.00 to 0.15 per cent.

The one natural rock cement tested showed twice as much variation in volume as Portland cement.

These variations in volume with change of moisture content do not disappear with lapse of years, for changes of 0.05 and 0.06 per cent. have been observed in bars cut from sidewalks which have been laid 20 years.

Changes in Monolithic Cement and Concrete.—These changes noted above may seem small, but when converted into other figures their real seriousness becomes apparent. The following hypothetical illustrations are presented to show the magnitude of the possible stresses.

Imagine a wall of neat Portland cement 100 ft. long anchored at each end to absolutely immovable supports. Let it be kept under water for 3 years. At the end of that time it would, had it been free, have expanded 0.1 per cent., or 1.2 ins. Since it is supposedly not free to expand the compression will be 0.1 per cent. and the compressive stress, on an assumed modulus of elasticity of 5,000,000, will be 5,000 lbs. per sq. in. Perhaps the cement could withstand this pressure.

Imagine now that this cement wall becomes dry. It should contract 1.7 ins., but since it is not free there will be developed a tensile stress of 7,500 lbs. per sq. in., which is several times more than it can stand. The wall would have to crack.

Suppose this neat cement wall had been originally allowed to harden in the open air. After 2 years it would, if free, have contracted 0.25 per cent., but since it is anchored at the ends there will be (assuming the same modulus) a tensile stress of 12,000 lbs. per sq. in. Is it not evident why neat cement is not used in practice?

If the above wall had been built of concrete with the same volume changes as the 1:3 sand bars and as the old sidewalks whose measurements are given above, its change in length between the wet and dry states would probably have amounted to 0.05 per cent., which with a modulus of elasticity of 2.500,000 lbs. per sq. in. corresponds to a stress of 1,250 lbs. per sq. in. The concrete could withstand this in compression but not in tension. Not even our best steel will stand indefinitely repeated alternate bending stresses nearly to its elastic limit. Why should we wonder, then, if a rich cement mixture should ultimately crack when exposed to the stress resulting from a volume change of 0.05 per cent. every time it is exposed to rain or sunshine.

There is no experimental evidence which shows the changes in volume of leaner concrete. It is evident that the properties of the sand and rock become of increasing importance as their percentage increases. The tests by Schumann on volume changes in building stones, quoted at the commencement of this paper, show small values for limestones but variable values for sandstones, the upper figures being almost as high as those quoted for neat cement. Whatever the values might be for crushed stone as used in concrete, it is hardly conceivable that gravels and sands which have withstood the action of the weather for centuries without disintegration can change their volume much when wet and dried. It seems probable that in gravel concrete the volume changes decrease as the proportion of cement decreases, until a certain lower limit is reached where the change in volume is purely a capillary phenomenon.

If this line of reasoning is correct those concrete structures should be most stable when exposed to the weather in which there is just sufficient cement to give strength but not enough to cause excessive volume changes. Practical experience apparently confirmes this view.

Stucco.—There are many instances where stucco has remained perfect even when exposed to the weather for half a century. There are probably more instances, especially in recent years, where stucco has failed miserably in five years. The excellence of old stucco is sometimes laid to the natural rock cement with which most of it was made. It is not safe to deny this on the evidence of a single experiment, yet attention may be drawn again to the one natural rock cement which has been tested in our laboratory, whose volume changes were in every way much greater than those of Portland cement.

Is it not more probable that the old stucco has survived because of its lower proportion of cement? When it was simply a question of providing a rough brick or stone wall, entirely durable in itself, with a smooth surface, and when in addition hydraulic cement was expensive, it was natural to use a mortar containing just enough cement to adhere to the wall. With the introduction of metal lath as the support for stucco, and the necessity of protecting the metal from corrosion, coincident with the drop in price of Portland cement came the use of richer stuccos.

The step was apparently an unfortunate one, for a volume change of 1 in. in 100 ft. as shown by the stucco 156 E as it changes from the wet to the dry state cannot but cause cracks. They may be only hair cracks, for with a crack every 12 ins. each crack need only be 0.01 in. wide to take up the whole change in volume. The elastic metal lath will probably yield without mechanical injury, but the protection against corrosion which the stucco is supposed to afford disappears with the first hair crack, and unless the lath has been better protected, by galvanizing or painting, than most sorts are by the manufacturers, its days are numbered. It would have been better to have used a leaner stucco and kept it free from cracks.

A stucco rich in cement may also split off in time from brick where a lean stucco would have remained good. The change in volume of brick when wet and dry is, according to Schumann, less than 0.02 per cent. If the change in the stucco is 0.08 per cent. there is opportunity for a stress corresponding to a volume change of 0.06 per cent. which might be 1,500 lbs. per sq. in. The fact that the stucco has not split off in one or two years does not mean that it may not split off in five or ten years.

Interior Floors.—The question of reinforced concrete is discussed in a later paragraph. Here only the changes in the concrete itself will be considered. The usual practice will be assumed in which there is a base of rather lean concrete covered with a wearing coat of mortar sometimes as rich as 1:1.

The first case assumed will be that of a cellar floor where the base is tamped down and the top coat at once put on, giving the best conditions for bonding. The whole mass gradually dries out and shrinks, but the top coat, because of its high content of cement, shrinks more. The top coat will tend to separate from the base, but since a cellar is always relatively damp there will probably be little trouble.

The situation is not so favorable when a top coat is to be laid on an upper floor of a concrete building. The main portion of the floor has been poured for possible three months and has already completed most of its shrinkage. Its surface is also probably dirty so that the freshly poured mortar will not readily unite with it. Both of these circumstances are unfavorable. The fact that the main portion of the floor has already dried out and shrunk causes an even greater differential shrinkage of the top coat. The advice is usually given to wet the floor thoroughly before pouring the top coat. It would be better to keep it wet for 24 hours beforehand in order to give it an opportunity to expand to somewhere near its initial volume.

It is not surprising if, under these crcumstances, the top splits off the base, shrinkage cracks appear, and the individual slabs curl up somewhat at the edges in the effort to relieve the shrinkage strains. In case electric conduits, etc., are bedded in the top coat their course will be indicated by shrinkage cracks following the lines of weakness which they cause. Since these floors remain continually dry, conditions will become constant after a few months, and there will be little further change.

Sidewalks and Pavements.—The chief factor which influences the behavior of sidewalks and pavements is the weather. The influence of temperature is well known and will not be dwelt upon. A sidewalk usually consists of a base of rather lean concrete covered with a wearing coat of cement mortar which may be as rich as 1:1, and is not usually poorer than 1:2. The walk is cut into blocks and is sometimes provided with expansion joints.

As the walk dries out the top coat shrinks more than the bottom, as shown in the experimental study of compound bars. The effect can often be seen in sidewalks where the contraction has dished the entire slab so that shallow puddles of water stand in them after a rain. When the walk is wet by the rain the top expands more than the base. The alternate bending stresses thus developed all too often show themselves after a few years when the top coat splits off the base.

The necessity of expansion joints is now well recognized, although they are put in principally to take care of expansion due to changes of temperature. The experiments presented in this paper on both neat and sand briquettes indicate that the expansion of cements kept wet ceases at the end of a year, and that the total expansion does not amount to cver 0.1 per cent. This would require a ¼-in. expansion joint every 20 ft. In addition there must be the joints to care for the expansion due to summer heat, which for a rise of 100° Fahr. is 0.05 per cent., about half of what may be expected from moisture. To take care of the volume changes from both these causes a ¼-in. expansion joint every 10 ft. should be adequate, although it does not include much margin of safety. In hot weather after a long rain these joints would be almost closed. In dry or colder weather they would be open.

According to the experimental figures any evils due to expansion should make themselves evident during the first two years, but practice does not always bear out this assumption. Reference was made at the commencement of this article to the cement walk laid around the campus of the University of Michigan twenty years ago, which is still showing expansion and giving mute evidence of the pressure generated by occasionally thrusting up two adjacent slabs in an inverted "V". This is not a phenomenon due to summer heat for it occurs usually in the spring. What is the cause which is still making this walk expand after twenty years?

An explanation may be suggested, although it is not possible to prove it completely. It is well known that the glass of thermometers expands when heated and contracts when cooled, but not to its original length except after a long lapse of time. Thermometers which are used frequently at high temperatures keep growing longer. If they are laid away for a long period of time they shorten again and may even become shorter than when first calibrated. Metals behave similarly, so that it is not possible to utilize their expansion for making pyrometers which will not need frequent recalibration. The warping of the grate bars of fireboxes due to expansion is another illustration. It would be natural to expect analogy that concrete would tend to a permanent expansion when it is kept wet longer and oftener than it is dry, and that it would tend to become shorter under the opposite conditions. The experiments of this paper in general confirm this theory. Of the five bars of neat cement which had been kept under water for three years and were then dried out and re-immersed, all but one were longer after the re-immersion than they had been, and the one exception is apparently susceptible of explanation.

A more striking illustration is afforded by the two neat bars 146 A III. and A IV. These bars were made on the same day from identical materials, but after the initial measurement A III. was left in the air and A IV. placed in water. They were then alternated between air and water, at first at the end of each week and afterwards at longer intervals. There is, however, a definite difference in the treatment of the two, for with A III. each cycle has consisted of a period in air of two or three months followed by an immersion in water of usually a week. It has, therefore, been dry most of its life and its mean length since the end of the first month has been steadily diminishing. The companion bar A IV. was subjected to the opposite treatment in that its long periods were in water and its short periods in air. Its mean length and also its length when wet has been steadily increasing for the 18 months of its existence, although the rate of increase since the ninth month has been slow. At its last measurement it was slightly longer than another bar of the same cement which had been kept constantly in water, but it will require a longer time to decide whether the increase is material.

This theory of the continued expansion of cement walks in a rather damp climate, such as that of Michigan, is the only one which seems to adequately explain the compression ridges still occasionally developing in the twenty-year-old walk on the campus of the University of Michigan which has been referred to before. If the theory is correct it would indicate that there would be more trouble with cement sidewalks and pavements in wet countries than in those which are reasonably dry, and that there is need of much wider expansion joints in damp climates.

Reinforced Concrete.—It is evident from the data presented here that concrete undergoes a notable shrinkage as it drys. If a concrete beam is formed rigidly fixed at both ends, as is practically the case in skeleton concrete construction, it is evident that it must, on hardening, be under an initial tensile stress due to contraction. Conditions will not be changed by the presence of steel reinforcement provided the ends are absolutely rigid. If, however, the ends of the beam yield at all, and the concrete adheres to the steel, the strains will be adjusted between the two. The steel will be in compression and the concrete in tension, but to a lesser extent. In the review of the literature at the commencement of this paper attention was directed to the experimental work of Considere and to the experiments of Emerson, who found that even with mixtures as lean as those used in practice, compressive stresses of 2,500 lbs. per sq. in. might be developed in the steel through the volume changes in the concrete of bars only 3 ft. long and not anchored at either end. The paucity of information on this subject should be emphasized. There is every probability that there are important stresses in all reinforced concrete work due to volume changes in the concrete of which the designers have had no knowledge. These stresses may have been to blame for some of the collapses which have occurred in reinforced work, and the small number of such collapses may be more a tribute to the value of the factor of safety than to scientific knowledge.

It is encouraging to note, however, that in buildings, where the beams remain dry, most of the contraction will have taken place at the end of the first three months and that from that time on the volume changes will be slight. Concrete floor beams are treacherous during the first few weeks, not only because the concrete itself is new and weak, but because of the tensile stresses developed.

There is danger that a rather slight load on a green beam may cause cracking if not total failure, for it is entirely possible that the whole of the concrete is in tension and its tensile strength at that stage is very small. Several weeks should be allowed to elapse, even in warm weather, before the forms are taken off and the supports removed. Fortunately these tensile stresses seem to practically reach their maximum in three months, while the concrete gains in strength for a much longer period, so that if a concrete building is successfully completed there does not seem to be a probability of future failure due to changes within the concrete.

Causes of Change of Volume.—There is no experimental work to account for these volume changes. Their progressive nature as the cement hardens in water or air makes it evident that they are connected with the chemical processes of hardening. Since the hardening of cement is recognized as being essentially a process of colloid formation and change, it may seem not unreasonable to hold that the changes are connected with the volume of the colloid water. The nature of the volume changes as cement passes from the dry to the wet state is in harmony with this view. It is probable that the volume changes are also due in part to purely capillary phenomena, for sandstones and other building stones expand when wet and contract when dry. The amount of the expansion and contraction of concrete decreases as less cement is used, so that it appears that the changes are more a function of the cement than of the mineral aggregate.

The subject has not been sufficiently studied to show how far such factors in the manufacture of cement as chemical composition, temperature of burning, fineness of grinding, and rate of setting, influence the result: nor how far conditions surrounding its use, such as amount of water, temperature of air, etc., affect it. Until the influence of these factors has been determined it will not be possible to make intelligent progress towards lessening the volume changes and increasing the reliability of structures containing Portland cement. The subject is of such importance as to merit most thorough investigation from both the chemical and mechanical side on a larger scale than has yet been attempted.

Conclusions.—Concrete hardening in a moist place and remaining continually moist throughout its life expands slightly, but the compressive stress developed in the concrete is probably not large enough to be injurious.

Concrete hardening in air and remaining continually dry contracts. The contraction is roughly twice as much as the expansion of concrete continually damp. This greater stress is harmful not only on account of its magnitude but because it puts the concrete in tension, where it is weakest. It introduces an error of unknown magnitude into the calculations for all reinforced beams. It is responsible for the cracks in the top coat of interior cement floors. Fortunately most of the bad effects become evident within three months.

Cement sidewalks, pavements, and stuccos exposed to the weather contract when dry and expand when wet. The richer the mixture is in cement, the greater is the volume change, so that there is a differential expansion between the top coat and base of sidewalks which is often sufficient to split the two apart. So also rich stucco may be split from brick. In damp climate irregular expansion occurs apparently for as long as twenty years. Its harmful effects may not appear for many years. Large expansion joints are necessary in sidewalks and pavements.

Rich stuccos will inevitably crack through expansion and contraction, and may be ruined. The few experiments made indicate that integral waterproofing compounds do not prevent or lessen the changes in volume. The only safety seems to lie in the use of lean mixtures whose volume change is slight. A stucco coat is inadequate as a protection for metal lath. If it is rich enough to keep water out it will crack. If it is lean enough to avoid the cracks water will go through it freely. In a dry climate the tendency is for sidewalks and stuccos to shrink more than they expand. Under these circumstances they will be much more durable, because of the slower corrosion stucco may be permissible as a protection for wire lath

AMERICAN IMPRESSIONS OF THE RISORGIMENTO BRIDGE AT ROME.

By Henry Grattan Tyrrell.*

Since the publication of my treatise on "Concrete Bridges and Culverts" in 1909, rapid progress has been made in the direction therein indicated, in the design of concrete bridges. Instead of the heavy masonry bridge with many piers, solid arch slabs and earth filling, practice has swung to the other extreme where reinforced concrete is used with individual members and outlines similar to those in steel, the framing in some cases being extremely light, as in the recent Mizenhead bridge in Ireland.

It is interesting to note that the world's record for a masonry arch, after the lapse of more than 2,000 years, is again at Rome. Pons Aemilius, (Fig. 1) which was completed 142, B.C., after undergoing numerous repairs, continued in use until 1890, when most of it was removed to make room for a new steel bridge with its deck supported on horizontal girders, the new structure now being known as Palatine bridge. Many of the old Roman bridges which were known as stone arches, were really only faced with stone, the body of the arch and piers in many cases being concrete; and the same system of construction was carried out in Roman buildings and other works. It is, indeed, known that concrete was much used many years before the Christian era, not only in Rome, but in Greece, Etruria, Assyria, India, and China, and it is also found in the Pyramids, the Walls of Babylon, as well as in the Great Wall of China. Occasional evidences of the use of concrete in bridge construction after the fall of Rome still remain, as in the bridge at Amalfi, Italy, built by the Moors in the sixth century.

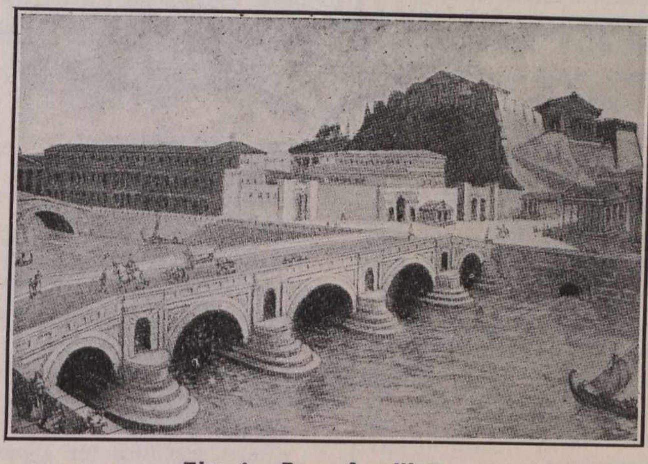

Fig. 1.—Pons Aemilius.

The Risorgimento bridge (Fig. 2) over the Tiber at Rome, with its clear span of 328 feet (100 meters) is in many ways a striking contrast to those adjoining it, and it is probable that if the old Roman engineer, Lucius Fabricius, who built bridges over the Tiber in the early part of the first century, could examine the latest one, he would likely view it with suspicion and disapproval.

The new bridge has a deck 65½ feet wide at a height of 47 feet above low water, and it crosses the Tiber with a single span. Compared with other concrete bridges, the next longest one Fig. 3) is at Auckland, New Zealand, with a span of 320 feet, and its deck 147 feet above water. In America the longest concrete spans are those at Larimer Avenue Pittsburg; Monroe Street, Spokane, and Detroit Avenue, Cleveland, with spans of 312 feet, 281 feet and 280 feet respectively. In Continental Europe the next longest concrete arch is that at Stein, Switzerland, over the Sitter River, with a length of 259 feet, (Fig. 4) though the stone arch at Plauen, Germany, has a span of 296 feet. In Great Britain, the longest concrete spans are those over the Nore River at Kilkenny, with a single opening of 140 feet, and a very flat rise, completed in November, 1910; and the slender foot bridge at Mizen Head, crossing the narrow channel to an island at the southwest extremity of Ireland, the length of span being 172 feet, and the deck 150 feet above water.

The most interesting features of the Risorgimento bridge are: (1) foundations, (2) flat rise, (3) hollow spandrels, (4) uncertain action, (5) surface treatment, (6) falsework.

(1) Foundations.—The chief requisite of an arch should certainly be an unyielding foundation. It has, in fact, become almost an axiom of design, that arches, especially those of small rise, are suitable only when such a foundation is obtainable, as at the crossings of the Niagara and Zambesi Rivers where rock cliffs rise on one side. Where arches are used on foundations other than rock, semi-circular ones, or forms nearly approaching to them are the best, and as the proportion of rise to span diminishes, the arch with its heavy lateral thrust becomes less desirable. The bed of the Tiber River, at the site of the new bridge, is composed of sand and clay underlaid to unknown depth with soft mud, necessitating pile foundations, covered with reinforced concrete grillage. This condition of subsoil would in itself, in most cases, lead to the use of shorter arch spans with greater relative rise, or to a girder bridge with only vertical reaction. Instead of heavy and massive abutments to resist the lateral thrust of so flat an arch, we find in the Risorgimento bridge, cellular construction with comparatively thin face walls backed up by seven 12-inch vertical walls, one of which is in line with each of the seven ribs on the bridge. There

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is no doubt that the builders of this bridge long experienced, long experienced in such work, and particularly with the "Hennebique" construction, were entirely competent to install these foundations which were on the "Compressol" system, and yet there is little question but that limited time and appropriation is responsible to some extent for the lack of more substantial abutments, such as used in many of the other "Hennebique" bridges.

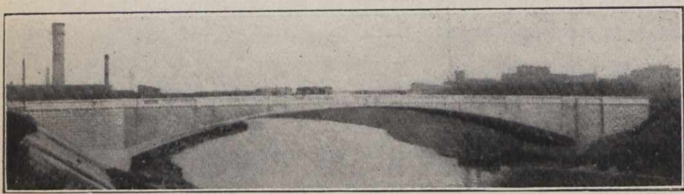


Fig. 2.—Risorgimento Bridge, Rome.

(2) Flat Arch.—Arches with small rise are generally not a desirable form, for they not only have excessive lateral thrust, but they plainly display their weakness in this respect. The beautiful Alexander III. bridge in Paris, which is a model in almost every way, is lacking in this one particular, for it fails to impress the beholder with its strength and security. Its span of 353 feet is only a little more than the latest one over the Tiber. Since other bridges at Rome have one or more river piers, it would seem that at least two piers at this site would have been permissible and would have greatly decreased the horizontal pressure on the abutments, at the same time making arches with a greater relative rise approaching the proportion of the beautiful Trinity bridge at Florence, which for more than 300 years has been accepted as ideal. A rise of about one-quarter of the span gives a very pleasing proportion when it can be obtained, an excellent illustration being that designed by Alexander Nimmo at Limerick, known as the Wellesley bridge. The desire among engineers and designers for making bridges of record proportions is well known, and while this motive may not have been an influencing one on the Risorgimento, three spans would certainly have made a much better appearance.

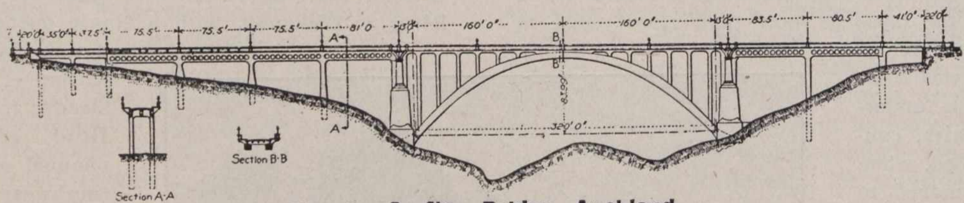


Fig. 3.—Grafton Bridge, Auckland.

(3) Hollow Spandrels.—The cellular type with hollow spandrels, which may be quite effective in the present case, is a violation of truthful construction, the general principle being that structures should, as nearly as possible, exhibit their real action and condition, and should appear to be just what they are. Concealment or deception should be avoided, and wherever consistent with construction, the general type and arrangement of parts should be evident. The accepted form in America for ribbed arches and open spandrel construction is to support the deck either on a series of spandrel columns, as in the Meadow Street bridge (Fig. 5.) in Pittsburg, or on longitudinal walls, as at Sandy Hill, over the Hudson (Fig. 6). For slab arches, the almost universal rule now is to use open spandrels with transverse arcades of colonnades. Lightness can as well be secured in these latter forms as in the more obscure and uncertain cellular type that was used in the bridge under discussion. The small thickness of the arch ring, varying from only 8 inches at the centre to 20 inches at the springs, contrasts greatly with the crown thickness of 48 inches and 72 inches on the Stein-Tuefen and Spokane bridges.

In the year 1896 Mr. Edwin Thacher made designs for two reinforced concrete bridges with hollow spandrels, enclosed on the face with curtain walls, one of the designs having a length of 150 feet. (Fig. 7). This resembles in some respects the Risorgimento bridge, and is one of the very few of this kind appearing in America. Unlike the Tiber River bridge, the American design showed only two longitudinal face walls, and those two were provided with expansion joints, making the stress conditions definite.

(4) Uncertain Stress Conditions.—Certainty of action and definite stress conditions are well known principles of bridge design. In the new Tiber River bridge with curved arch slab without hinges, rigidly connected to seven vertical ribs, it would seem that the stress condition was indefinite and the amount of thrust taken by the vertical ribs indeterminate. It is customary now, where a slab arch is used, to omit the vertical rib, or, if vertical ribs are used, to omit the slab. But the Tiber River bridge is a combination, and from the drawings which are shown in the reports of the "Ponts et Chasees" its action in this respect is indefinite. It is the practice in some bridges in America, notably those at Paterson and Clifton over the Passaic River, to make the arches continuous over the piers and anchor them securely back into the abutments, for the purpose of developing cantilever action. One of the first and perhaps most interesting experiments in this direction was that made by Brunel in 1836, when he erected a half cantilever arch of brick and cement at Rotherhithe when he was chief engineer of the Thames Tunnel. Brunel used no centering, the curve of the arch being formed by face moulds or sweeps. His experimental half arch stood on a 10-foot base, the long arm being 60 feet, while the rear or cantilever end was only 30 feet. The longer end had a rise of 10 feet 6 inches, and was balanced at the shorter end by a suspended anchor of about 31 tons. The upper and lower portions of the arch were 4 to 5 feet in width, while the spandrel wall was only 18 inches thick. He used hoop iron bands one inch wide and one-sixteenth inch thick, laid horizontally on the brick courses, and the strength of his experimental cantilever was proven by the fact that it continued standing for about two years. This interesting ex-

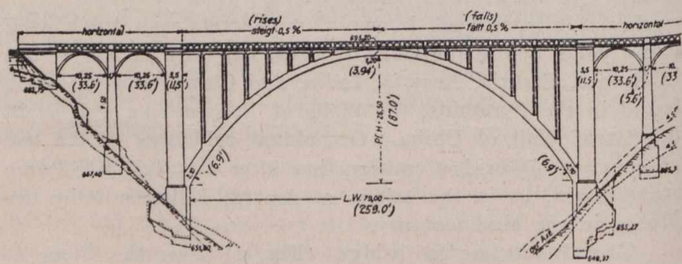


Fig. 4.—Stein-Teufen Bridge, Switzerland.

periment, which was probably the first of its kind, has been followed in more recent years by the construction of concrete cantilever bridges with members properly arranged for definite stress computation. While the Tiber River bridge was doubtless carefully designed, its stress conditions are certainly indefinite, owing to the combination of curved arch slab and vertical ribs, fastened rigidly together.

(5) Surface Treatment.—The surface treatment of the new bridge at Rome, with a fine flat face on the centre portion, resembling cut stone, and moulded blocks on the abutments, is excellent, being similar to that of the Sandy Hill bridge over the Hudson River, the Connecticut Avenue bridge at Washington, and the Chatellerault bridge over the Vienne (Fig. 8) built by M. Hennebique, 1899. In connection with surface treatment, it is interesting to note the efforts made in this direction since concrete bridges were first introduced. The Romans made extensive use of concrete in the body of their piers and arches, the surface being faced with travertine, their constructive methods being very plainly visible on the portion of old Ponte Rotto (Fig. 9) which still remains. The same system of construction was

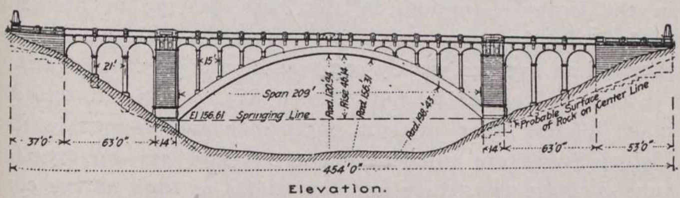


Fig. 5.—Meadow Street Bridge, Pittsburg.

extensively used on public works during the latter half of the eighteenth and the first part of the nineteenth centuries, but it was not until 1840 that a bridge was made almost wholly of concrete at Grisoles in France. It was the work of the eminent French engineer, M. Le Brun, who erected a span of 39 feet 4 inches over a branch canal of the Garonne. The only place where material other than concrete was used was in the exposed end of the arch ring, which was faced with brick, and the four vertical abutment edges below the springs, which were faced with stone. All other exposed surfaces, including the soffit and spandrels, were of concrete. Ten years after the completion of this little bridge,

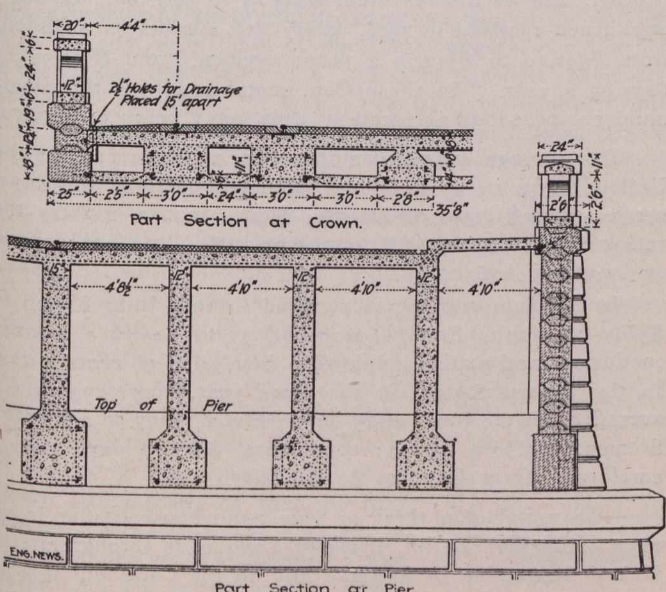


Fig. 6.—Sandy Hill Bridge, over the Hudson.

the building of the Grand Maitre Aqueduct in France was begun, the construction of which continued for fifteen years. The long series of arches, carrying the aqueduct was made wholly of concrete, the magnitude of the undertaking being hardly excelled by any later works. The surface finish on this aqueduct, however, was not satisfactory, for when concrete arches were again used in France about 1855, on many fine bridges, some of which are masterpieces of constructive art, they were faced with stone. These bridges include: Ponts au Diable, Notre Dame, Austerlitz, Arcole, Petit, Napoleon, Invalides, Alma. Experimental treatment of arch faces was again tried in 1868 when a 75-foot concrete span was erected near Gloucester Road station over the Metropolitan Extension Railway, London, the arch face being lined to represent ashlar. It was found that while bridges with concrete faces were aesthetic failures, they could be quickly built at small cost, and for several years following 1873 they were generally used by the Irish engineer Nathaniel Jackson in spans of 18 to 45 feet for highway crossings in the rural districts of Ireland.

The design of the Risorgimento bridge is lacking aesthetically, in that some prominent feature, such as pylons, statuary, or even lamp clusters, should appear above the deck over the springs, thus marking the limits of the arch and separating it from the abutments, but the absence of such features may be due to insufficient money appropriation.

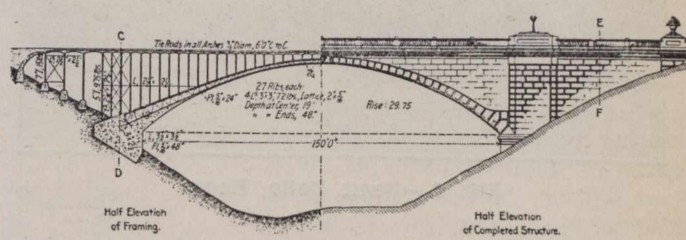


Fig. 7.—Proposed Bridge for Pittsburg.

(6) False Work.—The use of reinforced concrete false work in the Tiber bridge is interesting and unusual, and is reported to have successfully resisted the rapid autumn rise of twenty-four feet, and the additional impact of a drifting steamboat. The Tiber River is notable for its floods, having experienced no less than thirty disastrous ones since the building of the earliest bridges there. In recent times, an expedient has been used in some cases where maximum flood conditions were uncertain, in which the bridge has been designed and proportioned to resist water pressure when submerged, instances being those at Maryborough, Australia, and Paterson, New Jersey. The arrangement requires heavier construction, but permits the deck to be placed at a somewhat lower level, thereby eliminating expensive approach grades. As previously stated, the bridges over the Passaic River at Paterson have reinforcement continuous over the piers, which extends to the abutments for anchorage. The balustrades are made to be easily removed in times of flood.

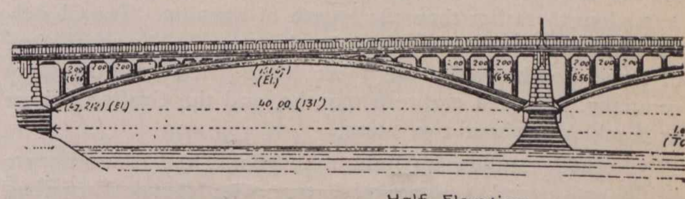


Fig. 8.—Chatellerault Bridge.

In reviewing the bridge as a whole, it is seen that the construction was carried out by representatives of the Hennebique Company, one of the most extensive builders of concrete structures in Europe. Ten years ago, their bridges were being built at the rate of one hundred per year, a record which can hardly be excelled elsewhere. The Saint Claude bridge over the Bienne, in France, with a span of 205 feet, and the well-known Chatellerault bridge over the Vienne were erected by this company. The first of these is a cellular type with springs at different levels, and built on a slight skew, finished about two years ago. It differs from the Risorgimento bridge by having an open archway through one of its abutments, a feature which is very evident and characteristic. Compared with the next longest concrete arch span of 320 feet, at Auckland, New Zealand, these two bridges appear to be of quite opposite types, for the Tiber River bridge is all enclosed, while the Grafton bridge at Auckland is open. The New Zealand bridge has two reinforced concrete arch ribs hinged at the springs and crown, on which the deck is supported by means of spandrel columns, the whole construction being open for inspection.

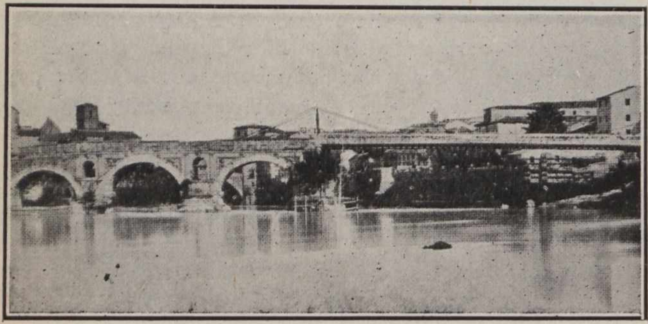


Fig. 9.—Ponte Rotto, Rome.

The cost of $7.50 per square foot of floor surface for the Tiber River bridge is about the same as those at Walnut Lane, Philadelphia (Fig. 10), and at Sixteenth Street, Washington; and is quite as high as similar ones elsewhere, those at Auckland and Cleveland costing only $5.00 per square foot. The Spokane, Cleveland, Philadelphia and Washington bridges all have double arch slabs separated by a space of 12 to 16 feet, which is bridged at the floor level by the regular floor framing. The Chatellerault bridge in France, a ribbed arch of three spans, on the Hennebique system, cost only $3.00 per square foot of road, the cost in

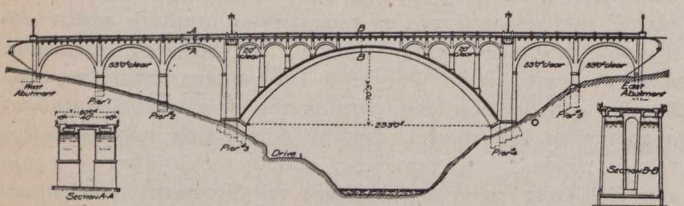


Fig. 10.—Walnut Lane Bridge, Philadelphia.

all the above cases being based on width of deck and extreme length rather than the length of opening. The Chatellerault bridge was completed in the remarkably short time of three months, while the Tiber River bridge, by the same company, occupied eighteen months, and the Grafton bridge at Auckland, about two years.

Notwithstanding its light proportions, the Risorgimento bridge withstood a remarkable test after completion, when seven steam rollers were passed over it, followed by wagons on which a large tree trunk was loaded, the whole being drawn by sixteen horses.

RAILWAY WAGES AND COST OF LIVING IN THE UNITED STATES AND EUROPE.

The Bureau of Railway Economics has completed the second of its comparative studies of railway conditions in the United States and the principal countries of Europe. This relates to the wages paid railway employees and the cost of living. and is based on the latest years for which comparative data are available.

The average daily compensation of railway employees of all classes for the year 1910 was in the United States, $2.23; in the United Kingdom, $1.05; excluding supplementary allowances negligibly affecting the average, it was in Prussia-Hesse 81 cents, and in Austria 89 cents. The lowest paid railway employee in the United States, the ordinary trackman, receives a greater compensation than many of the railway employees of France, even those of higher grades and with responsible duties. The compensation of railway employees is from two to three times as high in the United States as in Italy.

A recent report of the English Board of Trade on railway wages shows that the average weekly pay of enginemen in the United Kingdom in 1907 was $11.17; of firemen, $6.67. In the same year enginemen on American railways received an average weekly compensation of $25.80, counting six days to the week, and firemen $15.24. Recent returns make it clear that in 1912 enginemen and firemen in the United States are compensated at rates of pay for specific runs that are two, three and four times as high as the corresponding rates on representative English railways. The annual compensation of enginemen in the United States, as reported by two representative railway companies, now ranges from $1,100 in switching service to over $2,800 in passenger service, and of firemen from $700 in switching service to over $1,700 in passenger service.

For Continental Europe official returns in requisite detail are not available for a later year than 1908. The salaries and allowances of the typical engineman in Germany amounted for that year to $646.88, in Austria to $870.80; of a fireman in Germany to $424.59, in Austria to $532.03. The annual compensation of enginemen on two of the principal railways of France ranged in 1908 from $505.66 to $906.91, and of firemen from $324.24 to $595.98. In Italy enginemen received in 1908, salary and allowances included, from $581.10 to $812.70 a year; firemen, from $330.30 to $475.05 a year. In these Continental countries the maximum compensation is received after many years of service.

The average annual compensation of enginemen in the United States in 1908, on an estimated basis of 300 days' service, was $1,335; of firemen, $792. In this country the rate of compensation to these employees does not depend on length of service.

In Belgium enginemen received in 1907 from $23.16 to $38.60 a month; firemen, from $17.37 to $23.16 a month; conductors and station employees, from 46 to 96 cents a day. In the United States, in the same year, 1907, enginemen averaged, on the basis of 25 days' service, $107.50 a month; firemen, $63.50 a month; conductors, $3.69 a day; station employees, form $1.78 to $2.05 a day.

The rental of a three or four room house or flat is almost as high in Berlin, Paris or London as throughout the United States, but in England and on the Continent it generally runs from thirty dollars to ninety dollars a year less. The quantity of food and fuel estimated by the Board of Trade of England as the standard consumption of a typical workingman's family costs in the United States 17.8 per cent. more than in France or in Germany; 35.3 per cent. more than in Belgium, and 38 per cent. more than in the United Kingdom.

It is well within the truth to estimate in a broad and general way that while the cost of living of a railway employee in the United States is less than fifty per cent. higher than that of a corresponding employee in the United Kingdom or on the Continent, his compensation averages over twice as great.

DIESEL LOCOMOTIVE ENGINES.

In a lecture delivered before many of the engineering societies in the United States, Dr. Rudolf Diesel goes into the present status of the Diesel engine in Europe. One of the most interesting parts of his address is that dealing with the Diesel engine, as applied to the railroad locomotive. The following is an abstract of that section of the paper:

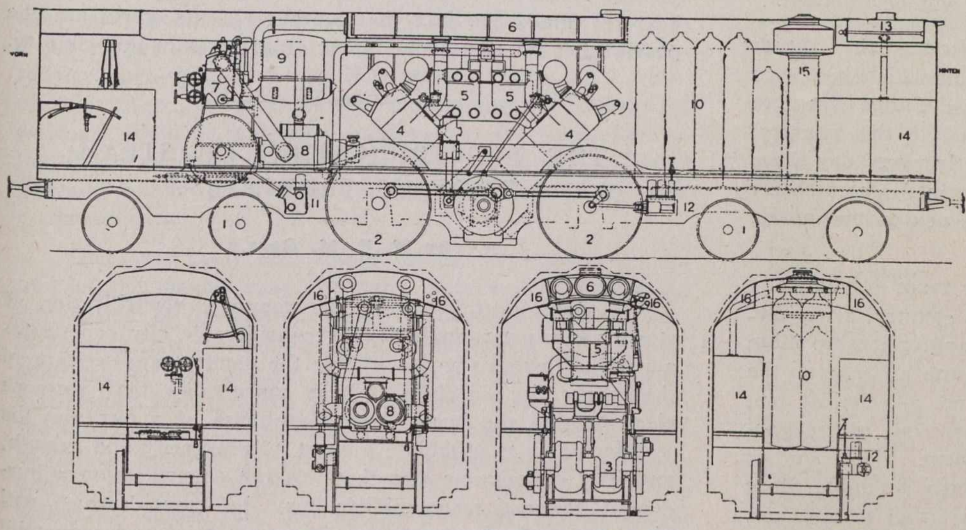


Fig. 1.—Diesel Engine Locomotive.

Of the Diesel locomotive nothing has as yet been published, and it gives the author a special pleasure to give a description of the first Diesel locomotive ever built, in this country of mighty oil wells and gigantic railways. From the early days of his invention the author was of the opinion that the special features of the Diesel engine would be of even greater importance for transport purposes than for stationary work, and, for that reason, the author devoted his time extensively to the development of the engine as motive power for transportation mediums. The author has already mentioned that he made the first small ship engine in 1902, and that since that time, the Diesel marine engine has been developed without interruption. The author further mentioned that he made the first automobile engine for trucks in the year 1909, and that he looks forward to the development of this branch within a few years. Finally, the author has to say, that he has worked for five years, together with Messrs. Sulzer Bros., at Winterthur, and Mr. Adolf Klose, of Berlin, on the construction of a Diesel locomotive, and that the first express train locomotive of 1,000 to 1,200 horse-power was finished a few weeks ago, and is now on the testing bed in the Winterthur shops. Five years is a very long time, and to explain why the work has lasted that long, the author must mention that the thermo-locomotive is the most difficult problem of construction that can be taken up in the way of modern engine building, not only on account of the difficulties in starting and manoeuvring with this special kind of motor, but also on account of the great limitations in space and weight. Compared with this, the development of the reversing marine motor has been relatively simple. Fig. 1 shows the design of this locomotive, the car of which was made in the renowned locomotive works of A. Borsig, at Berlin. It is 16.6 metres long over the buffers, and has two trucks of two axles each, 1-1, and two driving wheels, 2-2. The latter are not directly coupled with the engine, but indirectly with the blind axle (3) which is, at the same time, the crank shaft of the Diesel engine (4).

The Diesel engine is an ordinary two-stroke cycle engine, with four cylinders (4–4) coupled in pairs at an angle of 90°, and which drives the blind axle (3–3), whose cranks form an angle of 180° (see III–III). This disposition gives complete balancing of the moving masses, the first and most important condition when putting such engines on a movable platform. Between the working cylinders are placed two scavenging pumps (5) driven by levers from the connecting rod. Beyond the engine in the roof of the car is placed the silencer (6). On one side of the main engine stands an auxiliary engine (7). This latter consists of two vertical two-stroke cycle cylinders (7–7) coupled to horizontal air pumps (8–8) driven by these cylinders (see II–II). 9 indicates the cooler for the air compressed by these pumps. These air pumps serve, according to a special and patented process, to increase the power of the main engine when starting, manoeuvring and going up-hill, in such a way that auxiliary compressed air and auxiliary oil-fuel are conducted into the main cylinder, by which means the power is increased, making the engine as elastic as the steam engine. For the ordinary running of the locomotives, the main cylinders work like ordinary Diesel engines without the help of auxiliaries. To the right of the main engine is placed a battery of air bottles (10), the air from which helps the action of the auxiliary engine, and which can be refilled by the auxiliary engine at times when the latter is not used. Two pumps (11–12) provide for the water circulation in the cylinder jacket. 13 indicates an apparatus for the back-cooling of the water by evaporation, and 14, the tanks for fresh water and for fuel (see sections II–II and IV–IV). 15 is a small donkey boiler for the heating of the train.

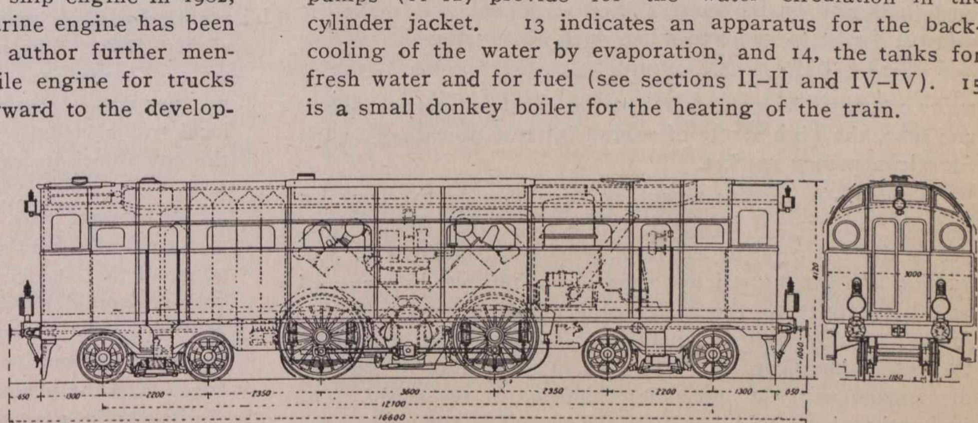


Fig. 2.

The whole plant is contained in a closed engine room which makes the locomotive look from the exterior like one of your steel cars. The canals (16) under the roof lead the fresh air to the suction pipes of the different motor and pump cylinders. The engineer can operate equally well on either side of the locomotive, as the engine is arranged for running in both directions. He has a direct view of the track. Doors and platforms lead from the engine to the train. Total weight in service of the locomotive is 85 tons.

The author does not wish to predict whether or not this attempt at an entire revolution in the working of railways will be successful at once, or whether it must be repeated in modified form; but one thing seems certain to him: the Diesel locomotive will come, sooner or later, depending on the perseverance with which the problem will be followed.

Conclusion.—Before concluding his lecture the author desires to touch a very important question which has been put to him by the Secretary of the United States Navy, to whom he paid his first visit when coming to this country, and which has been repeated to him nearly every day since he left the pier at Hoboken: Why are we in America so far behind Europe in the development of this new prime mover, which in fact is no more new to-day?

To answer this question the author must emphatically state that the Diesel engines built in this country, after having passed the necessary manufacturing apprenticeship more than ten years ago, have been and are quite as good as the European machines. So the question is not a technical one, but merely a commercial one, or even more one of the general economical conditions of this country. The author does not know the United States sufficiently to judge these conditions on his own behalf, but he has tried to find out, in his conversations with many prominent engineers, and the following is what he could learn:

First.—Coal is much cheaper than in Europe, and, therefore, people are more wasteful with it; while the leading idea in Europe is always the economy in operating cost, the leading idea in America is economy in first cost. The word efficiency, which is the base of every contract in Europe, seems to be unknown to a vast proportion in this country. Of course, not to engineers, but to business men and to purchasers of engines.

Second.—Steam engines are much cheaper in America than in Europe, but the Diesel engine is not and will not be a cheap engine; it aims to be the best engine and must be constructed of the very highest class of material, with the best tools and by the most skilled workmen; this makes it difficult for it to compete when such ideas prevail.

Third.—Another general reason seems to be, in very many cases, the lack of capital of the prospective purchasers, and also, the higher rate of capital interest prevailing in the American money market.

Fourth.—A further reason is this: that in the last few decades the general business profits have been so big, that people did not care for the most economical methods of production and for the strictest economy in the fuel bill, as well as other expenses,—the ruling object having been to manufacture quickly and in quantities, without much regard to the cost. American industries had not, as those of Europe, to compete with the industrial countries of the world. The author has been told by American engineers that what has happened with the Diesel engine, has also exactly happened to the large gas engines, especially with blast furnace gases, and also with the steam turbine, both of which have been taken up in this country long after the development in Europe. The same has also happened with the by-products of coke ovens. Even to-day, the wasteful beehive oven is in use, while in Europe the industry of the valuable by-products earns hundreds of millions every year and has had the tendency to keep the prices of the natural liquid fuels on a lower level.

All the conditions the author has alluded to seem to be changing rapidly now; this terribly wasteful performance begins to be realized, the competition has become more keen, and a conservation of natural resources is striven for more than ever before. If this is true, the high-class engines with the highest efficiency will begin on this side of the ocean to have the same importance as abroad.

In conclusion the author expresses the hope that he has given a true and clear picture of the development of the Diesel engine in old Europe, with a few reminiscences of the pioneer work in America, and finally wishes to call to his hearers' minds the fact that nowhere in the world are the possibilities for this prime mover as great as in this country.

THE ELECTRIFICATION OF STEAM RAILWAY TERMINALS.*

By W. F. M. Goss.†

A proposition involving the complete electrification of steam railway terminals in any considerable city constitutes a problem which touches closely the comfort and welfare of the community involved. It is conceivable that through electrification the beauty and cleanliness of a city may be so affected as to stimulate greatly its prosperity and growth, and it is conceivable also that through electrification a burden of financial responsibility may be created which will place severe limitations upon its commercial and industrial development.

The city of Chicago presents at the present time an area of 194 square miles, which is cut up by 2,600 miles of railway track. The Committee of Investigation on Smoke Abatement and Electrification of Railway Terminals of the Chicago Association of Commerce, in the study of its problem under the immediate direction of Mr. Horace G. Burt, has thought it wise to add certain areas so as to include outlying transportation lines correlated with those within the city limits. The area thus defined, which is known to the committee as Zone B, embraces 235 square miles and contains about 4,000 miles of railroad track. It is estimated that 60 per cent. of this track mileage is in yards, sidings, freight and passenger terminals and industrial tracks. The remainder is in main or running tracks. In the language of Mr. Burt, "There are within the city limits 105 separate railway yards and there are many junction-points of intersecting track where an enormous volume of through and local traffic is daily interchanged and handled." A map of the city shows its railway yards to be spotted over its entire area.

If it were true that the electrification of Chicago railway terminals would at once banish smoke from the atmosphere of the city, certain important unknowns in the general problem would be eliminated, but it happens that there are in Chicago other smoke and dust-making agencies besides the 1,600 locomotives which are required to operate its railroads, and the percentage of the whole that is contributed by its locomotives is not known.

Chicago more than most cities can boast of the number and significance of her metallurgical, manufacturing and other industrial fires, not all of which are smokeless. Statistics show that within the city are 17,000 steam boilers served by nearly 10,000 stacks. Thousands upon thousands of domestic fires warm and otherwise serve the homes of this city, and these are not all smokeless. Even the motor cars

* Abstract of a paper read before the City Club of Chicago.

† Dean and Director, College of Engineering and Engineering Experiment Station, University of Illinois.

of Chicago add their quota of smoke, and the wasting of their tires their quota of dirt. It may be that the railways' proportion is, after all, not large, and that the complete abolition of this portion through electrification, or otherwise, would result in but little change in the atmospheric conditions above this city. This is one of the phases of the general problem to which the committee of the Association of Commerce, to which I have already referred, has properly directed its attention. . . . So perfectly have the plans been laid and so scientifically are they being developed that it is easily possible to foresee an accurate determination of a percentage of the total pollution which is chargeable to railway operation. . . . If it should appear as a result of this investigation that the atmospheric conditions of Chicago would be materially improved by the prohibition of the steam locomotive within the city limits, the people of Chicago will be justified in desiring most strenuously such a consummation.

There are many indications of an assumption on the part of the people that the only sure way to secure the elimination of locomotive smoke is through electrification. It appears that the validity of this assumption has not been conceded by the railways. . . . If it should appear after a thorough investigation, such as is now being made under the direction of the Association of Commerce, that the railroads are, relatively speaking, not large producers of smoke, and if it should appear that further reductions in the amount of smoke they produce are practical, the arguments to sustain a change would be materially weakened.

In the meantime, other interests in the field propose the substitution of storage battery locomotives for the existing steam locomotives. They enforce their suggestion with the argument that such a change could be made at a cost which would be comparatively small, and that while the change would add to the cost of operation, it would not involve any serious change in operating conditions. Again, the recent visit to this country or Dr. Rudolph Diesel, the originator of the Diesel engine, has stimulated in many quarters an interest in the possibility of developing a locomotive of the motor-car type which will be operated through the action of a Diesel oil engine, an internal combustion machine of high efficiency. The Diesel engine commonly uses crude oil as its fuel, but other forms of combustible liquid may be employed. The field of application of these engines has been rapidly extended in recent years. Their use in marine service has been extremely successful, and Dr. Diesel has himself developed in Germany a Diesel locomotive of a thousand horse-power. The adoption of such a locomotive for the terminal work of the railways of Chicago might result in the complete elimination of smoke and dirt, and it is believed that while it would add to the expense of existing operations, as would the storage battery locomotive, it would not greatly disturb present conditions, and the expense of the change would be small as compared with that of general electrification.

It is apparent from these statements that, if brought to the issue, the railways may prefer to adopt some form of terminal operation, which, while entirely meeting the objections to existing practice, will not involve the complete electrification of the city's railway terminals in the large sense in which that term is being used.

The general problem of electrification presents two aspects, the characteristics of which are, to my mind, wholly different. These are, first, electrification as applied to suburban passenger traffic, and second, electrification as applied to all other traffic, including, of course, switching, through freight and through passenger service. In the working out of details, these two phases may, of course, be regarded as a single problem, but the considerations which may be set forth as justifying development are not the same in both cases.

The simpler phase of the problem is that which involves the suburban passenger traffic. Every detail which enters into this problem has been threshed out by extensive construction in many parts of the country. The experience which has been gained in the electrical operation of elevated railroads in Chicago, in the electrical operation of the subways in New York and Boston, and in the extensive electric operation of interurban roads in many parts of the country, bears directly upon this aspect of the problem. Among the advantages which the public would derive from electrically operated suburban service in the city of Chicago may be counted that of reduced atmospheric pollution, of cleaner cars, of freedom from inconvenience due to the presence of smoke and cinders, and probably also that of more frequent and more rapid service. The operating railway companies would find some gain in an increased capacity of existing track facilities, in the incidental advantages which would accrue from the maintenance of a more attractive and a more effective service, and in the anticipated gain in business which the improved service would in time attract. There are no real difficulties in bringing about such a change, except such as grow out of the fact that the railroads are now equipped for steam operation. To electrify means that the existing steam operated railways which are earning dividends for their companies must practically be wiped out of existence, and new railroads built and equipped to conform with other standards of practice must be supplied. Very little of that which is now possessed, excepting the track and track structures, and possibly, though not probably, the car bodies, could be of use under the new conditions. Everything electrical, such as power plants or their capitalized equivalent, transmission and distributing lines, new cars or trucks for cars and repair shops in which the new equipment can be kept in order, must be supplied. While I am not authorized to speak for the railroads, I imagine that the difficulty is not that the cost of these things, so far as they apply to suburban service, is prohibitive, but that there is no immediate way by which existing revenues can be materially increased as the result of such a change, and because present-day directors and present-day stockholders are content with what they have. The considerations controlling the financial aspect of the matter are somewhat similar to those controlling the matter of track elevation. The progress of track elevation places heavy burdens on the railroads affected, for which the immediate return is slight, but the work once accomplished raises the character of the railway establishment to a higher standard of construction, and permits its operating service to be gradually tuned up to higher stages of efficiency. The electrification of suburban service in Chicago, while hedged about by similar difficulties, would lead to similar beneficial results, and in the absence of a plan which might insure immediate and complete electrification, it is reasonable to expect the gradual development of suburban electrification.

The complete electrification of Chicago steam railway terminals constitutes a problem of far greater proportions. As already noted, such a development would, as set forth by Mr. Burt, spread over an area of 235 or more square miles, would need to deal with approximately 4,000 miles of track and perform a service which now involves the use of 1,673 steam locomotives apportioned as follows:

To yard service	555	33 per cent.
To through passenger service	367	22 " "
To road freight-train service	364	22 " "
To suburban passenger service	208	12 " "
To freight and passenger transfer service	179	11 " "

If accomplished, it would give the public of Chicago the most marvelous railway terminal that the world has ever seen. The difficulties are not technical, but chiefly financial, and the problem of financing such an undertaking is not one which can be unceremoniously dumped on the railways, for the interests of the railways and of the community served by them are more or less identical, and neither can afford to ignore or injure the other. Probably no one knows the first cost of such an improvement, nor what its effect would be upon the earning capacity of the railways. Those who are especially qualified to speak on this subject are not talking. The Association of Commerce committee, to which I have referred, will have all the facts later, but no figures have as yet been given out.

Some conception of the manner in which expense arises can be gathered from the following very crude illustration: The first cost of a modern steam locomotive may be taken as $20,000. An electric locomotive of the same power will cost about twice as much, but the electric locomotive, unlike the steam locomotive, is not in itself a power unit. It can only be effective in doing work when there is somewhere available a power plant from which it may be supplied with current, and the cost of that portion of the power plant which is chargeable to a single electric locomotive will be a rather large percentage of the total cost of the steam locomotive. Between the electric locomotive and its power plant must be a labyrinth of electric feeders, numerous expensively equipped substations, trolley wires and substantial structures for carrying them, or, in the absence of these, a third rail and all the complicated equipment necessary to transmit the current from the plant to the electric locomotive in whatever location it may occupy on the track. Moreover, in entering upon any large scheme, such as that of complete electrification, many incidental matters arise, the cost of which, while not directly chargeable to electrification, goes to swell the total cost for the whole improvement. By the end of another year the Association of Commerce will, it is hoped, be ready with an estimate based upon an extensive research which will be entitled to the confidence of all parties in interest. The public can well afford to reserve its judgment until the committee's work is completed.

Not only must the railways consider the charges incident to the first cost of electrification, but they must be prepared for some increased cost in operation. Contrary to a commonly expressed popular conception, the actual movement of a train of cars from one point to another upon the terminal railways of Chicago can probably not be accomplished more cheaply electrically than by steam. Again, in the through train service, the electric operation of Chicago terminals would not reduce cost. Under present conditions, through trains approaching Chicago from a distant division point are brought directly into the city by their steam locomotives. The electrification of the terminals would involve the withdrawal of the steam locomotive and the attachment of an electric locomotive at a terminal located at the boundary of the electrified zone. Assuming no electrification, the additional cost of fuel and of service of the steam locomotive crew for taking the train on to its Chicago terminal, as compared with the costs entailed where the locomotive gives up its train outside of the city, is so small as to be almost negligible, while with electrification each train must bear its share of the cost of the electric service which receives it at the boundary of the zone and takes it into the city terminal; that is, electrification would make two operating divisions where one now exists, and short divisions are expensive to operate. There are many other minor difficulties and there are also minor advantages which are revealed by an analytical study of the problem, but excepting in the one matter of smoke and dirt elimination, the advantages in Chicago, where there is no operation in tunnels, are all minor advantages.

Not all of the forty railroads entering Chicago are prosperous. It would be extremely difficult for some to secure the capital necessary for the complete electrification of their Chicago terminal by the sale of securities constituting a lien upon property extending out over the country and through other insistant cities. Compulsory electrification as a measure for immediate execution would add to their present embarrassment and could hardly fail to work to the ultimate disadvantage of the business interests of Chicago.

Here it will be well to note that no great scheme involving the electrification of steam-operated lines, has ever been voluntarily entered upon by a railway company merely for the purpose of raising the character of its service from the conditions of steam operation to those which become possible through electric operation. Where electrification has been undertaken there has always been some large business purpose of interest to the railway company, in the working out of which electrification has entered more or less as a detail. For example, in New York City, the New York Central Railway was operating a long series of tunnels into its Grand Central Station. Its traffic had increased until the frequency with which trains passed kept these tunnels filled with smoke and steam. Operation became increasingly difficult, until an accident in which many lives were lost, resulting from the inability of an engineer to see the signals as he passed them, convinced the railroad officials that a change in operating conditions was necessary. In this case it was a question of giving up the Grand Central Station or of resorting to electricity. The great purpose was to preserve for the railway a valuable terminal property, and electrification proved a ready means to such an end. Similarly, the Pennsylvania Railway entered upon an extensive scheme of terminal improvement, involving a new station in the midst of Manhattan, where before no station had existed, a rail connection with the roads of Long Island which previously had constituted an isolated railway system, and the operation of tunnels under two rivers and a great city. The purpose was not primarily to electrify, but to gain a great terminal, and in the development of this purpose electricity entered as a desirable detail.

It would seem that the City of Chicago, instead of insisting upon the complete and immediate electrification of its steam railway terminals as they now exist, would do well to study carefully in conjunction with the railroads, perhaps through the instrumentality of a commission having large powers, the whole terminal problem. Such a commission could work out in a large way a development adequate to future needs. It could rearrange and simplify existing tracks, it could combine and extend existing terminal stations, it could consider every factor affecting the efficient movement of cars and the transfer of merchandise and passengers from railway terminals to destination. The working out of such plans might be expected to give not only increased facility, but also reduced cost in operation. Such a procedure, covering all of the transportation interests of Chicago, would constitute a stupendous undertaking, but nothing less can satisfy the real requirements of this great rapidly-growing modern city. The working out of any large scheme of terminal betterment, which can be justified as an economic measure, would at once provide an opening through which electrification as a detail could be, and probably would be, readily admitted.

AN ELEVATED CONCRETE TANK.

A tank constructed of reinforced concrete with a capacity of 100,000 gallons, has been erected recently for the Chicago City Railway Company Car Shops, at Seventy-Eighth Street and Dincennes Avenue, Chicago. The tank will provide fifty pounds pressure on the mains of the sprinkler system of the shop. It rests on columns 75 feet high and has a double dome bottom.

Built for auxiliary water storage to supplement the existing 1000-gal. per minute motor-driven underwriters' pump taking water from the city mains, the water in the tank will feed into the system, when the normal pressure, 90 lb. per square inch, maintained by the pump is reduced to 50 lb. per square inch. The underwriters' pump starts automatically and, to insure its constant readiness to serve, a few taps in the shops are connected to the sprinkler service mains. Ordinarily the pump starts every three hours. It is estimated the tank will supply four 1¼-in. nozzles for four hours. There are many acres of buildings, including the barns which house each night cars valued at $2,000,000. As to the choice of materials, the engineers estimated the cost of painting a steel tank with the attendant danger of fire each year while it was out of service would be about one-third of the difference between the first costs of steel and reinforced concrete tanks.

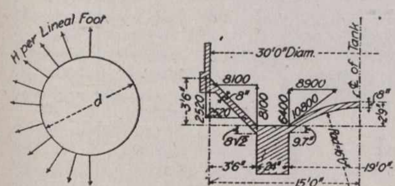


Fig. 1.—Calculation Diagrams.

In designing the tank the shell was made 8 in. thick although the engineers claim they would use 6 in. if another were built, as 4 in. is used in German practice and only this thickness is required by the calculations. Greater thickness, they hold, only weakens the structure by the additional load. Each horizontal ring is reinforced to sustain itself from bursting pressure in the usual manner. A heavier section is used at the top to contain sufficient steel to care for the domed roof. This form was used to eliminate beams, and for drainage purposes six holes opening into the tank are left at the periphery.

Two domes, as shown in the accompanying drawing, make up the bottom of the tank. The sizes are so proportioned that the horizontal thrusts over the supporting circular girder are approximately equal and opposite. The outward thrust of the inverted concentric dome at the base of the shell is cared for by an enlarged concrete section reinforced for these horizontal stresses. The methods used by the engineers in calculating the more unusual features of the tank are given below.

The roof is a section of a sphere, which is 30 ft. in diameter and 3 ft. high, and weighs approximately 58,000 lb. The shear per lineal foot at the base of the dome is $S = wd^2\pi/4 \div \pi d = wd/4$. This shear or vertical reaction is divided into two components, the horizontal tension H and the thrust T. Graphically, we obtain $H = 2.4$ $S = 0.6\ wd$ and $T = 2.6\ S = 0.65\ wd$, or substituting $w = 70$ lb., $d = 30$ ft., then $S = 525$ lb., $H = 1260$ lb. and $T = 1365$ lb.

The component H produces a ring action at the base of the dome as shown in Fig. 1, and the tensile stress on the reinforcing is $Hd/2 = 18{,}900$ lb. The area of four ⅝-in. square bars is 1.33 sq. in. and the tensile stress is $18{,}900 \div 1.33 = 14{,}200$ lb. per square inch.

The shearing stress per square inch on the concrete at the base is $525 \div 48 = 11$ lb. The compressive stress at the base is $1365 \div 48 = 28.4$ lb., or a factor of safety of at least 40 for the dome proper.

The vertical load per lineal foot at the base of the shell due to the weight of the shell and roof is 2520 lb. This force may be divided, as shown in Fig. 1, into two components, a horizontal tension on the ring and a thrust on the inverted dome. The angle being 45 deg., the tension per lineal foot is 2520 lb., and the thrust per lineal foot is $2520\sqrt{2}$ or 3560 lb. The stress on the ring reinforcement having an area of 2.65 sq. in. is $(2520 \times 30.67/2) \div 2.65 = 14{,}600$ lb.

The inverted dome is subject to tension in a horizontal direction from the water pressure and is figured accordingly. The top of the dome is subject to a vertical shear of 2520 lb. per lineal foot and to a compression of 3560 lb. per lineal foot, or a shearing stress of $2520 \div 12 \times 8 \times \sqrt{2} = 18.6$ lb. and a compressive stress of 3560 lb. $\div 12 \times 8 = 37.1$ lb. The weight of the inverted dome, by Guldin's rule, is $6 \times 2/3 \times 144 \times 27\pi = 50{,}000$ lb. The weight of water on inverted dome is $(30^2 - 23^2)\ \pi/4 \times 20.5 \times 62.5 = 292{,}000$ lb. The total shear at the base of the inverted dome equals the weight of the roof, the shell, the dome and the water on the dome, or a total of 586,000 lb., and per lineal feet $586{,}000 \div 23\pi = 8100$ lb.

This shear or vertical reaction may be divided into two components, as shown in Fig. 1, a horizontal thrust in the ring girder and a thrust on the inverted dome. The angle being 45 deg. the thrust on the dome is $8100\sqrt{2} = 11{,}450$ lb. per lineal foot. The shearing stress per square inch is $8100 \div 12 \times 8\sqrt{2} = 60$ lb. The compressive stress per square inch is $11{,}450 \div 12 \times 8 = 120$ lb.

The sphere has a radius of 16 ft., and the section of the sphere forming the dome a diameter of 19 ft. and a rise of 2 ft. 9 in.

The weight of the dome is approximately $19^2\pi/4 \times 1.1 \times 100 = 31{,}000$ lb. The weight of the water above it is $19^2\pi/4 \times 20 \times 62.5 = 355{,}000$ lb. and the vertical shear or reaction at the base per lineal foot is $386{,}000 \div 19\pi = 6400$ lb. This force may be resolved into two components, as shown in Fig. 1, a thrust on the ring girder nearly counterbalancing the thrust from the inverted dome, and a thrust of 10,800 lb. per lineal foot on the dome.

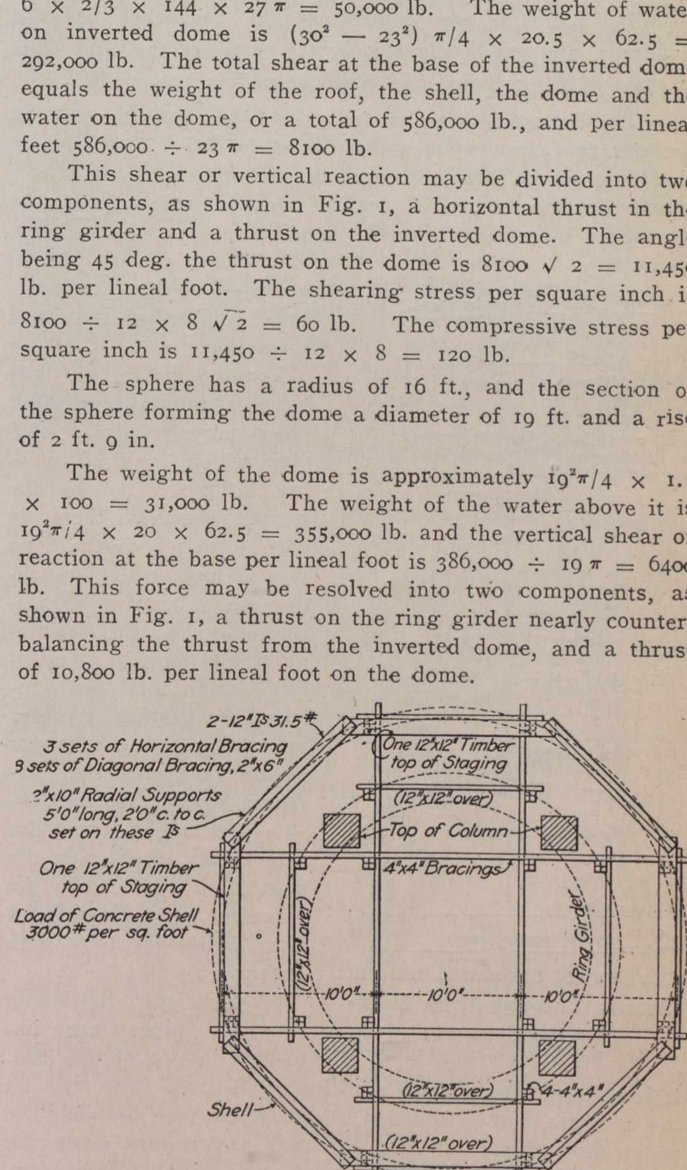


Fig. 2.—Plan of the Top Staging.

The shearing stress per square inch is $6400 \div 12 \times 9.7 = 55$ lb. The compressive stress per square inch is $10{,}800 \div 12 \times 8 = 113$ lb., showing also an unusually high factor of safety.

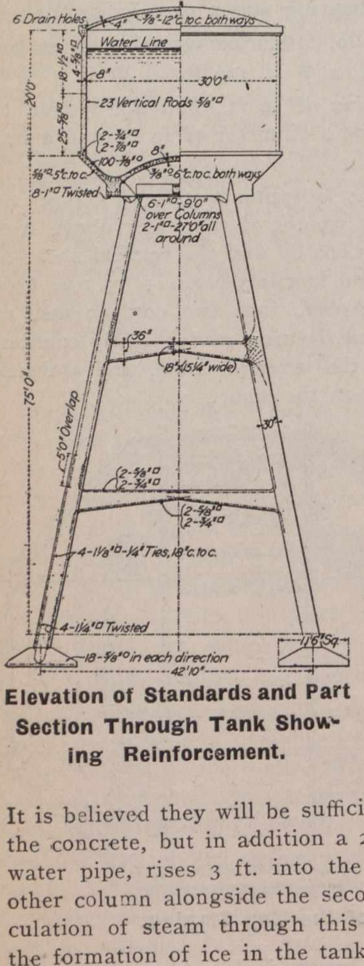
In calculating the ring girder supporting the tank structure it was assumed that the portion of the load over the columns was carried directly. The girder was then figured as a continuous beam with supports assumed 13½ ft. apart. Bending moments of the straight line span were compounded with the torsional moment.

While stresses in the circular girder as soon as construction was completed are held to be vertical only, the weight of the green concrete in the inclined columns produced four inward thrusts on the ring. To care for these stresses concrete struts in the form of a cross connected the tops of the columns.

Assuming a force of 50 lb. per square foot on a flat surface, the total force of the wind on the round tank is 31 × 27 × 50 × ⅔ = 28,000 lb. The assumption was made that each of the two bents in one direction takes care of half this force or 14,000 lb. On account of appearances and the fact that the structure was built over an existing building, diagonal bracings were omitted, and each bent was figured as a nine times indeterminate structure.

The omission of the diagonal bracings caused bending moments in the horizontal ties and in the columns. These bending moments are greatest at the joints of ties and columns, and practically zero in the centre of the ties. The weight of the columns and ties amounts to 302,000 lb.

The direct compression from the wind at the base of the column is 14,000 × 84 ÷ 42 = 28,000 lb. The greatest load on one column is 409,000 lb. and the greatest direct stress 409,000 ÷ 900 = 454 lb. per square inch, which is increased by 390 lb. from the bending moment due to wind stresses on account of the omission of diagonal bracings, neglecting the reinforcement.



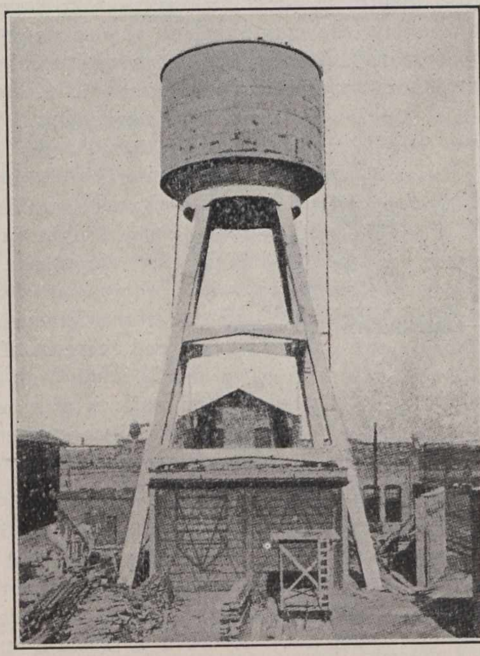
Elevation of Standards and Part Section Through Tank Showing Reinforcement.

Foundations for the legs were carried down to solid, comparatively dry, blue clay which required picking to loosen it. To the casual observer there is such a batter to the legs that sliding on the foundation would seem to be considerable, but the calculations indicate it is a negligible factor and the provision for bearing stresses, amounting to 2.9 tons per square foot, was the governing stress. No measurable settlement could be detected by leveling on the bench marks placed in the concrete legs before and after filling the tank with water.

Six-inch inlet and outlet cast-iron pipes are imbedded in two of the legs. It is believed they will be sufficiently insulated from frost by the concrete, but in addition a 2-in. steam pipe parallels the water pipe, rises 3 ft. into the tank and returns down the other column alongside the second water pipe. By the circulation of steam through this pipe it is hoped to prevent the formation of ice in the tank.

A check valve, protected by gate valves on each side ordinarily kept open, is placed on the connection to the high-pressure mains. An altitude gauge indicates the elevation of the water and a 2-in. tell-tale overflow pipe imbedded in one of the legs discharges on the ground near the outlet pipe manhole when the water is within 3 ft. of the top of the tank, at the 100,000-gal. level.

To support the form work a staging in the shape of a maltese cross was erected on top of the outer and partition brick walls of the kiln house. Six series of 8 x 16-in. timbers were laid on edge transversely over the walls and on these twenty uprights, 46 ft. long and made up of four or six 4 x 4-in. sticks, were erected. These smaller timbers were all in 18-ft. lengths as they had come from another job. Holes for the clamping boards over the butt joints were bored with electric drills and the timbers assembled and bolted up in 3 days by 3 men. While the uprights were assembled in the shop they were knocked down and subsequently erected in 18-ft. lengths by means of a gin pole and a hand winch. There were 3 sets of horizontal bracings of 4 x 4-in. timber and 8 sets of diagonal bracings of 2 x 6-in. lumber.



View Showing Elevated Concrete Tank.

Vertical supports for the shell ring form consisted of 2 x 10-in. Y.P. No. 1 planks, 4 and 5 ft. long, placed on end radially, 2 ft. apart. Fig. 2 shows the support for these radial planks. The 12-in I-beams across the corners rest on top of the 12 x 12-in. timbers laid over the uprights. Three weeks after the concrete had been placed some apprehension was felt on the part of the engineers when three of these radial supports were accidently knocked out. An examination of the remainder disclosed the fact that there was a space of 1/16 in. between their tops and the forms due, it was thought, to the shrinkage of the concrete which would cause rotation around the circular girder and also to a slight shrinkage of the staging which had been exposed all winter.

Concrete for all parts of the work except the foundation was a 1:1:2 mixture of cement, torpedo sand and 1-in. gravel. On account of the intricate framing the contractor concluded it would not be feasible to use wheelbarrows or spouts so a double elevator carrying 8 buckets of concrete on each platform was erected at one side and operated by a team of horses.

Mr. L. J. Mensch, of Chicago, designed and constructed the tank for the Chicago City Railway Company, M. H. B. Fleming, vice-president and chief engineer. The designs were checked by Mr. Hugo Schmidt, superintendent of buildings of the railway company, under whose immediate direction the work was carried out.

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COAL IN CANADA.

The second volume of a series of six on an investigation of the coals of Canada with reference to their economic qualities, has just been published by the Mines Branch of the Department of Mines of Canada. This investigation of Canadian coals and lignites was begun about six years ago. At that time Dr. A. P. Low, Director of the Geological Survey, undertook a study of the fuels of the Dominion somewhat on the lines of the fuel tests which had already been commenced by the United States Geological Survey. The Government, however, had not, at Ottawa, any suitable mechanical laboratory. The Mining Department of McGill University possessed suitable equipment, and the work was, therefore, assigned to Dr. J. B. Porter, the head of the Mining Department there. Shortly after the commencement of the investigation the Dominion Deparment of Mines was created, with Dr. A. P. Low as Deputy Minister; and the investigation, together with all matters relating to economic minerals, was transferred from the Geological Survey to the Mines Branch under the directorship of Dr. Eugene Haanel. The original arrangement, however, was in all respects continued without change. It was intended originally to confine the investigation with coals and lignites of the Dominion; but owing to limited means the following points only were covered: Sampling in the field, crushing the samples and preparing them for treatment, washing and mechanical purification, coking trials, steam-boiler trials, producer and gas engine trials, chemical laboratory work and miscellaneous investigations. The technical staff engaged in the operation comprised Dr. J. B. Porter, Prof. R. J. Durley, Mr. Theo. C Dennis, Mr. Edgar Stansfield, and a large staff of trained assistants.

As was noted above, the results of the investigation will be published in six volumes, of which the second has just come to hand. A very large amount of information has been gathered for the report; much of it, however, is so highly technical as to be only of interest to specialists, hence it has been thought best to divide the report into two main sections of two and four volumes, respectively.

It was the Government's intention to compile and publish a report covering the whole field of the coals of Canada which would be of interest, not only to the engineer, but to the layman, and which would place on record all the facts possible regarding the economic value of Canadian fuels. The results, as seen in the first two published volumes, reflect great credit to the Mines Branch of the Department of Mines, who superintended the investigation, and to the Mining Department of McGill, who conducted a great portion of it.

The succeeding volumes will be awaited with interest, and, when complete, we are satisfied that this investigation will stand as an authority on the subject for many years.

AMERICAN WATERWORKS ASSOCIATION.

The American Waterworks Association has just finished its thirty-second annual convention in Louisville, Ky., and as usual the meeting has been replete with most instructive papers and interesting discussions. This year a Canadian, Mr. Alexander Milne, superintendent of the Waterworks Department of St. Catharines, Ont., has been elected president, and Canadians are well represented in its membership. The

Association is a most valuable one in that, by the co-operation of its members, information concerning waterworks affairs is brought to the public attention. Water supply systems are among the most important of the public service enterprises, and it is only through the cordial co-operation of the heads of waterworks departments that increased efficiency can be secured. It is surprising that the present membership of the Association is not greater when one considers the great benefits the Society are conferring. Its field of usefulness is a large one, for it deals with one of the prime requisites of our modern civilized life.

THE INSTALLATION OF ELECTRICAL MINING EQUIPMENT.

The use of electrical machinery in mines is steadily increasing. The many advantages of its use has tended towards this increase, but the requirements of safety as well as those of efficiency must be considered when installing electrical mining equipment. So important has this been considered by the United States Bureau of Mines that Mr. H. H. Clark, in the technical paper issued by the Bureau has taken up the subject quite extensively. The paper calls attention to the fact that, wherever the service conditions are indeterminate or variable, engineers are accustomed to use factors of safety in their designs, especially in those cases where the protection of human life is a consideration.

To quote from the paper: "The safe operation of electrical mining equipment is an engineering problem that invloves the element of human life, and that is influenced by conditions and events that cannot always be foreseen. The successful solution of the problem will, therefore, depend largely upon the factor of safety that is considered in the selection, installation, and maintenance of such equipment."

The paper proceeds to classify the electrical accidents that may occur in mines, and states the principal sources of danger incident to the use of electricity underground, and the paper shows that the requirements of ment in mines are compared to similar conditions above ground, and the paper shows that the requirements of mining work present certain difficulties in the way of maintaining electrical apparatus in perfect condition. The effect of roof-falls, dampness, dust, and acid water are mentioned, and the observation is made that the temporary character of underground work limits the economical investment in electrical equipment and its installation. The author does not regard the safeguarding of mine electrical equipment as a simple problem, and states that there is no general formula for its solution. It is suggested, however, that a logical step would be to remove contributory causes by placing lights and erecting guards at particularly dangerous points, and by selecting apparatus especially designed to offset the effect of dampness and dust. A concrete view of the problem is presented as follows: "The problem of safeguarding may be divested of some of its vagueness and put in concrete form by considering that if the electric current can be kept where it belongs—in the conductors designed to carry it—it cannot give shocks, set fires, or ignite dust or explosives. Electricity becomes actively dangerous only when it breaks away from its proper channels in stray currents, or as sparks and arcs."

Stress is laid upon the importance of first-class installation at the outset and frequent inspection of equipment after it is in place. The author considers that a competent electrician is needed to ensure the safest and most efficient operation of mine electrical equipment, and dwells upon the responsibilities and requirements of such a position.

EDITORIAL COMMENT.

We draw attention in this week's issue to the Index for the past six months.

* * * *

The destruction of cement mortars and concrete through expansion and contraction has an exceedingly important bearing for the engineer. The use of mortar and concrete, in engineering structures, is so extensive that any investigation having for its aim the determination of facts regarding the action of the materials under the conditions of use will be welcomed by all. In this issue of *The Canadian Engineer* will be found an abstract of a paper by Prof. A. H. White before the American Society for Testing Materials. Investigations conducted by Prof. White appear to show that cracks in concrete and mortar are due, not so much to the expansion and contraction from temperature change, but rather the volume change, due to alternate wetting and drying. The paper will repay careful reading.

* * * *

The Canadian Electrical Association convention always repays attendance, as the members well know. This year's meeting, which was held last week in Ottawa, was successful, both from the point of view of numbers in attendance and the discussion resulting from the papers read. The discussion on the paper by Dr. H. T. Barnes on "Ice Troubles in Connection with Power Plants" was particularly worthy of mention. The paper will be found in this issue of *The Canadian Engineer*. Dr. Barnes has spent many years on the study and investigation of the formation of ice in our northern waters, and it is surprising that the fundamental precautions he outlines in his paper are not universally followed by hydraulic power companies in Canada. There appears, however, to be an absolute disregard of all precaution in the design of many power plants now operating, and as a result every winter brings reports of shutdowns through ice troubles.

MUNICIPAL WORKS CONSTRUCTED BY CIVIC LABOR.

An editorial in a recent number of the Galt, Ont., Reporter deals with the above subject and states that the contractor, in as much as large civic works are concerned, has been unknown here for years—to be exact, not since 1905-6, when the $225,000 sewer contract was finished—and though many mistakes have been made, citizens prefer the present system, under which this municipality is to-day employing nearly 100 men in the construction of various civic works.

ENGINEERING WORK IN SOUTH AMERICA.

The British firm of S. Pearson and Sons, Limited, London, have received official advice from the Chilian government that the contract amounting to $13,000,000, for the construction of the new port at Valparaiso, has been awarded to them.

THE NEW STEAM-HYDRAULIC FORGING PLANT AT THE NEW GLASGOW WORKS OF THE NOVA SCOTIA STEEL AND COAL COMPANY, LIMITED.

The growth and development of its steel trade has now come to be an accepted standard for measuring a country's industrial progress. Canada's expansion in the last thirty years is strikingly shown by her steel statistics, but it is even more vividly brought home by the accomplishments of the pioneer in this line, the Nova Scotia Steel and Coal Company.

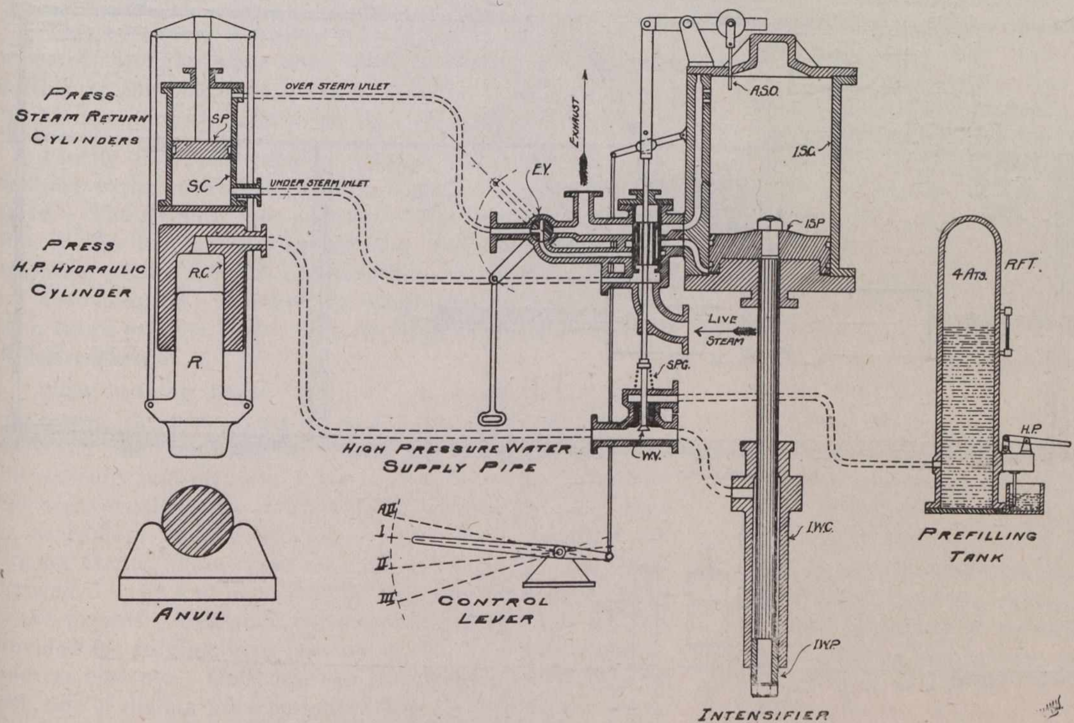
Starting as a country forge-shop with four thousand dollars' capital, this concern has expanded until its capitalization is fourteen millions, and it controls all the operations entering into the production of some six or seven hundred varieties of finished and semi-finished steel products. Particular attention, however, has always been paid to the line of work first carried on and there has never been a time when it could not claim to be the leading forge company of Canada.

By the recent installation of a complete new plant in this department, substituting steam-hydraulic presses for the hammers so long used, it has not only outstripped any Canadian company, but is in a position to challenge the product of any similar company in the world.

Man's ingenuity has been taxed frequently to produce the massive forgings required by the engineering and mechanical advancement of the past century. Often it has seemed tnat great projects could not be carried out for lack of facilities to produce the immense steel shapes required for some particular design, but in the invention and development of the steam-hydraulic press, it would seem that these difficulties had been overcome and a principle had been discovered which would dispel all engineering difficulties of this nature.

Nasmyth's invention of the steam hammer in 1833 revolutionized the forging process of his day. During the latter part of the nineteenth century such enormous progress was made in the engineering and shipbuilding that forgings were required of a size unknown not many years previously. In turn, this resulted in a great increase in the size of forging appliances. Steam hammers were largely used at first and served their purpose well, but as the size of forgings grew, the hammer, being unable to develop a blow with sufficient penetration, became more and more unsatisfactory, and hydraulic-forging presses, operated by means of accumulators, were introduced. Among the first of these was one constructed at the Armstrong Works in 1850. However, they proved so slow in operation, and so expensive, that large steam hammers could still successfully compete with them. In 1860 a hammer was installed at the Krupp Works, Essen, Germany, having a 50-ton ram and a 1,000-ton anvil, while as late as 1901 a 125-ton steam-hammer was installed at the South Bethlehem Works of the Bethlehem Steel Company. Although the latter was easily the largest hammer ever constructed, it was discarded after only a few months' operation and replaced by the more efficient press.

With a hammer of this size, the force of the blow was enormous, but there were numerous difficulties in its operation. The energy developed, depending upon the weight of the falling parts, and the height through which it acted, was delivered suddenly and was exerted for but a moment. Repeated blows were therefore necessary, taking longer time than the press, and with a consequent low efficiency in steam consumption. The constant vibration made it difficult to keep a large hammer in adjustment, and wear and tear was excessive. And, lastly, the lack of control with which the blow is delivered made it a difficult operation to produce good work, and particularly to finish up heavy forging. Thus the relatively small output, and operating cost, makes hammers economically as well as technically unsuccessful in dealing with heavy forgings.



Diagrammatic Sketch of Steam Hydraulic Press, showing the operating cylinder and valve systems with single control lever.

The need for a more effective and cheaper method of manufacture was met by the "steam-hydraulic" press, introduced in the late eighties, in which are united the advantages of the steam hammer, combined with those of the hydraulic-press. In this apparatus, steam cylinders lift the striking piece, or tup, which thus moves with the speed and force of a steam hammer; while constant hydraulic pressure may be supplied at any stage of the stroke by a large water-cylinder. This high pressure water is intensified in and flows from a separate apparatus called an intensifier. Thus the method of operation can be varied widely to meet different conditions. In the most modern type, in which the Scotia Company's presses are the last word, this feature enables much larger, as well as a greater range of work being performed with an efficiency impossible to any other apparatus.

The new Scotia plant consists of two presses complete with all manipulating devices, heating furnaces, etc., housed in a steel, brick, and concrete building 240 x 72-ft. Two electric cranes, of 50 and 30 tons capacity respectively, command the entire building. One press has a capacity of 600 tons, the other of 4,000 tons, at a steam pressure of 140-lb. per sq. in. (See accompanying plan of plant). The larger press has a distance of 128-in. x 64-in. between supporting columns, single stroke, 7-in.; total stroke, 80-in.; weighs 740,000 lbs., and is adapted for forgings up to 75 tons in weight. As the presses are exactly similar, except in size, the following description applies to each.

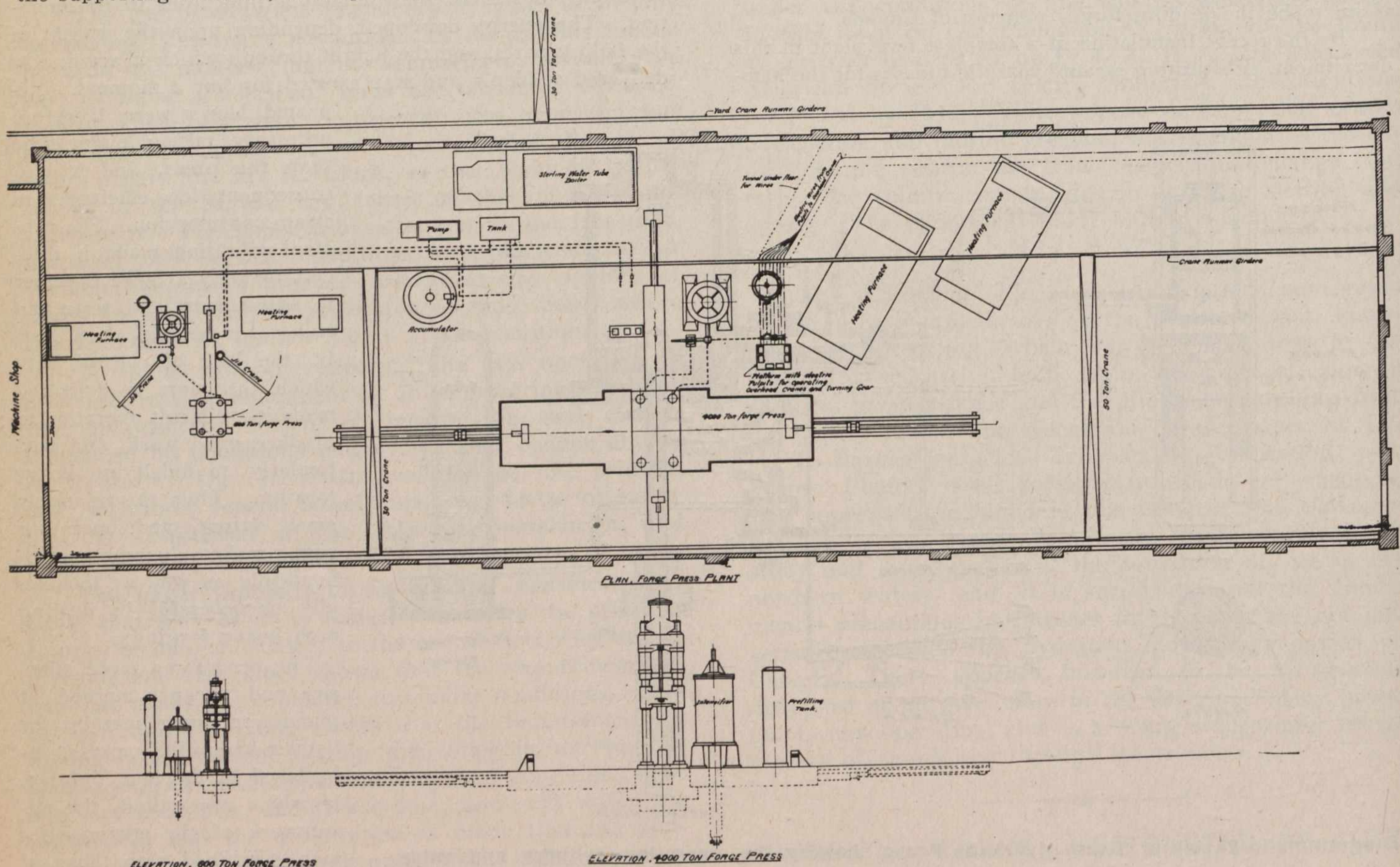
Each installation consists of the press proper, the prefilling water tank and the patent hydraulic intensifier. The press consists of a heavy base plate, embedded in the concrete foundations, on which stands the anvil, also the four forged steel columns which support the press head. Situated near the top of the press are two return steam-cylinders, and the hydraulic or ram-cylinder which is located on the centre line of the press.

Immediately below the press-head is situated the press-traverse, the upper end of which is firmly attached to the piston rods of the three cylinders above referred to. Below the traverse is fastened the upper forging tool or tup. The traverse has four bushed guides, encircling and sliding on the supporting columns, to keep it in alignment and take up the heavy side strains when the ingot is not exactly under the tool centre.

The pre-filling water-tank is an air-chamber equipped with a pump for charging to a certain level at a pressure of 65-lbs. to the sq. in. This tank supplies water to the ram and intensifier cylinders and again stores the water which leaves the ram-cylinder when the piston rises, the flow being automatically controlled by a water valve.

The intensifier, which produces the high hydraulic pressure, consists of two cylinders, a large one, with steam actuated piston, placed immediately above a smaller one containing water. They have a common piston rod, the lower end of which, extending through and working in the water cylinder, acts as the plunger of a force pump. When the steam-cylinder piston moves upwards, the water is forced from an opening near the top of the lower or water-cylinder, at very high pressure, owing to the difference in their diameters, and enters the ram-cylinder giving a greatly increased pressure there. The intensification is 50 to 1, and gives a water-pressure of 3½ tons per square inch in the ram-cylinder.

This type of intensifier possesses many advantages over that of the ordinary type where the steam-cylinder is below, in that the design of the whole is lower, giving greater access to the working parts. The piston rod is always in tension, resulting in less wear and tear on glands which therefore are more readily kept tight. Vibration is largely eliminated by the valve arrangement which admits steam on the inside of the lower cover of the steam-piston, thus providing a steam cushion, and resulting in a noiseless drop. The valve system is automatic in controlling the press and prevents any injury to the tups or dies from below, due to momentum (for instance when cutting) for the weight of the tup is at once taken up by the under steam in the press traverse steam lifting cylinders. All the valves controlling the various operations are at the side of the intensifier and are all operated by a single lever, so adjusted that the press follows its movements in speed and stroke.



The Forge Press Plant of the Nova Scotia Steel and Coal Co., Ltd.

The press may be operated in four separate ways and under each the tup may at moment be arrested instantly and a new stroke inaugurated by a single movement of the controlling lever. The tup may be actuated (1), By the steam cylinders alone, the press then operating like an ordinary single acting steam hammer; (2), With intensifier giving high pressure only toward the end of the stroke. This is the method used in ordinary forge work; (3), With high pressure throughout the entire stroke, used in pure press work, cutting, etc.; (4), With intensifier and under steam-cylinders which results in rapidly repeated heavy blows delivered at a fixed height. This method is used for finishing work to exact size, the length of the stroke being automatically controlled.

The accompanying diagrammatic sketch of the operating cylinder and valve systems, showing the single lever control will make the mode of operating the press clear.

At all times steam pressure is acting on the under side of the press steam-piston, With controlling lever in position I., the top side stands open to exhaust. There is no movement owing to the water being confined over head of ram, the water valve, WV, being closed.

To lower ram, push the controlling lever down to II., thus balancing piston by admitting steam to both sides of it. Thus the weight of the press-traverse, assisted by the pressure of the prefilling tank (this latter having automatically opened the water valve) causes the ram to fall.

When using the intensifier, the hammer is dropped as already described, until it reaches the work, when the controlling lever is pushed down to position III. This raises the steam valve, SV, still higher, admitting steam to the large intensifier cylinder, ISC, thus forcing down ram of the press with the high pressure generated due to the difference in diameter of the steam- and water-cylinders or pistons.

By returning the lever to position II., the steam exhausts, and allows the intensifier-piston to fall; the vacuum thus formed drawing in more water from the prefilling tank. Upon pressing down the lever again, the pressure is again obtained from the intensifier.

This operation, of taking a new hold as it were, may be repeated throughout the total stroke, enabling pressing and cutting to continue at a uniform pressure for this distance. In this operation the oversteam is never open to exhaust.

Finally to obtain rapidly repeated short strokes, lower hammer to be required, then throw open the large exhaust valve. The steam is then admitted alternatively to the underside of the hammer-piston, and the intensifier-piston; this operation giving a heavy down-stroke and light up-stroke at any desired speed. To lower the range of these short strokes, open large exhaust valve, thus allowing the hammer to fall to desired height.

When making heavy forgings, whether under hammers or presses, the piece must be frequently moved and turned, especially when the finishing strokes are being given. To do this speedily and cheaply, a mechanical handling equipment has been installed, the forging being suspended and rotated by an endless chain driven by electric gear attached to the forging crane. This crane may be operated from the usual suspended cage and also from a pulpit at floor level, close to the presses. Hydraulic manipulator and mandrel gear is provided for forging long massive shafts, cylinders and turbine casings, etc. There are two hydraulic operated rests on each side of the big press for supporting long forgings. These travel twenty feet each way. Hydraulic manipulating gears are provided for adjusting the different bottom anvils. On the large press, the stroke of this appliance is about 12 ft.

The low pressure hydraulic installation operating this mechanism consists of a dead-load accumulator supplied by an electrically-driven three-throw vertical pump. The motor is 50-horse-power, and the pump supplies 50 gallons per minute against a working pressure of 720 lbs. per sq. in. in to the accumulator ram.

Rapid working, range of utility, economy and every other requirement of modern forging practice are fulfilled by this plant. The steam consumption is extraordinarily low as the cylinders do not have to be kept filled continuously. The plant is exceedingly compact and with its wide scope and splendid equipment of accessories, will be able to furnish all the Canadian requirements in forgings for years to come.

From the view-point of the consumer, the product of the steam-hydraulic forging press has many advantages. This is not only because forgings may be produced at a lower cost, for the improvement in the quality of forgings is even more important.

The product of a modern steam-hydraulic press is denser and more homogeneous than can be provided with the steam hammer, due to the effect of the blow of the latter not penetrating to the centre, in contradistinction to the uniform kneading effect of the press; while the amount of work that can be done by the latter at one time, with little variation in temperature, strongly tends to produce a better product. This simplifies the required heat-treatment by reducing the number of heating and their duration. It also prevents the liability of damage due to working at a blue heat. Thus the greater uniformity and reliability of steam-hydraulic forgings makes their use imperative wherever high-class forgings are necessary.

PROPOSED MONTREAL HARBOR IMPROVEMENTS.

According to a plan of improvement recently spoken of by the harbor commissioners of the Port of Montreal, it is proposed to expend from $1,500,000 to $2,000,000 on improvements in the west end of the harbor. The harbor of Montreal has a length of many miles, but the central or upper portion is no more than about half a mile in length. The harbor commissioners' office is close to the mouth of the lower entrance of the Lachine Canal, and from here down to Bonsecours market is situated the harbor of Montreal, as it is known to all the passenger boats and most of the large carriers of general merchandise. Here are situated the big elevators which take the grain from the upper lake vessels and tansfer it into the holds of the ocean liners. These elevators are equipped with carrying belts which discharge cargoes into vessels docked at any point along the wharves of the upper harbor. Passenger steamers all dock in this vicinity and the regular passenger companies have their offices not far distant.

Owing to all these advantages, as well as to the ease with which freight can be handled from ships docking in this vicinity to the importing and exporting houses, as well as to the railway depots, space for dockage is most desirable and there is greater demand for it than there is supply.

The harbor commissioners now propose to build a twelve hundred foot concrete pier straight out into the river from opposite the offices of the habor commission, at the foot of McGill Street. This locality is now used as a basin for vessels entering or leaving the canal, the entrance to which is nearby. As the entrance to the canal would be made difficult by the construction of this new pier, the plan includes the moving of the entrance to a point a convenient distance further west. Other improvements include the deepening of some of the old basins and the construction of other new concrete wharves, together with the lengthening of three of the principal piers now in existence, namely, King Edward, Alexandra, and Jacques Cartier piers, each of which will have 300 feet added to them. The completion of the new pier at McGill Street will provide accommodation for at least two more large ocean steamships, while the lengthening of the piers referred to and the completion of Victoria Pier, will increase the capacity of the central and most valuable proportion of the harbor by a very considerable percentage.

Meantime, work is proceeding on the completion of more elevator capacity, and on various other improvements which have been undertaken. Additional permanent sheds are being planned for the extensions which are being added to the piers and for the new piers, and it is believed that the commissioners have under consideration improvements in the way of railway facilities, to and from the ships, which will greatly facilitate the handling of freight.

THE INFLUENCE OF ICE ON WATER POWER DEVELOPMENT.*

By H. T. Barnes, D.Sc., F.R.S.†

The industrial development of our vast water powers is of great interest to everyone looking to the future. As public utilities become more and more dependent on hydraulic power, the question of continuous operation is of far-reaching importance. Chief among the causes which affect uninterrupted service is the presence of ice, which for five months of the year forms in the water. Hitherto it has generally been accepted that disturbances from ice inevitably occur, bringing about temporary "shut-downs." It has been thought necessary in every well-designed plant to instal an auxiliary steam plant to carry the load, and so far as the public is concerned, little is known outside the power house. It cannot be said that this is desirable, and in the future big developments is will be too costly. That it is not necessary it is my desire to point out in the present paper. The matter is creating not a little interest among engineers who have had personal experience of ice troubles, and the public generally are beginning to awaken to the fact that inconvenience from the stoppage of the power is not to be allowed. During the days of small developments it was a matter of little importance; but in the near future an abundance of cheap power will become available that must not be subject to caprice of Nature. Continuous service must be preserved if the confidence of the public is to be gained, and the wealth of power around us utilized to its full capacity. Canada has a great inheritance in its water powers. She is also blest with a vigorous winter, so that a study of ice conditions is of increasing importance.

Nowhere can one find a more wonderful example of the delicate poising of the forces of Nature than in one of our northern rivers. As soon as winter sets in, the water cools to the freezing point, and varies but a few hundredths of a degree for the entire period of ice production. The reason is to be found in the particular nature of the freezing process. Every liquid which produces a crystalline solid has a definite freezing and melting temperature, which we are told never varies. The process of change involves a heat transfer without temperature change. We know, however, by the second law of thermodynamics that heat cannot pass from one body to another without a temperature difference. The latent heat of water cannot pass out without a temperature gradient be it ever so small. In the case of water the molecules give up their heat readily when changing to ice, and the change proceeds rapidly when the temperature difference is only a small fraction of a degree. The microthermometer has revealed the magnitude of these temperature differences which have escaped detection in the reading of the ordinary thermometer. Thus when ice is forming rapidly, the temperature is found to be of the order of a hundredth of a degree below the freezing temperature, and the heat flows out of the molecules to keep the water from going lower. Similarly, when ice is melting rapidly, the temperature rises slightly. As a rule, ice forms, and that which is already formed, grows when the temperature is only a few thousandths of a degree lower than 32° F. Water can crystallize at a certain rate. When the heat loss is rapid, the temperature falls, thereby accelerating the ice production and preventing too rapid a growth. Similarly, ice can melt only at a certain rate, and the rapid supply of heat results in a slight rise of temperature in the water which accelerates the melting. A mixture of ice and water is at the true freezing point only when it is neither gaining nor losing heat. Rapid freezing or melting results in a temperature slightly lower or higher than this. Hence we find the balance in Nature continually swaying one way or the other, depending on the outside conditions.

It is doubtful whether the ice itself wetted on the surface ever differs from the true freezing point, since the surface of the crystal emits or parts with the latent heat, and is thus continually surrounded by a source or sink for the heat produced. The birth of an ice crystal takes place by the disturbing influence of foreign matter in the water such as fine particles of denudated material and by the direct action of cold air churning up the surface into spray which falls back frozen. The vapor from open water also furnishes the nucleus for the ice crystal, and the beautiful ice flowers noticed on a very cold day on thin ice are caused by the freezing of these particles. The steam noticed on a cold day from open water is a direct sign of the comparative warmth of the water, and must supply a vast number of small crystals which fall back into the current.

There are three distinct forms of ice met with in Nature; there are, surface ice, frazil ice and anchor—or ground—ice. Of these, frazil ice is the most troublesome to power houses, and causes probably all the "shut downs." I will briefly describe all these forms.

Surface Ice.—Wherever water is still, ice forms rapidly over the surface and closes it in. This ice starts in two ways, depending on the general weather conditions. It may spread over the surface quietly, commencing from the shore and working outward, forming a sheet that is smooth and often clear, but it forms more often from the freezing of the frazil and scum ice blown by the cold wind into the bays or inlets. In this case the ice grows backwards against the wind, being increased by the fresh accumulations. This surface layer is rough and opaque, and consists of large and small pieces with the crystal pointing in every direction. While the first method of freezing requires absolutely quiet conditions, the second will often proceed over the surface of quite a rapid current. In both cases the water must be at the freezing point; and the heat carried off by the cold air. The effect of a wind is to increase very much the heat loss, and, therefore, the second method is the one which causes the more rapid freezing. Evaporation from the surface furnishes a large part of the heat loss due to the high latent heat of vaporization. Hence a wind from the north with little moisture in it will produce more evaporation and a greater ice production than one of the same temperature from the east or south. But, as a rule, a north wind is accompanied by fair weather, and sunshine inhibits the ice production to an enormous extent. An east wind with clouds and snow often causes vast numbers of crystal nucleii in the water.

As soon as the first ice layer forms, by whichever method, the wind is shut off from the surface, and scum ice is no longer formed. The ice sheet now grows rapidly in thickness by the conduction of heat through the ice to the cold air above. The rate of growth of ice may be calculated from ordinary data of heat conduction. The velocity of the wind and the rate of evaporation of the ice surface also determines the rate of growth. Presumably the water under the ice is at 32 deg. Fahrenheit and layer after layer of ice is frozen on. The ice thus produced is of great purity, since the freezing proceeds so gradually that air and frozen matter are readily expelled. It is always possible to tell this ice from the first layers, as it is clear and hard. The crystals are all grown with the main axis at right angles to the surface. Hence when the surface becomes rotten in the spring, the ice often consists of a lot of vertical needles standing on end. A wind or current will topple these over, and they quickly melt, giving rise to the

*Abstract of paper presented at annual convention of Canadian Electrical Association, Ottawa, June 19-21, 1912.

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tradition that surface ice sinks in the spring. Surface ice grows more and more slowly as the thickness increases, until it finally becomes stationary. It then proceeds to melt and decreases in thickness until the warm sun of April rots it away.

There is a limiting thickness to the surface ice which is determined by the temperature of the water under the ice. In our rivers the water gently flowing along the under surface of the ice is seldom exactly at the freezing point. This is due to not only the natural heat of the river bottom, which is entrapped in the water flowing over it, but also to the increasing power of the sun in the late winter months. The limiting thickness of the ice is due to this, and the decrease towards spring to the rising water temperature. The average water temperature under the ice is about 1/100th of a degree as shown by the microthermometer. In cases where undercurrents are brought to the surface, we find what are called air-holes in a lake or river otherwise frozen over. This is due to the higher temperature at these places which prevents the ice from growing, and rapidly melts any surface layer formed at the outset of cold weather.

Surface ice, when it can be induced to grow, is a protection to the water, and prevents scum and frazil ice, but also holds the water temperature back long into the spring, turning back the greater part of the sun's heat. Water running under surface ice faster than half a mile per hour, will carry with it floating ice. Attention must be directed to this whenever an intake is situated in open water. Surface ice may also prove to be a menace and a continual source of trouble, as will be better understood when frazil ice is described.

Frazil Ice.—Frazil, as its name implies, is cinder-ice, so-called by the French from its resemblance to cinders or ashes. It is the fine needle ice found floating in the open water, and varies in size from minute crystals to large agglomerated masses. It is formed by surface cooling in water flowing too swiftly for surface ice to form. An estimate of the number of these crystals in a cubic foot of water shows on an average cold day in winter about a quarter of a million, but this I have found often reaches several millions. The current carries these crystals downwards and under the barrier of surface ice which extends over the quieter parts of a river, and there they settle upwards and become attached to the under side of the surface sheet. In a short time immense hanging dams are produced which impede the water course and cause a rise of the water level. During cold weather the under passages may become blocked entirely and a rapid rise of water produced above the dam. When sufficient head of water is gained, the whole ice jam is forced out and a winter "shove" produced. At some parts of the river, like the St. Lawrence, there is a continual rise and fall of water level going on all winter. This frequently interferes with the normal head of a power house and causes serious trouble.

During the period of rapid formation of frazil ice, the water is slightly below the freezing point, and, in consequence, the crystals are growing rapidly. They readily freeze and form agglomerated masses, and they attach themselves to objects immersed in the water which are likewise cooled slightly below the freezing point. The time during which supercooling takes place does not last very long, and is quickly relieved during the periods of fine sunny weather.

Anchor Ice.—Whenever a river is open in winter, the presence of ice growing on the surface of objects immersed in the water is observed. This ice forms in long needle crystals attached in the same manner as the ice flowers. As the ice thickens, the crystals become large, and finally form masses many feet thick of coarse-grained crystals. Anchor ice forms primarily from the cooling of the river by radiation. Water is an almost perfect absorber of heat, and, likewise, it is an almost perfect radiator. During the intense radiation at night in winter when the sky is clear and the air almost devoid of water vapor, the water and objects in it become supercooled. Ice forms rapidly and covers the entire river bottom. During the day the effect of the sun is to raise the water temperature slightly, and the ice soon loosens and rises to the surface.

Anchor ice plays little part in power house troubles, for during the period of frazil sticking, the anchor ice is frozen to the bottom and held in place. In fact, it appears to remove many of the frazil crystals in as much as it is growing rapidly and readily causes an adhesion of the fine needle crystals.

Power House Location.—A power house may be situated at a rapid or fall where the water normally freezes over for many miles above. As soon as the winter ice is formed, usually no trouble fro n ice need be feared. Until, however, the river closes in, a period of frazil production may result and consequent closing down of the plant.

Sometimes open water conditions above compel a long forebay to be constructed where the surface ice is allowed to form. If the forebay is fed from open water, frazil jams are sure to occur, and the free waterway reduced or stopped altogether. It is better to run a canal up to the position of permanent surface ice to avoid this. When jams occur, little can be done beyond blowing up the ice by dynamite and blasting out a clear channel. In this case men must be stationed to remove the frazil from the channel, as the ice is drawn in by the current. When a forebay is fed from open water, it is better to keep it from freezing and handle the ice at the power house.

Ice troubles at the power house show themselves in the freezing of the racks, gates and turbine wheels. Special heating devices must be provided to avoid the sticking and freezing of the frazil crystals. The ranks must be protected from the direct action of the cold air by a curtain wall, and may to advantage be heated. The iron bars of the rack when exposed draw the heat from the water and cause an abundant supply of anchor ice even when the water is not supercooled. By enclosing the racks, the natural heat of the water has full effect, and usually nothing is needed to keep them free of ice.

When a power house is fed from open water, at times frazil may come down in such quantities as to stop the racks mechanically. In such a case the ice can be removed mechanically. Revolving racks would be of great service under such circumstances. For the turbines and gates steam-heat may be used, as in Mr. John Murphy's appliances. It is only necessary to keep the surface of the machinery a very small fraction of a degree above the freezing point, and this can be done easily. Mr. Murphy, who has already read a paper before this association on ice troubles, has been wonderfully successful, and a visit to the Ottawa and Hull Power Company will show the practicability of his apparatus. Repeatedly the stations equipped with his units have been running when neighboring stations not so equipped have been shut down with not a wheel turning.

The tail race sometimes causes trouble when the ice jams below and causes the level to rise. This is the most difficult to deal with. It involves dealing with the channel below, which is often too costly for a small development. By maintaining an open channel below, trouble of this kind can be avoided. In general we can give some rules for avoiding ice troubles:—

1. Have covered racks and steam-heat provided for the trouble which always comes to a power house before the permanent ice forms.

2. Instal a few meteorological instruments to watch the weather in order to be prepared for the first cold snap.

3. Where the forebay is fed from a lake or canal, induce freezing as soon as possible: otherwise maintain an open channel down to the power house. Provide a special way for floating frazil.

4. Watch the temperature of the winter at the outset of cold weather, and when 32° F. is approached, have the steam-heating plant in readiness.

CONVENTION OF AMERICAN WATERWORKS ASSOCIATION.

The members of the above association held their thirty-second annual meeting in Louisville, Ky., on June 3-8 last. Mr. Dow R. Gwinn, of Terre Haute, Ind., presided in the absence of the president, Mr. Alexander Milne, of St. Catharines, Ont.

After the reports of the various committees had been presented several papers dealing with matters of interest to the members were read and discussed.

Three papers dealing with efficient management of large works were presented by Mr. Harrington Emerson, of New York, Mr. E. C. Church, of New York, and Mr. I. M. de Varona, also of New York.

Prof. Albert F. Ganz presented an illustrated paper on Electrolysis from Stray Electric Currents.

Considerable discussion followed the reading of papers on "Water Waste," by Mr. Edward S. Cole, of New York, and Mr. F. H. Shaw, of Lancaster Pa. Mr. Reimer mentioned in the course of the discussion that East Orange, N.J., had reduced the per capita consumption from 93 to 80 gallons by combined inspection and metering 25 per cent. of the services.

Dr. D. D. Jackson's paper on "Results of Chlorination at Cleveland, Ohio," was illustrated with lantern slides. He outlined the seasonal and geographical typhoid distribution in Cleveland as well as at a number of other cities. Valuable tables on typhoid rates for the past three years in 16 cities having populations of 100,000 and over with a filtered water supply showed up the large amount of typhoid that is due to general sanitary conditions. Relative percentages of typhoid rates in Cleveland he classified as follows: 10 per cent. of the water supply, 10 per cent. to out of town cases, 10 per cent. to raw foods, 30 per cent. to general sanitary conditions and 45 per cent. to contact cases.

An open discussion followed the reading of this paper which ended by resolutions being passed urging upon boards of health the importance of ascertaining and recording the distribution of typhoid fever by causes and modes of infection to the end that a division of responsibility may be made between water supply, contact cases, general sanitary conditions, milk and other food supplies liable to contamination and typhoid carriers. It was further resolved that boards of health be urged to do their full duty in the elimination of all causes of the spread of typhoid fever, including the use of polluted private wells, or other polluted water, when a pure public water supply is available.

The election of officers for the coming year resulted as follows: Mr. Dow R. Gwinn, Terre Haute, Ind., president; Mr. Robert J. Thomas, Lowell, Mass., first vice-president; Mr. John A. Affleck, Harrisburg, Pa., second vice-president; Mr. George G. Earl, New Orleans, third vice-president; Mr. Theodore A. Leisen, Louisville, Ky., fourth vice-president; Mr. Charles R. Henderson, Davenport, Ia., fifth vice-president; Mr. J. M. Diven, Troy, N.Y., secretary and treasurer; Mr. H. E. Keeler, of Chicago, Mr. Leonard Metcalf, of Boston, and Mr. Leslie C. Smith, of Cleveland, finance committee.

The convention next year will be held in Minneapolis.

TESTS OF STEAM TURBINES.

The results of the following tests on the Zoelly steam turbine are of considerable interest. The capacity of the turbines ranged from 1,250 k.w. to 10,000 k.w. The resulting steam consumptions are of interest on account of the low figures obtained, and from the fact that the increased consumption at partial loads is kept within very narrow limits when it is remembered that the efficiency of the generator is decreased considerably when running at loads below normal. The figures from the official tests have been furnished us by Mr. T. Heyerdahl, chief engineer of the Escher-Wyss Company in Canada:—

Two 1,250 k.w. Zoelly turbines, 3,000 r.p.m., delivered to the municipal power station at Drammen, Norway; in commercial operation since January, 1912. The official test was carried out February 19th and 21st. 1912:—

Load.	Full.	Three-quarters.	Half.
Power in k.w., inclusive of excitation, but exclusive of power required for the condenser	1,275	981	656
Over-pressure at stop-valve of turbine in lbs. sq. in.	183.0	174.5	174.0
Temperature at stop-valve, deg. Fahrenheit	588	494	472
Vacuum at the exhaust branch in inches (referring to 30-inch mercuri)	29.06	29.22	29.42
Steam consumption in lbs. per k.w. and hour	12.60	13.80	14.80

One 5,000 k.w. Zoelly turbine, 1,500 r.p.m., delivered and installed at the power-house of Escaut, near Antwerp. The official test was carried out January 22nd and 23rd, 1912:—

Load.	Full.	Three-quarters.	Half.	Quarter.
Power in k.w., inclusive of excitation, but exclusive of power required for the condenser	5,418	4,305	3,160	1,184
Over-pressure at stop-valve of turbine in lbs. sq. in.	167.0	168.0	173.5	169.5
Temperature at stop-valve, deg Fahrenheit.	588	556	559	520
Vacuum at the exhaust branch in inches (referring to 30-inch mercuri)	28.90	29.10	29.26	29.55
Steam consumption in lbs. per k.w. and hour	11.92	12.32	12.65	14.70

One 10,000 k.w. Zoelly turbine, 1,250 r.p.m., delivered for La Sociéte le Triphase à Asnière. Officially tested February 12th, 1912:—

Load.	Full.	One-third.
Power in k.w., inclusive of excitation, but exclusive of power required for the condenser	10,006	3,678
Over-pressure at stop-valve of turbine in lbs. sq. in.	154.0	162.5
Temperature at stop-valve, deg. Fahrenheit	566	567
Vacuum at the exhaust branch in inches (referring to 30-inch mercuri)	28.72	29.19
Steam consumption in lbs. per k.w. and hour	12.00	14.52

STANDARD HOSE COUPLINGS AND HYDRANT FITTINGS.*

By F. M. Griswold.†

The first concerted attempt to secure the adoption of a standard hose coupling dates from the organization meeting of the "National Convention of Fire Engineers," in Baltimore in October, 1873, when with the lesson of the great Chicago fire of 1871, added to that of the conflagration in Boston, November, 1872, before them, this assemblage of fire chiefs adopted the following resolution: "Whereas, experience has shown that the fire departments of the country should be provided with a universal or standard coupling for hose and fire hydrants, so that when a city or town calls for aid, in case of large fires or conflagrations, from another city or town, that each department can act in unison with the other; therefore, be it resolved that a committee be appointed by this convention to take under consideration, and report back to this Convention the practicability of adopting a standard coupling of some kind to be used by all fire departments throughout the United States."

The standard thus established was of 2½-in. inside diameter, 3 1/16-in. outside diameter over thread of male end, with 7½ threads to the inch. Some chiefs changed their couplings to conform to this and have since maintained that standard in operation. But standardization failed of immediate accomplishment because no concerted and continued action was undertaken to keep the proposition alive.

The firemen's convention of 1875 adopted as its standard a coupling showing 2⅝-in. inside diameter, by 3⅛-in. outside diameter "exclusive of the thread" and of 3⅜-in. outside diameter inclusive of the thread, the latter to be 8 to the inch. In 1878 a special committee reported that the 1875 specifications were found to be "impracticable in use."

In 1879 the firemen again took up the subject and this time submitted as their standard a coupling showing 2½-in. inside and 37/32-in. outside diameter with six V-shaped threads to the inch, which was duly adopted. The matter lay dormant until 1883, when the 1879 specification was endorsed and resolutions passed to secure co-operation through state legislation.

In 1890 the Firemen's convention appointed a committee to report a standard for adoption in 1891. Mr. C. A. Landy, chairman of the committee presented a report covering coupling dimensions in 1339 towns where 2½-in. fire hose was in service, showing outside dimensions over male ends ranging from 3 to 3⅛-in. and including 7, 7½ and 8 threads to the inch. Having demonstrated by the use of a model coupling of 3 1/16-in. outside diameter, with 7½ threads to the inch, that about 70 per cent. of the couplings listed might serviceably be converted to use with a coupling of these dimensions through the simple process of decreasing the diameter of the male thread, or of increasing that of the female swivel, he urged the adoption of a standard conforming to these dimensions as an intermediary which would permit standardization at the least expense.

The feasibility of adapting these non-conforming couplings to practically serve with the proposed standard carried conviction to the members of the Convention and a standard for 2½-in. hose was adopted under specifications showing 3 1/16-in. outside diameter over male end, with 7½ threads to the inch, but in nominating the number of threads for the larger sizes of couplings, the committee then having the matter in charge, increased them in ratio proportional to the expansion in diameters, thus presenting a mechanical anomaly not to be tolerated in practice.

For thirteen years after the adoption of a standard in 1891, which action was simply an endorsement of the specifications of 1873, the hose coupling proposition appears to have reposed in undisturbed quiet.

Confronted with this record of 31 years of failure, the National Fire Protection Association selected the writer as its delegate to the convention of the International Association of Fire Engineers at Chattanooga, in 1904, instructing him to propose joint action to devise an acceptable coupling. This proffer of co-operation was accepted and a committee appointed to take charge of the work.

This committee suggested as a standard coupling for 2½-in. hose one showing a diameter of 3 1/16-in. over male end thread, with 7½ threads to the inch, by the use of which it was practically demonstrated that couplings ranging in outside diameter from 3 1/32 to 3 5/64-in., with either 7, 7½ or 8 threads to the inch, could be so modified as to serviceably couple-up with this suggested standard, and thus render over 70 per cent. of the majority couplings known to be in use conformable to the proposed standard at small expense.

The committee took the matter up with the Insurance Committee of the American Waterworks' Association in April, 1905, at which there was also present a number of the associate members of the Association. The specifications were critically considered and accepted without change, and were adopted by the Association in 1905. The writer also presented the proposition to the International Association of Fire Engineers at Duluth, 1905, when the convention voted almost unanimously in the approval of the standard specifications. Following this action at Duluth the committee secured other approvals of the standard from important organizations.

When this proposition was first presented to the American Waterworks' Association the committee held data relating to couplings' dimensions in only about 1,600 separate localities in this country. Since that time it has created a card index record covering 3,133 towns in the United States and Canada. Analysis of the data shown in this record, based upon actual results accomplished in the conversion of non-standard couplings to safely interchange with the established standard, demonstrates that approximately 80 per cent. of the couplings listed are either of standard dimensions or may readily be so modified as to conform to them.

The record shows 73 cities in which the standard has been put into service, seven of these installations including the complete substitution of standard couplings and hydrant nipples in place of previously prevailing non-standard devices.

In St. Louis, Mo., over 11,000 hydrant outlets and the couplings on many thousands of feet of fire-hose were changed from 6-thread to the standard by city employees, at an average net cost of $1 per hose coupling, and $2.82 per hydrant outlet, the latter being principally of 4½-in. steamer suction type, each of which was laboriously chipped-out by use of a cold chisel.

During the winter of 1910-11, Sprinfield, Mass., discarded the Universal clutch coupling and substituted for it the standard, changing over 1,350 hydrants, some of which had four outlets, at the rate of from 50 to 100 outlet replacements per day, at an average net cost of $1 per outlet, giving credit for the old metal, and excluding cost of labor performed by the regular force of water-works employees. Couplings on 2,000 feet of hose were changed by department employees at a like net cost of $1 each.

This work was carried out in the winter. Where hydrant nipples were leaded-in, the use of a 6-lb. sledge proved an efficient means for their removal, while in the case of screwed-in nipples, an expanding wrench entered from the out-board end of the nipples engaged the operating lugs and permitted the easy removal of the device, while the 4½-in. leaded-in suction nipples were melted out by a plumber's blow torch, at the rate of 5 minutes per operation.

*Abstract of paper presented at 32nd annual convention, Louisville, June 3rd to 8th, 1912.

†General Inspector, House Insurance Co., New York.

NEW TYPE OF STEEL FORMS.

The increased use if concrete for pipe and conduit manufacture has made time and energy spent in form improvement profitable, and from this fact is due the many and satisfactory methods of conduit manufacture now in use.

Many of these machines manufacture the pipe in sections, which are so formed at the ends as to allow them to be bonded together. The "Blayney" system recently patented, allows the conduit to be constructed in one piece, and presents some features worthy of comment. A description of the system follows:

Wooden forms are bulky and clumsy to handle; they shrink and swell; are difficult to clean; costly to repair each time they are used and are useless after being used a few times. Wooden forms are expensive because they require skilled labor to handle and without special care they will leave a rough surface which is objectionable in many concrete pipes.

Extensive use has demonstrated the desirability of using steel forms. Their first cost is more than that of wood, but the total cost of steel forms is much less than the total cost

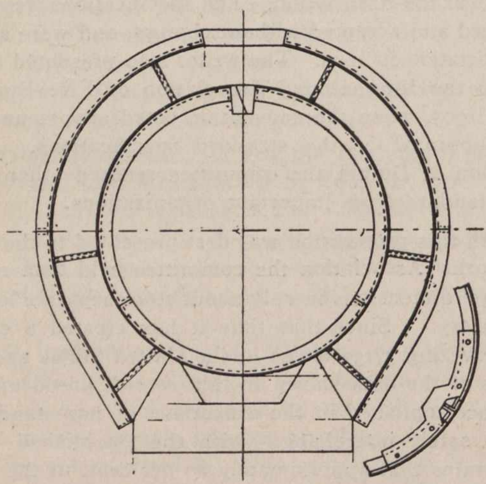


Fig. 1.—End Sectional View of "Blayney System" Collapsible, Telescoping Steel Forms and Centering.

of wood forms. One set of steel forms is sufficient to complete the longest pipe in existence, or contemplated, and still be good, providing only reasonable care is exercised. The steel forms will leave a smooth surface, so that little pointing of the concrete is necessary.

The advantages of steel forms and centering are many. They are callapsible and telescoping, so that no forms are idle. Therefore less forms will do more work, because they are all in use at all times during the progress of the work. The forms will either be ready for pouring the concrete or supporting green concrete. As soon as the concrete is sufficiently set, the forms can be taken down, collapsed, and passed through the forms ahead and re-assembled ready for concreting without interfering with the concreting of the section that is already being poured.

A pipe built with this system is a continuous concrete monolith, built, or poured, in sections of whatever length constitutes a day's work. This may be twenty feet or it may be one hundred feet or more. The total circumferential section should be built in one pouring and in that way avoid all horizontal seams or joints.

The dove-tailed bulkhead is removed, and each succeeding day's concreting is poured against the green dove-tailed end of the previous day's work. This method secures a bond and an even bed is secured for the pipe.

The forms are made of sheet steel, bent to the required shape, with stiffeners or ribs of angle iron riveted to the plate. They are made in segments bent to conform to the contour of the desired pipe. For a round pipe the segments are symmetrical and therefore interchangeable. This adds to the speed with which the forms can be erected. Each

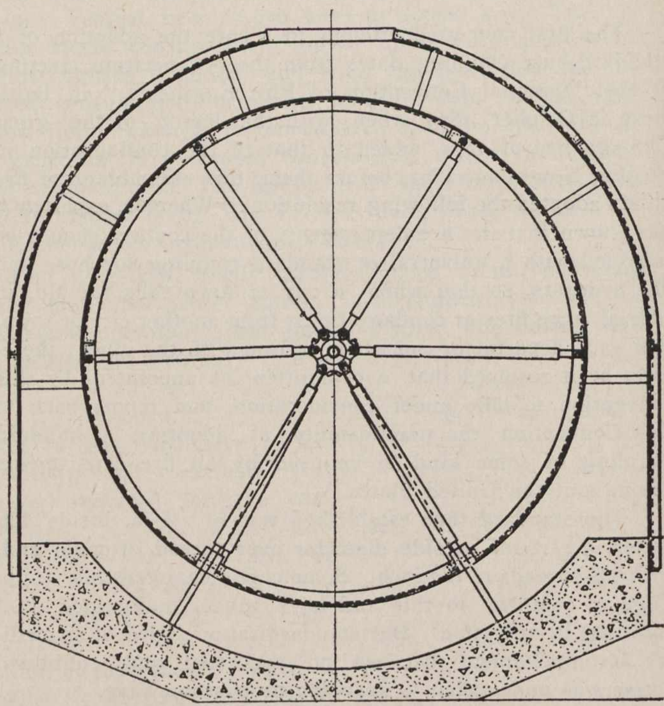


Fig. 2.—The System Used for Building Large Concrete Pipes.

segmental section of inside forms is small enough to allow it to pass through the forms ahead. Each segment is bolted to its adjoining ones, making, when assembled, a rigid form.

The outside forms may be built up as the concrete rises, thus allowing working space for tamping the concrete.

For pipes larger than seven feet it is necessary to have inner bracing. Figure 2 shows this bracing. It consists of a longitudinal central shaft on which is a cast iron collar which is shown in Figure 3. This shaft is supported by two legs running from the footing in bottom trench, or saddle, as the case may be, to the cast iron collar on the central shaft. By means of left and right hand male and female threads a turnbuckle effect is produced on these legs and they may be shortened or lengthened at will. This forms a simple and efficient method of holding the central shaft and consequently the whole form to line and grade.

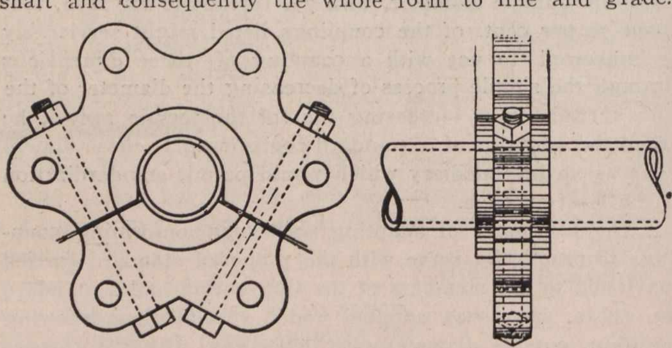


Fig. 3.—Cast Iron Collar on Central Horizontal Shaft.

From this central shaft run arms also having this turnbuckle attachment to regulate and hold the segments to their proper positions.

Like the smaller pipe forms each segment of the inside forms is interchangeable and will pass under the central shaft and between the supporting legs which holds the shaft. This will enable workmen to be placing new forms daily without interfering with the concreting of the forms already erected. The outside forms are held in position by being accurately spaced from the inside forms by pipe separators which may afterwards be grouted.

The system is not restricted to the building of round concrete pipes as these forms are designed for and will readily accommodate themselves to the building of any pipe from round to square. The forms will take care of a curve or bend in any direction.

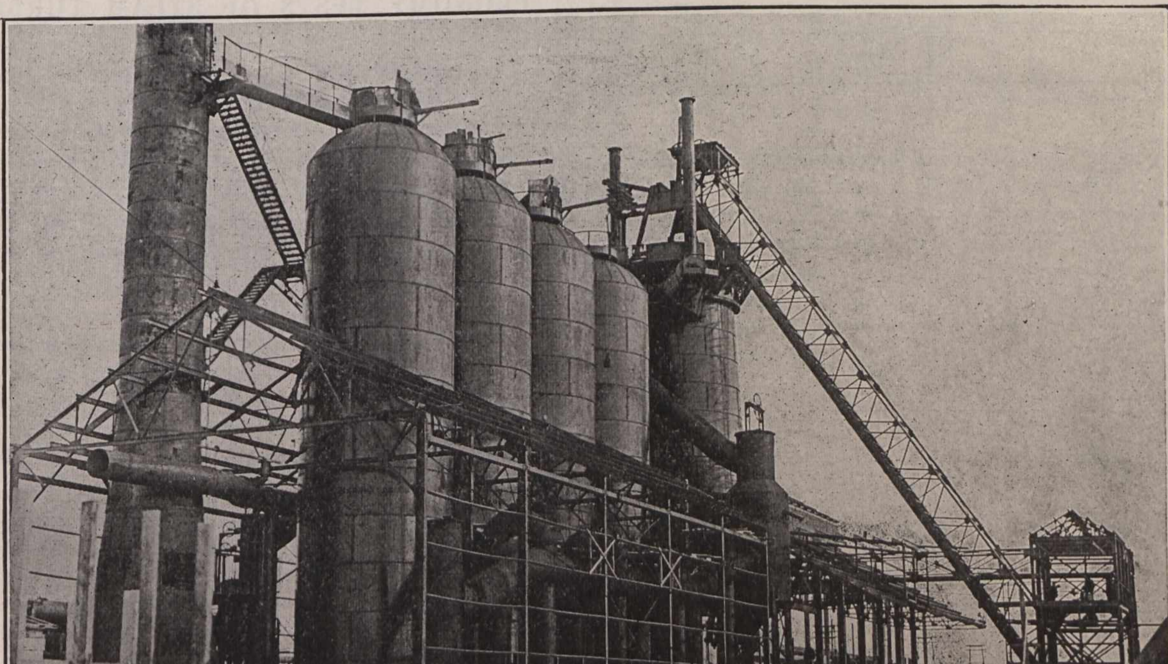
The system adapts itself to almost any style of reinforcing required to make the pipe sufficiently strong for its particular use. The hollow pipe separators afford an admirable chance to wire the steel to them, thus holding the reinforcing securely in place.

These forms are manufactured by the Standard Steel Form Company, Niagara Falls, Ont. The system is known as the Blayney System. The above company manufacture these forms to order. They are for sale, or lease to municipal and other corporations contractors, owners, or others who are interested in or responsible for the construction of all kinds of plain or reinforced concrete pipe, including concrete culverts, canal walls, conduits, trunk sewers, sanitary and storm sewers, twenty-four inches in diameter and over, pressure pipes of concrete for all purposes, water mains, concrete tunnels through soil, rock or water, and subways for electric, steam or other railways.

DOMINION IRON AND STEEL COMPANY, LIMITED, SYDNEY, N.S.

While the following is not intended as a complete description of the illustration which is shown in connection with this article, some of the major points in connection with same may prove of interest to our readers.

When the Dominion Iron and Steel Co. decided to extend the iron producing portion of its plant it was decided to parallel the present blast furnaces, known as Nos. 1, 2, 3 and 4, with another complement of four furnaces some 400 feet to the westward of the furnaces now operating. As all the plant units are numbered from the north to the south, it will explain how the fifth furnace of the installation was called No. 8, as the construction began from the southern



end of the new plant addition.

The old plant was designed and constructed under the direction of Mr. Julian Kennedy, Pittsburgh, during ten years of operation, and has been more or less altered. With this information and precedent at hand the Dominion Iron and Steel Co. contracted with the Canada Foundry Company for the erection of the No. 8 furnace, and at a later date for No. 7 furnace, which is the opposite end of No. 8 and of equal capacity.

The illustration shows the general view of the stack, stoves, stove shelter, furnace proper and cast house from the northwest side of the plant, including also portion of the skipway where it joins the bin system. This No. 8 furnace is the second furnace to be constructed in Canada by the Canada Foundry Co., Limited, they having completed a contract for the construction of the furnace for the Atikoken Iron and Steel Company, at Port Arthur, some four years ago.

The Canada Foundry Company has recently closed contracts for a portion of the work in connection with the new Canadian Furnace Company, Limited, at Port Colborne, Ont. These facts clearly establish that this class of construction can readily be obtained in Canada.

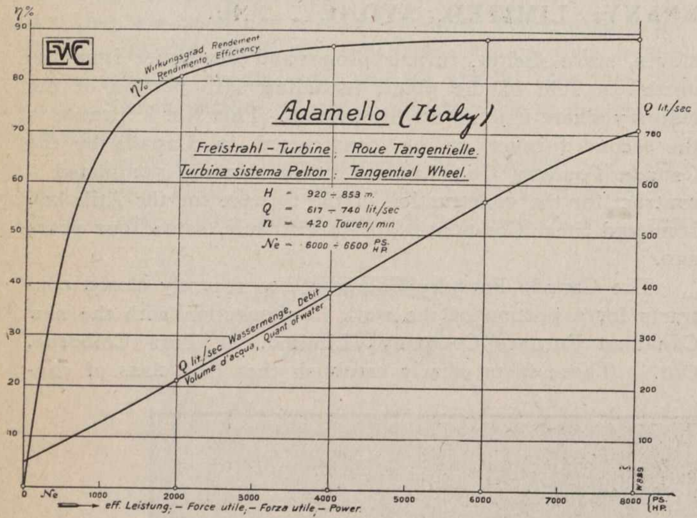
We believe that those interested in this class of engineering work who will look into the matter carefully will find that Canada has ample facilities and skill to execute all work in connection with our metallurgical developments to the entire satisfaction of all concerned.

We hope to supplement this short article from time to time with other various details of interest in this connection and at an early date furnish complete description of the above extensions referred to at the Dominion Iron and Steel Co., Sydney, N.S.

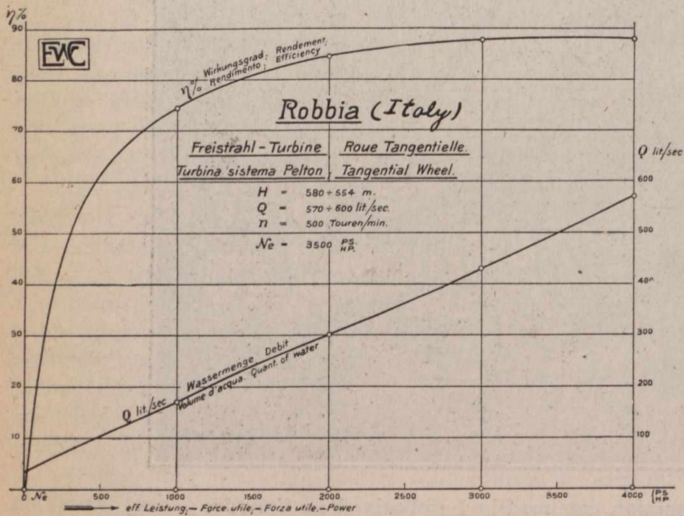
EFFICIENCY TESTS OF IMPULSE WATER-WHEELS.

The accompanying curves show the results obtained in recent tests on impulse wheels designed and installed by Escher Wyss & Company, of Zurich, Switzerland, whose Canadian head office at the Canadian Express Building, Montreal, is under the supervision of Mr. T. Heyerdahl, chief engineer. The results of the official tests as shown in the curves are exceedingly interesting on account of the efficiencies obtained.

The Adamello plant is situated on the border between Switzerland and Italy. The curve relates to an impulse turbine installation working under an effective head of 3,000



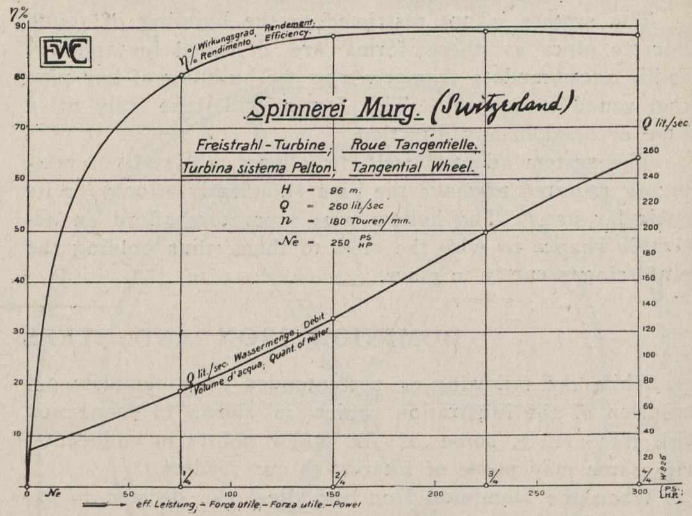
feet, each unit being designed for a maximum power of 6,600 B.H.P., when running at a speed of 420 revolutions per minute. These turbines are all of the Escher Wyss Company's special design and patent, fitted with deflecting nozzle which eliminates the employment of any relief valve, at the same time keeping the rise of pressure in the penstock remarkably low. As a matter of fact, when tests were made and the full load was thrown off, the pressure at the end of the penstock



only rose to a very few per cent. above normal. The above efficiency curve which exceeds the guaranteed figures by about 8 per cent. is remarkable by the fact that it remains above 80 per cent. from over-load to one-quarter load. A general description of this plant was given in The Canadian Engineer of August 31st, 1911, where full details of the installation were given.

The Robbia plant is situated on the border of Switzerland and Italy.

This curve relates to the same type of turbine as above described, the effective head being 1,900 feet, and each unit



having a capacity of 3,500 B.H.P. when running at a speed of 500 revolutions per minute. This curve is also remarkable on account of the efficiency remaining above 80 per cent. from full load to almost one-quarter load.

ECONOMY TESTS OF STEAM TURBINES.

The table herewith is part of a paper on the "Present State of Development of Large Steam Turbines," read at the spring meeting of the American Society of Mechanical Engineers by Prof. A. G. Christie, of the University of Wisconsin. With regard to this phase of the subject he says:—

The efficiency of a steam turbine may be expressed in terms of pounds of steam per kilowatt-hour, as an efficiency ratio or as the B.t.u. required per kilowatt-hour.

The steam consumption is dependent on the initial steam pressure, its temperature or quality, and the condenser pressure. These factors vary in almost every test and the effect of a variation in each is not the same for all classes of turbines. Hence, different turbines cannot usually be compared satisfactorily on the basis of their steam consumption alone.

If the steam could expand freely to exhaust pressure in a turbine without radiation, friction, eddy or windage losses, its expansion would be adiabatic and on the Rankine cycle. The "efficiency ratio" expresses the proportion of the heat actually turned into work to that available from such an adiabatic expansion; in other words, it expresses the efficiency of the actual turbine as compared to the ideal turbine, and is independent of the type of turbine.

The B.t.u. per kilowatt-hour is figured above the heat of the liquid at exhaust pressure. This is not a satisfactory standard by which to compare results, for it is largely dependent on conditions beyond the control of the turbine builder. For instance, if the plant does not contain superheaters, the B.t.u. per kilowatt-hour will be high. The same will be true of a plant which has a warm cooling-water supply for condensers and consequently carries low vacuum. Yet the turbines may be designed to give a high efficiency ratio under these conditions. In fact, they may be able to utilize the heat available more efficiently than the turbines in another plant with both high superheat and high vacuum.

This can be seen in the accompanying tabulation of recent turbine results. The Brown-Boveri turbine at the Dunstan power plant uses 14,980 B.t.u. per kilowatt-hour with an efficiency ratio of 68.8 per cent. Yet the Westinghouse City Electric, with a lower steam pressure, superheat and vacuum, has an efficiency ratio of 68.9 per cent., though using 16,925 B.t.u. per kilowatt-hour. The Erste Brünner Vienna turbine requires 16,460 B.t.u. per kilowatt-hour with 71.8 per cent. efficiency ratio. It is therefore apparent that the efficiency ratio alone will express in the best manner the degree to which the designer has approached ideal results in his turbine.

The test results in the table were grouped in order to analyze the relative merits of the different types of turbines on the basis of efficiency ratios. The Curtis-Parsons machines built by Erste Brünner hold first place in the list, but are followed closely by others of the same type built by Brown-Boveri and Westinghouse Machine Co. The Parsons turbines built by Allis-Chalmers and Brown-Boveri also show high efficiencies. The second class in the order of efficiency includes turbines of the Curtis-Rateau and Curtis-Zoelly types, among which the turbines of the A. E. G. and British Westinghouse Co. show remarkably good results. The next group includes simple Zoelly and Rateau turbines. The last group comprises straight Curtis types.

The parsons low-pressure sections evidently utilize the heat in the steam only slightly more efficiently than do the impulse turbines. The great surface areas of all disk-type turbines which must be whirled in steam, produce losses which are apparently somewhat larger than the combined whirling losses and leakage in the Parsons drum turbines. Both the Zoelly and Curtis-Rateau types appear to use the steam more effectively in the low-pressure sections than the Curtis alone. Many European engineers hold the opinion that where high economy is to be obtained, the impulse turbine of the Rateau or Zoelly type is superior to the Curtis, though its manufacturing costs are higher. The Curtis-Rateau construction has all the commendable features of impulse turbines and has proved very economical.

The results in the table are from the best reliable tests that have been made on each type. Objections may be raised that these results do not represent actual operating condition as under varying loads, nor the average economy of any type of turbine. For instance, the Curtis turbine usually gives a very flat water-rate curve, while the Parsons type is more convex.

It is interesting to note that the best results have been obtained within the past two years and that these show a considerable increase in efficiency over the earlier turbines.

ECONOMY TESTS OF HIGH PRESSURE STEAM TURBINES

Efficiency Ratios Based on E.H.P. Marks & Davis Steam Tables Used

Maker of Turbine	Type	Date of Test	Load-Kw.	R.p.m.	Steam Pressure, Lb. Absolute	Temperature at Throttle, Deg. F.	Vacuum Referred to 29.92" Bar.	Condenser Pressure, Lb. Absolute	Lb. of Steam per Kw.-hr.	B.t.u. per Kw.-hr.	Heat Utilized per Lb. of Steam	Heat Available per Lb. of Steam	Efficiency Ratio	Reference
Erste Brünner M. F. G.	Curtis-Parsons	1910	2,128	1500	156.2	482	27.89	0.995	13.82	16,460	247.0	343.8	71.8	*Periodische Mitteilungen*
Erste Brünner M. F. G.	Curtis-Parsons	..	6,000	960	184.9	573	28.18	0.854	12.56	15,570	271.5	380.7	71.3	*Zeit. D.V.D. Ing.*, 12/10/'10
Erste Brünner M. F. G.	Curtis-Parsons	1910	7,442	960	192.0	584	28.18	0.853	12.625	15,705	270.2	384.4	70.3	*Periodische Mitteilungen*
Westinghouse Machine Co.	Curtis-Parsons	1910	9,173	1800	181.7	433	27.81	1.032	14.57	16,925	234.1	340.2	68.9	*Trans. A.S.M.E., vol.* 32
Brown-Boveri & Cie.	Curtis-Parsons	..	3,053	1360	150.2	505	29.00	0.456	13.01	15,990	262.2	385.5	68.0	*Dinglers P.J.*, 6/17/'11
Erste Brünner M. F. G.	Curtis-Parsons	1910	1,416	1260	128.2	482	27.60	1.137	15.18	18,060	224.6	326.5	68.8	*Periodische Mitteilungen*
Brown-Boveri & Cie.	Curtis-Parsons	1911	1,750	1500	176.4	586	27.08	1.392	14.23	17,500	239.5	354.8	67.5	*Zeit. F.D.G. Turb.*, 5/30/'11
Brown-Boveri & Cie.	Curtis-Parsons	1910	3,764	1500	161.2	561	28.77	0.562	13.04	16,290	261.5	391.4	66.8	*Zeit. F.D.G. Turb.*, 5/30/'11
Westinghouse Machine Co.	Curtis-Parsons	..	9,830	750	192.2	475	27.22	1.322	15.15	17,790	225.2	336.0	67.0	*Trans. A.S.M.E., vol.* 32
Brown-Boveri & Cie.	Curtis-Parsons	1911	1,495	3000	200.6	563	26.41	1.720	14.78	17,880	230.7	345.5	66.8	*Data from Manufacturer*
Brown-Boveri & Cie.	Curtis-Parsons	1911	1,271	3000	172.1	568	27.31	1.278	14.61	17,880	233.5	354.3	65.9	*Data from Manufacturer*
Westinghouse Machine Co.	Curtis-Parsons	..	11,466	750	191.7	484	28.07	0.910	14.45	17,210	236.0	360.5	65.5	*Trans. A.S.M.E., vol.* 32
Erste Brünner M. F. G.	Curtis-Parsons	..	1,250	3000	184.9	573	27.89	0.996	14.32	17,680	238.2	373.1	63.9	*Zeit. D.V.D. Ing.*, 12/10/'10
Brown-Boveri & Cie.	Curtis-Parsons	1910	3,320	1500	180.9	525	29.02	0.440	13.50	16,680	252.7	401.3	63.0	*Zeit. F.D.G. Turb.*, 5/30/'11
Brown-Boveri & Cie.	Curtis-Parsons	..	5,128	1000	171.2	565	28.52	0.726	14.35	17,830	237.7	382.9	62.1	*Stodola, 4th ed., p.* 449
Breitfield, Danek & Co.	Impulse Parsons	1909	3,585	896	160.7	457	28.32	0.782	16.08	19,070	212.0	352.4	60.2	*Zeit. D.V.D. Ing.*, 12/10/'10
Brown-Boveri & Cie.	Parsons	1910	6,257	1210	203.7	559	29.02	0.440	11.95	14,980	285.5	415.0	68.8	*Official Test Report*
Allis-Chalmers	Parsons	1908	4,300	1800	186.4	484	27.96	0.960	14.02	16,690	243.4	355.7	68.4	*Sibley Jour. of Eng.*, 1/'11
Brown Boveri & Cie.	Parsons	1903	3,500	1360	156.4	499	28.84	0.532	13.71	16,720	248.5	378.6	65.6	*Zeit. D.V.D. Ing.*, 12/10/'10
Brown-Boveri & Cie.	Parsons	..	3,000	1360	165.0	625	27.02	1.420	14.75	18,433	231.3	359.5	64.3	*Die Turbine*, 6/20/'11
C. A. Parsons & Co.	Parsons	..	5,164	1200	214.3	509	28.95	0.473	13.18	16,140	258.7	402.3	64.3	*Stodola, 4th ed., p.* 439
Allis-Chalmers	Parsons	1911	3,850	1800	164.7	491	27.91	0.983	15.40	18,410	221.3	348.3	63.5	*Power*, 1/2/'12
A. E. G.	Curtis-Rataeu	1911	6,518	1220	198.7	601	29.28	0.352	11.43	14,640	298.4	434.2	68.7	*Official Test Report*
A. E. G.	Curtis-Rateau	1911	6,565	1220	200.2	597	29.18	0.406	11.64	14,848	293.0	427.7	68.5	*Official Test Report*
British Westinghouse	Curtis-Rateau	1911	5,066	1500	190.2	552	28.68	0.649	13.00	16,100	262.4	391.5	67.0	*Electrical Review*, 6/23/'11
M. A. N.	Curtis-Zoelly	..	3,584	1500	178.3	569	27.54	1.166	13.99	17,190	243.7	361.3	67.5	*Data from Manufacturer*
Bergmann	Curtis-Rateau	1909	1,545	1500	188.5	581	28.59	0.654	12.97	16,230	263.0	396.3	66.4	*Zeit. D.V.D. Ing.*, 12/10/'10
Bergmann	Curtis-Rateau	1910	2,477	1500	140.0	522	28.81	0.588	13.93	17,135	244.8	373.4	65.6	*Elec. Zeit.*, 4/20/'11
A. E. G.	Curtis-Rateau	1908	4,239	1500	188.3	662	29.11	0.397	11.97	15,620	284.9	439.0	64.9	*Stodola, 4th ed., p.* 404
British Westinghouse	Curtis-Rateau	1911	2,930	1500	210.2	568	28.18	0.894	13.72	16,935	248.7	383.3	64.9	*Electrical Review*, 4/28/'11
A. E. G.	Curtis-Rateau	1907	3,169	1500	184.7	592	29.11	0.397	12.74	16,230	267.7	425.1	63.0	*Trans. A.S.M.E., vol* 32
M. A. N.	Curtis-Zoelly	..	2,507	1500	175.5	460	27.40	1.234	16.24	19,020	210.0	334.6	62.8	*Data from Manufacturer*
Bergmann	Curtis-Rateau	1909	1,562	1500	186.8	555	28.33	0.780	14.57	17,970	234.1	381.3	61.4	*Data from Manufacturer*
James Howden & Son	Zoelly	1909	6,383	1000	202.7	520	27.33	1.269	14.305	17,150	238.5	353.0	67.5	*Enginer, London*, 10/29/'09
M. A. N.	Zoelly	1910	1,400	3000	180.7	554	27.40	1.237	14.21	17,310	240.0	356.2	67.4	*Zeit. D.V.D. Ing.*, 12/10/'10
Escher, Wyss & Co.	Zoelly	1910	2,052	3000	193.9	585	28.39	0.750	13.04	16,290	261.5	392.6	66.6	*Zeit. F.D.G. Turb.*, 2/20/'11
Escher, Wyss & Co.	Zoelly	1910	4,189	1000	179.7	557	28.66	0.618	13.30	16,520	256.5	391.3	65.5	*Zeit. F.D.G. Turb.*, 2/20/'11
F. Ringhoffer	Zoelly	1908	3,000	1000	170.7	470	27.60	1.138	15.52	18,278	219.8	339.2	64.8	*Zeit. D.V.D. Ing.*, 12/10/'10
M. A. N.	Zoelly	1910	1,250	3000	182.1	582	28.82	0.540	13.09	16,500	260.2	404.5	64.4	*Zeit. D.V.D. Ing.*, 12/10/'10
Oerlikon	Rateau	1911	3,166	1500	213.9	663	29.25	0.367	11.44	14,970	298.2	450.6	66.1	*Engineering*, 10/20/'10
Escher, Wyss & Co.	Zoelly	..	5,118	1000	133.7	549	27.55	1.161	15.18	18,530	224.6	341.6	65.7	*Dinglers P.J.*, 7/15/'11
Escher, Wyss & Co.	Zoelly	1908	5,000	1000	166.4	539	26.38	1.736	16.13	19,350	211.2	330.4	63.9	*Zeit. D.V.D. Ing.*, 12/10/'10
Escher, Wyss & Co.	Zoelly	..	3,540	1500	155.1	469	28.21	0.838	15.07	17,940	226.3	349.5	64.8	*Dinglers P.J.*, 7/15/'11
Escher, Wyss & Co.	Zoelly	1910	1,641	3000	221.0	672	27.91	0.985	13.08	16,775	260.6	406.5	64.1	*Zeit. F.D.G. Turb.*, 2/20/'11
Escher, Wyss & Co.	Zoelly	1910	1,235	3000	176.8	451	28.39	0.750	15.35	18,156	222.3	357.8	62.2	*Zeit. F.D.G. Turb.*, 2/20/'11
British Thomson-Houston	Curtis	1911	2,987	1500	154.7	505	26.75	1.557	15.96	18,960	213.7	321.2	66.5	*Engineering*, 10/20/'11
Gen. Elec. Co.	Curtis	..	3,464	..	210.0	513	28.75	0.575	13.62	16,620	250.4	393.4	63.6	*Trans. A.S.M.E., vol.* 32
British Thomson-Houston	Curtis	1909	2,500	1500	126.5	414	28.47	0.711	15.92	18,590	214.0	336.1	63.7	*Zeit. D.V.D. Ing.*, 12/10/'10
A. E. G.	Curtis	1906	3,000	1500	191.3	590	29.05	0.427	12.79	16,240	266.6	420.4	63.4	*Zeit. D.V.D. Ing.*, 12/10/'10
A. E. G.	Curtis	1909	2,236	1500	191.6	654	29.34	0.284	11.77	15,450	289.8	455.8	63.6	*Zeit. D.V.D Ing.*, 12/10/'10
Gen. Elec. Co.	Curtis	..	8,880	..	192.5	487	28.02	0.933	15.05	17,965	226.7	359.5	63.1	*Trans. A.S.M.E., vol.* 32
British Thomson-Houston	Curtis	1911	1,541	1500	149.7	365	27.97	0.956	17.46	19,720	195.3	320.2	61.0	*Engineering*, 10/20/'11
Gen. Elec. Co.	Curtis	..	10,816	750	190.0	525	29.39	0.260	12.90	16,135	264.5	427.3	61.9	*Trans. A.S.M.E., vol.* 32
Gen. Eelc. Co.	Curtis	..	5,095	..	185.1	554	29.40	0.255	12.71	16,090	268.4	436.0	61.6	*Trans. A.S.M.E., vol.* 32
British Thomson-Houston	Curtis	1911	1,221	3000	134.7	448	27.16	1.353	17.75	20,690	192.2	314.0	61.2	*Engineering*, 10/20/'11
Gen. Elec. Co.	Curtis	1910	8,775	750	194.0	451	27.95	0.956	15.95	18,720	213.8	350.8	61.0	*Trans. A.S.M.E., vol.* 32

References: *Zeit. D.V.D. Ing.—Zeitschrift des Vereines Deutscher Ingenieure; Zeit. F.D.G. Turb.—Zeitschrift fur das Gesamte Turbinenwesen; Dinglers P.J.—Dinglers Polytechnisches Journal; Elec. Zeit.—Electrotechnische Zeitschrift.*

ENGINEERS' LIBRARY

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

BOOK REVIEWS.

Concrete Costs. By Frederick W. Taylor and Sanford E. Thompson. Published by John Wiley and Sons. Canadian agents, Renouf & Co., Montreal. Cloth, size 5 x 8 in., 82 figures, 709 pages. Price $5.00 net.

This is the first attempt that has been made to present in book form a thorough and minute analysis of the times required for performing every separate operation in concrete construction, and the cost of all these operations each by itself, as shown by the cost records of a great number of jobs taken from the records of many large contractors. The authors, Frederick W. Taylor and Sanford E. Thompson, have been engaged for some seventeen years past in a study of the building trades with the idea of applying to these trades the methods of time study and scientific management which have been so notably successful in factories. It was thought at the outset that this investigation could be made in a comparatively short time, but the difficulties of making accurate time studies of men engaged in the numerous tasks of concrete construction proved to be very great. The active work of time study was carried out by Mr. Thompson and his assistants under the advice of Mr. Taylor, and the investigation already completed covers some half dozen of the building trades.

"Concrete Costs" is believed by the authors to be of special value to (1) architects, engineers and contractors in making accurate estimates of the costs of concrete works and structures; (2) contractors, superintendents and foremen, to help them to lay out and plan their work in such a way that their materials will be more economically handled and used than in the past, so that each workman shall do more and better work than heretofore; and (3 to assist in introducing the principles of scientific management in the building trades.

The distinctive feature of this book is that the information given in its tables, curves, etc., as to how long workmen, machines, and teams ought to take to do all kinds of tasks, has been done by careful timing with the stop watch of all these tasks as they were being done in the course of the day's work. Heretofore, the best knowledge of the time required to do work of this character has been obtained by keeping records of the pay, and sometimes of the time of gangs or groups of workmen while they were doing whole jobs of work, or at best, quite large sections of the contract. Such figures, however, because of the fact that no two contracting jobs are exactly alike has made it impossible for the contractor to make much better than a good guess of the cost of his next job.

Tested by the actual cost figures of various jobs, as shown by the contractors' records, the tables of this book have proved themselves very accurate, since the cost as estimated from the tables has agreed very closely with the costs of the actual work as carried out under the most efficient contractors' systems.

Chapters I. and II. of the book present and analyze as a guide for very rough estimates the approximate costs of miscellaneous concrete work as given in technical publications. Curves showing the approximate costs of reinforced concrete buildings of specified dimensions from one to six stories in height, are given in Chapter III. The next two chapters include the first of the unique contributions of the book in an account of the applications of the principles of scientific management to construction operation. Succeeding chapters treat of the proportioning of concrete: The labor costs of excavating, crushing and transporting materials, and mixing of concrete by hand and machine; management, including illustrations of plant equipment and layout on many actual jobs. Three chapters are given to the subject of forms, both for mass concrete, for arches, and for a wide range of reinforced concrete buildings. A great number of detailed tables present the cost of every element, of every operation in construction work under stated conditions, and with directions on the same page as the table for adapting each particular table to certain variations of wages and other conditions. Probably not all readers will agree with all of it, but a careful study of the book will probably convince everyone that it is the most important book on concrete that has appeared on this side of the water.

Design of Electrical Machinery. Vol. I. Direct Current Dynamos. By William T. Ryan, E.E., assistant professor of Electrical Engineering, University of Minnesota. New York, John Wiley & Sons; London, Chapman & Hall, Limited; Montreal, Renouf Publishing Co. Price $1.50 net.

"A Manual for the Use Primarily, of Students in Electrical Engineering Courses." Two subsequent volumes are to treat of alternating current generators, synchronous motors, rotary converters, and transformers.

A theoretically sound and practical work whose worth is enhanced by the author's sensible recognition that it is not the function of a college course to develop full-fledged commercial designers. The treatment presupposes the knowledge—or at least the simultaneous study—of the fundamental scientific principles involved, and confines itself to the presentation and illustration of a logical and well arranged method of practically applying such principles to specific problems of design. There are many practical tables and empirical formulae exemplifying modern commercial practice and the recommended procedure is such as should enable anyone with the requisite knowledge of fundamentals to produce successful operating designs. The author makes no claim to have furnished a substitute for the experience and special knowledge without which commercially successful designs are not to be expected. As a manual for beginners within or without the class room the volume should be extremely useful.—J.A.J.

Superheated Steam in Locomotive Service. (An abstract of publication No. 127 of the Carnegie Institution of Washington) by W. F. M. Goss, has just been issued as Bulletin No. 57 of the Engineering Experiment Station of the University of Illinois. Price 40 cents.

This bulletin gives a summary of foreign practice in the use of superheated steam; it contains a report of an elaborate series of tests made upon an American locomotive to determine the precise advantage to be derived from superheating under various conditions of locomotive service; and it shows that the use of superheated steam is not attended by serious difficulties. The superheater is easily maintained, and its presence as a detail of locomotive mechanism introduces no new problems in maintenance. The superheater improves the efficiency of the locomotive through the saving of coal and water. Tests run with boiler pressures varying from 120 to 240 lb. per sq. in., for which the steam was superheated approximately 150° F., prove that neither the steam nor the coal consumption is materially affected by considerable changes in boiler pressure. This fact justifies the use of comparatively low pressures in connection with superheating. The saving in water consumption was found to vary from 18 per cent. at a boiler pressure of 120 lb. to 9 per cent. at a boiler pressure of 240 lb., the corresponding saving in coal varying from 17 per cent. to 6 per cent. between pressures of 120 and 240 lb. The power capacity of the superheating locomotive was found to be greater than that of a saturated steam locomotive of the same general dimensions.

A New Analysis of the Cylinder Performance of Reciprocating Engines. By J. Paul Clayton, has just been issued as Bulletin No. 58 of the Engineering Experiment Station of the University of Illinois.

The uses of the steam engine indicator have hitherto been limited to rather simple processes such as that of determining the indicated horse-power of an engine, or to that of settling valves. The investigation described in this bulletin discloses the fact that the indicator diagram constitutes sufficient evidence upon which to base an analysis of cylinder performance, the results of which have not heretofore been considered possible. The process involves the transferring of the indicator diagram to logarithmic cross-section paper, and the drawing of a figure called a logarithmic diagram. By the aid of this diagram, it has been found that the expansion and compression of all elastic media used in practice obey substantially the polytropic law $PV^n = C$. From this fact there have been developed rational methods of approximating the clearance of a cylinder, of closely locating the cyclic events, and of detecting moderate leakage with the engine in normal operation.

It has been discovered that the value of n in the law $PV^n = C$ is controlled directly in steam cylinders by the quality of the steam in the cylinders at cut-off, and that this relation of the value of n and the quality is practically independent of cylinder size and of engine speed for the same class of engine. From this fact there has been devised a method of computing the actual steam consumption of an engine from the indicator card alone, to within 4 per cent. of the consumption as measured by test.

Copies of Bulletin No. 58 may be obtained upon application to W. F. M. Goss, director of the Engineering Experimental Station, University of Illinois, Urbana, Illinois.

Bulletin No. 24, "The Economy Steam Turbine for Belt Drive," has just been published by the Kerr Turbine Co., Wellsville, N.Y. This bulletin shows belted economy turbine installations.

Note.—The book reviews will be continued in next week's issue.

NEW GOVERNMENT BUILDING.

The new government building at the Canadian National Exhibition is being rushed to completion and will be ready for the year's Fair. It will cost $160,000, of which the Dominion Government pays $100,000, the Ontario Government $25,000 and the city of Toronto the balance. It will be used for Provincial, Dominion and educational exhibits.

VALUE OF FOREST PRODUCTION.

The total value, at the point of production, of the annual forest products of Canada is at least $166,000,000. This is $22.44 for every person in Canada, March 31, 1909. In 1909, there were cut from Canadian forests about 400 cubic feet of timber for every inhabitant of the country. This is a per capita timber usage unequalled by that of any of the other important countries in the world.

CANADIAN ELECTRICAL ASSOCIATION.

The members of the above association held their twenty-second annual meeting in the city of Ottawa, June 19th, 20th and 21st last.

The members of the association were welcomed on behalf of the city by Controller Hinchey, acting mayor. The titles of the papers and those who delivered them were: "Recent Developments in Lamps and Reflectors," by J. G. Henninger, illuminating engineer, National Electric Lamp Association; "The Influence of Ice on Water Power Development," by Professor H. T. Barnes, D.Sc., F.R.S., McGill University, and "Distributing Systems for Outlying Districts and Smaller Points," by S. Bingham Hood, Toronto Electric Light Company. On each of the papers an interesting discussion took place, and in particular on that of Professor H. T. Barnes, Mr. J. Murphy, electrical engineer of the Department of Railways and Canals, showing a number of fine slides illustrative of the ice difficulty.

In the evening the delegates to the convention and their friends to the number of several hundred journeyed out of the Victoria Hotel at Aylmer, where they were the guests of the city at an informal dance and garden party.

Mr. Pack, of the Toronto Electric Light Company, was elected president, and Mr. T. S. Young is the honorary secretary.

PERSONAL.

MR. C. D. CAMPBELL has been appointed town engineer, of Galt, Ont., succeeding Engineer Fuce, who is going to Calgary to open a private office.

MR. F. S. HAM, of the firm of Ham, Baker and Company, Limited, London, England, visited Toronto last week. Mr. Ham is in Canada on a business trip.

DR. A. A. WEAGANT, Ottawa; DR. THOS. E. KAISER, Oshawa, and DR. HENRY R. CASGRAIN, Windsor, have been appointed to the Provincial Board of Health of the Province of Ontario.

MR. BION J. ARNOLD, Chicago, and MR. J. M. MOYES, Toronto, have been engaged by Corporation Counsel Drayton and Mayor Geary as traffic experts to report on a comprehensive street railway system for the city of Toronto.

MR. H. G. BURD, who for some time has been connected with the Standard Underground Cable Co., as sales engineer in the New York office, has been appointed assistant to the sales manager of the Standard Underground Cable Co., of Canada, Limited, with headquarters at Hamilton, Ont.

MR. WILLIAM H. MARSH, who for the past ten years has been connected with the Standard Underground Cable Co., of Pittsburg, Pa., in the capacity of superintendent of construction, has been appointed secretary and assistant treasurer and sales manager of the Standard Underground Cable Co., of Canada, Limited, with headquarters at Hamilton, Ont.

OBITUARY.

CAPTAIN KILLALY GAMBLE, R.A., late secretary-treasurer of the Association of Ontario Land Surveyors, is dead. His death occurred at Bournemouth, England.

He was born at Enniskillen, Ireland, educated at Portora school, and entered as a cadet at Woolwich, where he took a high stand. During his military career he served on duty at Dublin, Malta, Gibraltar, Halifax, Bermuda, and other British garrisons.

Invalided after sixteen years, he retired from the service and came to Canada in 1882. He then entered the profession of land surveying at Winnipeg, and later, having received commissions as Dominion Land Surveyor and Provincial Land Surveyor for Ontario, became established in Toronto. In 1886 Captain Gamble married Miss M. d'A. Killaly, youngest daughter of the late Hon. H. H. Killaly, and was predeceased by her two years.

During the year 1911 Mr. Gamble was president of the Engineers' Club of Toronto, and had many warm personal friends, not only in the city, but throughout the province and in the old land.

COMING MEETINGS.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—June 26th-28th. Annual meeting at Boston, Mass. Sec'y, H. H. Norris, Cornell University, Ithaca, N.Y.

THE UNION OF CANADIAN MUNICIPALITIES.—August 27, 28 and 29. Meeting at City Hall, Windsor, Ont. Hon. Secretary-Treasurer, W. D. Lighthall, K.C.

CANADIAN FORESTRY ASSOCIATION.—Convention will be held in Victoria, B.C., Sept. 4th-6th. Secy., James Lawler, Canadian Building, Ottawa.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Second Annual Meeting to be held in Toronto, Sept. 16, 17 and 18.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Annual Assembly will be held at Ottawa, in the Public Library, on 7th October, 1912. Hon. Sec'y, Alcide Chaussé, 5 Beaver Hall Square, Montreal, Que.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary. Professor C. H. McLeod.

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

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

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

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving: Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, W. Alan, Kennedy; Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-jack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

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

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

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

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

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

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

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

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

UNION OF ALBERTA MUNICIPALITIES.—President, Mayor Mitchell, Calgary.; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

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

CANADIAN TECHNICAL SOCIETIES

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

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

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

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

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

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

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

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

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

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

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

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

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

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

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

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

CANADIAN STREET RAILWAY ASSOCIATION.—President, Jas. Anderson, Gen. Mgr., Sandwich, Windsor and Amherst Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

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

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

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

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

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

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

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

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

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

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

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

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

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

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President. Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

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

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

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

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

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

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

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

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

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phoenix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

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

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close		Noted in issue of
7-3	Storm Drain, Orillia, Ont. ....(P. & S.)	6-20
7-1	Boilers, 300-h.p., Verdun, Que. ....(S.)	6-20
7-10	Supply of electrical machinery and sewage disposal works, Battleford, Sask. ....(P. & S.)	6-27

(Battleford plans and specifications are also on file at The Canadian Engineer Offices, Montreal and Winnipeg.)

TENDERS PENDING.

In Addition to Those in this Issue.

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

Place of Work.	Tenders Close.	Issue of.	Page.
Alert Bay, B.C., operating house, etc.	July 1.	June 20.	68
Arden, Man., bridge	July 3.	June 13.	78
Barrie, Ont., public buildings	June 27.	June 13.	67
Boswell, B.C., pile bent wharf	July 2.	June 6.	68
Brundage's Point, N.B., wharf	July 4.	June 20.	68
Cache Bay, Ont., wharf	July 10.	June 20.	68
Carr's Brook, N.S., breakwater wharf	June 27.	June 6.	68
Calgary, Alta., motor generator	June 26.	June 20.	67
Carleton Place, Ont., sewerage and water supply	July 9	June 20.	67
Elkholm, Man., industrial school buildings	July 9.	June 20.	67
Fort William, Ont., sewer	July 5.	June 13.	67
Fort William, Ont., sewer, Marks Street	July 5.	June 20.	67
Guelph, Ont., dairy barns	June 29.	June 20.	68
London, Ont., breakwater	June 27.	June 20.	80
Norwood, Ont., drill hall	July 3.	June 20.	67
Omemee, Ont., drill hall	July 2.	June 20.	68
Orillia, Ont., storm drain	July 3.	June 20.	78
Orillia, Ont., sanitary sewers	July 3.	June 20.	78
Ottawa, Ont., Hudson Bay Rly.	Aug. 1.	June 20.	80
Ottawa, Ont., wooden hopper scows	July 3.	June 20.	68
Ottawa, Ont., alterations to school buildings	July 12.	June 20.	68
Ottawa Ont., designs for monument	Oct. 1.	Apr. 18.	60
Ottawa, Ont., sale of steamer	July 3.	June 6.	78
Ottawa, Ont., design and construction of steamship	June 30.	May 16.	76
Perry Point, N.B., dredging	June 26.	June 20.	68
Port Arthur, Ont., dredging	July 2.	June 20.	68
Port of Quebec, Que., proposals for drydock	July 2.	Apr. 18.	60
Point Grey, B.C., plans for university	July 31.	Feb. 7.	60
Point Edward, Ont., operating house	July 1.	June 13.	68
Quebec, Que., leasing of waterpowers	June 26.	May 2.	72
St. Catharines, Ont., trunk sewer	July 3.	June 13.	80
Toronto, Ont., high level interceptor	July 2.	June 13.	80
Toronto, Ont., reinforced concrete girder bridge	July 2.	June 30.	80
Toronto, Ont., opera chairs	July 22.	June 20.	68
Toronto, Ont., water main, Front Street	July 2.	June 20	68
Vancouver, B.C., bridge construction	July 8.	May 30.	74
Verdun, Que., boilers	July 1.	June 20.	78
Windsor, Ont., quarantine buildings	July 8.	June 20.	68

TENDERS.

Arthur, Ont.—Tenders will be received by Mr. D Brocklebank up to noon of June 28th for the construction of five reinforced concrete girder bridges for the County of Wellington, near Arthur. Plans, etc., at the office of Messrs Bowman and Connor, engineers, 36 Toronto Street, Toronto

Battleford, Sask.—Tenders will be received by J. P. Marshall, secretary-treasurer of the town of Battleford, Sask. until noon of July 10th, 1912, for the supply and delivery of machinery and materials for the erection of generators, exciters and switchboard, pumps and motors, power house and reservoir, sewage disposal works, supply and delivery of steel water pipe and specials, trenching and laying steel water pipe, etc., two pneumatic storage tanks. Plans and specifications may be seen at the offices of The Canadian Engineer, Winnipeg, Toronto and Montreal, at the office of the Battleford town engineer and electrical engineer, and at the office of Messrs. McArthur, Murphy and Underwood, consulting engineers, Bottomley Block, Saskatoon. (See advt. in Canadian Engineer.)

Carleton Place. — The Sewers and Water Commission will receive tenders up to noon of July 9th, 1912, for the supply of all materials and construction of about five miles of sewers, and five miles of water mains. Plans and specifications may be seen at the offices of the consulting engineer, Toronto, or the office of B. G. Michel, Carleton Place, Ont. T. Aird Murray, 303 Lumsden Building, Toronto, consulting engineer. (See advt. in Canadian Engineer.)

Estevan, Sask.—Tenders will be received until July 9th, 1912, for the construction of the following works:—

Contract "A"—Water works force main.
" "B"—Water works pump house.
" "D"—Water pipes.
" "G"—Pumping machinery.
" "I"—Pump well.
" "O"—Outfall sewer.
" "X"—Sewage disposal works.

Plans and specifications may be seen at Estevan, or at the engineer's offices. L. A. Duncan, Esq., secretary-treasurer, Estevan; Chipman and Powers, engineers, Toronto and Winnipeg.

Estevan, Sask.—Tenders will be received by H. N. Scott, Esq., secretary-treasurer, High School Board, up to noon of July 10th, 1912. Plans and specifications may be seen at the office of Storey and Van Egmond, Architects, Regina, Sask., and at the office of the Secretary-Treasurer.

Guelph, Ont.—Tenders for the construction of a 70 x 18 ft steel bridge at Rockwood, concrete abutments for same, and for a reinforced girder bridge near Elora, will be received by J. W. Sutton, Esq., Court House, Guelph, until June 29th, 1912.

Guelph, Ont.—Tenders will be received until July 5th, 1912, for the following works:—

1. Concrete work on a combined bridge and dam on the River Credit, at the paper mills, Georgetown.

2. For the steel beam superstructure of the above bridge.

3. For the concrete abutments and floor for a steel highway bridge, 100-ft. span, over the River Credit, on the 10th line, Esquesing Township.

4. For the steel superstructure of the above bridge.

5. For the construction of a concrete abutment under Capias Bridge in Glen Williams.

Plans and specifications at the Paper Mills, Georgetown, at the office of Mr. Moore, Reeve of Georgetown, or at the office of Malcolm and Rudd, Metropolitan Bank Building, Guelph. J. Hutcheon, Engineer, Guelph. (See advt in The Canadian Engineer.)

High River, Alta.—Tenders will be received by Geo. E. Mack, Esq., secretary-treasurer, High River, until July 16th, 1912, for the following works:—

Contract "B"—Pump house.
" "G"—Pumping machinery.
" "I"—Pump well.
" "P"—Ejector station.
" "X"—Sewage disposal works.

Plans and specifications may be seen at High River or at the offices of Messrs. Chipman and Powers, engineers, Toronto and Winnipeg, after June 29th.

Kindersley, Sask.—Tenders will be received until July 22nd, 1912, for the supply and delivery of waterworks and electric light equipment. Specifications, etc., at the office of the Engineers, The John Galt Engineering Company, 317 Portage Avenue, Winnipeg. D. MacTavish, Secretary-Treasurer, Kindersley. (See advt. in The Canadian Engineer.)

Kingston, Ont.—The Government will call for tenders shortly for the construction of the temporary bridge over the Cataraqui River, to take the place of the present structure until such time as the new bridge is completed.

Moose Jaw, Sask.—Tenders will be received until noon of July 10th, 1912, for water gates for high pressure distribution pipes. Plans, etc., may be obtained at the office of the City Commissioners, Moose Jaw, where tenders will be received.

North Battleford, Sask.—Tenders for the construction of a pump well will be received by H. W. Dixon, Esq., secretary-treasurer, until July 2nd, 1912. Plans and specifications may be seen at North Battleford, or at the office of the engineers, Messrs. Chipman and Powers, Toronto and Winnipeg.

North Toronto, Ont.—Mr. F. How, Chairman Board of Works, will receive tenders up to noon, Tuesday, July 30th, 1912, for the construction of pavements and storm sewers. (See advt. in this week's issue The Canadian Engineer.)

Ottawa, Ont.—Tenders will be received until July 4th. 1912, for the construction of a wharf at Needles, B.C. Plans, etc., at the offices of R. C. Desrochers, Secretary, Department of Public Works, Ottawa.; C. C. Worsfold, district engineer, New Westminster, B.C.; postmasters at Needles and Victoria, B.C.

Ottawa, Ont.—The Department of Public Works will receive tenders until July 2, 1912, for dredging required at St. George, N.B. Full particulars may be obtained from the Secretary, Department of Public Works.

Ottawa, Ont.—The Department of Militia and Defence will receive tenders up to noon of July 10, 1912, for the construction of a rifle range at St. Catharines, Ont. Full particulars at the offices of the officer commanding the 2nd Division, Toronto, Ont.; Lt.-Col. W. W. Burleigh, O.C. 19th Regiment, St. Catharines; and the Director of Engineer Services, headquarters, Ottawa.

Prince Albert, Sask.—Tenders for sewage pumps will be received by the City Commissioners up to noon of July 12th. 1912. Specifications and plans may be obtained at the office of the City Engineer. C. O. Davidson, city clerk. (See advertisement in The Canadian Engineer.)

Peterborough, Ont.—Tenders will be received until June 27 for the erection of a fire-proof addition to the Nicholls Hospital. Also a laundry building. Plans and specifications can be seen at the office of W. Blackwell, architect, Water Street. John Crane, secretary.

Port Hope, Ont.—Mr. Henry White, secretary Library Board, will receive tenders up to noon of July 5th for the several trades in connection with the erection of a library. Plans and specifications at the library building, Port Hope, or at the office of W. A. Mahoney, architect, Telephone Building, Guelph, Ont.

Regina, Sask.—Tenders for the trenching and laying of sewer mains on certain streets in the city will be received by the City Commissioners until June 27, 1912. Plans, etc., at the office of the City Engineer. L. A. Thornton, City Commissioner.

St. Charles, Man.—Tenders will be received until July 6th, for the construction of a trunk sewer on Ferry Road. Plans, and specifications, with full information may be obtained at the office of the Municipal Engineer, Municipal Hall, St. Charles. Frank Ness, Treasurer, Kirkfield Park P.O., Man.

St. John, N.B.—The city of St. John invites tenders for the following works, viz.: Excavation, backfill and cartage for water main in Milford Road; excavation, backfill and cartage for main sewer in St. John Street West. Plans, etc., at the office of the City Engineer, No. 5, City Hall. Rupert Wigmore, Commissioner of Water and Sewage.

Stratford, Ont.—The Board of Works intend to call for tenders immediately for the Remeo Creek scheme.

Toronto, Ont.—Tenders will be received until noon of July 4th, 1912, by W. W. Scott, Esq., township clerk, Moorefield, for the construction of a steel bridge of 110 ft. span over the Connestogo River, also for concrete abutments for the same. Plans and specifications at the office of the clerk. or Bowman and Connor, engineers, 36 Toronto Street, Toronto.

Watrous, Sask.—Tenders will be received by Joseph Gaye, secretary-treasurer, of the town of Watrous, for the following works:—

Contract A—All labor and certain materials necessary for the laying water pipes and sewers.

Contract B—All labor and materials necessary for the construction of pump house.

Contract C—This contract will be subdivided as follows:—

1—Furnishing materials and labor for and erecting steel water tower.

2—Furnishing materials and labor for and constructing concrete foundation for water tower.

3—Furnishing material and labor for and constructing frame housing for water tower.

Contract D—Furnishing cast-iron water and special castings.

Contract E—Furnishing gate valves, fire hydrants, etc.

Contract G—Furnishing and erecting pumping machinery.

Contract I—Furnishing material for and constructing collecting galleries and suction well.

Contract S—Furnishing sewer pipes and junctions.

Contract T—Furnishing labor and material for concrete walks.

Tenders will be received until July 15th, 1912, for Contracts A, C, D, E, S and T, and until July 31st, for Contracts B, G, and I.

Plans, etc., may be seen at the Town Hall, Watrous, or at the Engineers' Offices, Winnipeg and Toronto, on or after July 1st. Messrs. Chipman and Powers, engineers.

Weston, Ont.—The Municipal Council of the Village of Weston will receive tenders up to noon of July 8th, 1912, for the supply of all materials and the construction of sewerage and storm water drainage. Plans and specifications at the office of T. Aird Murray, consulting engineer, 303 Lumsden Building, Toronto. J. H. Taylor, clerk, Weston. (See advt. in Canadian Engineer.)

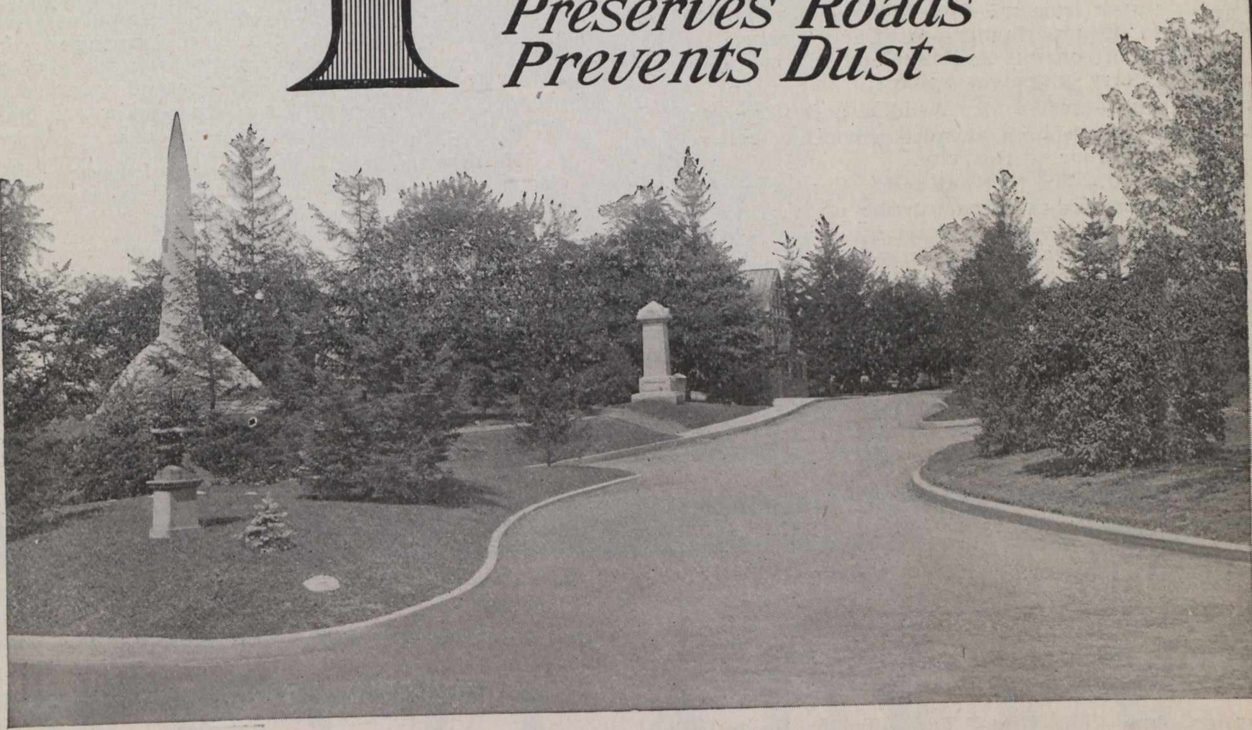
Winnipeg, Man.—Tenders will be received by the Chairman, Board of Control, until July 15th, 1912, for the supply for a quantity of 12-inch cast-iron water pipe and specials, hydrants and gate valves for extension of the fire service waterworks. Specifications, etc., at the office of the City Engineer, 223 James Avenue. M. Peterson, Chairman, Board of Control Office, Winnipeg.

CONTRACTS AWARDED.

Charlottetown, P.E.I.—Messrs. Clark and Morrison have received the contract for the erection of a railway station to cost $30,000 for the Federal Government, Ottawa

Dartmouth, N.S.—Messrs. F. A. Ronnan and Co., of Halifax, have the contract for the erection of a three-story brick and stone hospital to cost $80,000. Mr. Herbert E. Gates, architect, Telephone Building, Halifax, N.S.

Moose Jaw, Sask.—The Canada Foundry Company, Winnipeg, have been awarded the contract to supply a number of hydrants for the municipality. Messrs. Drummond,



Tarvia Modern Pavement in Mount Pleasant Cemetery, Toronto.

McCall Company of Montreal will supply a number of valves.

Newmarket, Ont.—Mr. J. J. McIntosh, of Alexandria, Ontario, has been awarded the contract for the erection of a Public school at a price of $21,760.

Toronto, Ont.—Messrs. Ross and MacFarlane, of Montreal, are the winners of the competition of the Board of Education for suitable plans for the new technical high school. Messrs. Brown and Vallance, of Montreal, and C. S. Cobb, of Toronto, came second and third respectively.

Toronto, Ont.—Messrs. Deaks and Hinds, of the Toronto Construction Company, have been awarded the contract for the proposed double-tracking of the C.P.R. between Sudbury and Port Arthur. Ten million dollars is the estimated cost of construction.

Toronto, Ont.—The National Iron Works, Toronto, has applied for a permit from the City Architect for alterations and additions to the pipe foundry on Cherry Street. The building is to be of concrete and steel and will cost $50,000. Mr. Gordon F. Perry is general manager.

Toronto, Ont.—Messrs. R. Weddell and Company, of Trenton, Ontario, have been awarded a contract calling for dredging in the harbor of this city.

Vancouver, B.C.—Mr. W. H. Rourke, Vancouver, has received the contract for the construction of the new lighthouse tower to be constructed at Point Atkinson. The structure will be of concrete and about forty-five feet high. Total cost will be about $15,000.

Vancouver, B.C.—Mr. Wm. O'Dell has the contract for the erection of a six story brick building for the Vancouver Realty Company. The cost of the building will be approximately $40,000.

Western Ontario.—Messrs. Deeks and Hinds, of Toronto, have received a contract from the Canadian Pacific Railway to double track the line for sixty miles between Sudbury and Port Arthur.

Winnipeg, Man. — The Provincial Government have awarded the contract for the construction of the new law courts to the National Construction Company. The amount of the tender was $760,000.

RAILWAYS—STEAM AND ELECTRIC.

Kingston, Ont.—The Grand Trunk Pacific Railway has placed an order with the Canadian Locomotive Works for 15 locomotives.

Niagara District, Ont.—A report states that the Niagara, Welland and Lake Erie Electric Railroad will construct and operate a new line between Welland and Port Colborne within the next few months. Mr. C. J. Laughlin is general manager of this company.

Ottawa, Ont.—The Board of Railway Commissioners have postponed a meeting called for July 2nd next to July 3rd.

At this meeting railway companies will be asked to show cause why a general order should not issue requiring railway companies to furnish a heated car service.

Toronto, Ont.—Both Queen Street and King Street subway are to be reconstructed within the next year by the Grand Trunk Railway.

Toronto, Ont.—The Ontario Railway Board has ordered the management of the Toronto Suburban Railway to rebuild their line on Bathurst Street and Davenport Road, and lay a pavement between the rails and eighteen inches on either side.

Western Canada.—A report emanating from Montreal states that there is a probability of the Canadian Pacific Railway electrifying their lines through the Rocky Mountains upon completion of the double track.

EXTENSION TO NATIONAL IRON WORKS.

The National Iron Works of Toronto, has received a permit for an extension to its pipe foundry. The extension will cost in the neighborhood of $250,000, the contract having been let to the Eastern Construction Company. With this enlargement the company will be in a better position to take care of the greatly increased orders for cast-iron pipe.

LIGHT, HEAT AND POWER.

Brantford, Ont.—Arbitration without any conditions attached whatever has been decided on between the city and Cataract Power Co., over local rates. The agreement between the city and the company will form the basis of the arbitration, the chief point to settle being whether hydro-electric municipalities are securing power and light at a lower rate than Brantford.

Edmonton, Alta.—The public works commissioners and the light, heat and power commissioners will confer on a report submitted by J. M. Brodie on the matter of a municipal gas plant. The report gives the two following alternatives, one of which makes a total of $700,000, which would provide for, in addition to the central generating station, 65½ miles of gas mains: 44 on the north side, and 21 on the south side. This amount would cover the expenditure for possibly four years. The other alternative was for a total of $465,-485, which, in addition to the central generating station, would give 26 miles of distributing mains; 20 miles on the north side and 6 miles on the south side.

Kindersley, Sask.—The municipal council will install an electric light system. The John Galt Engineering Company, Winnipeg, Man., are interested in the scheme.

Lethbridge, Alta.—The financial statement of the municipal electric and street railway departments to the end of April is given as:

Month	Receipts.	Expenditures.
January	$10,733.82	$ 5,059.31
February	9,755.22	5,535.45
March	8,449.57	4,279.35
April	8,614.07	3,819.61
	$37,552.68	$18,693.72

This leaves a profit of $18,858.96. Deducting $11,911.-86 for interest and sinking fund, a net profit for the four months is left amounting to $6,947.10.

In the power house there has been generated 577,540 K.W.H. for the four months and 113,560,000 gallons of water pumped.

GARBAGE, SEWAGE AND WATER.

Winnipeg, Man.—The municipal engineering department are about to commence work on a system of high pressure water mains.

Kindersley, Sask.—The town council have decided to install a waterworks taking the supply from a dam located about a mile to the south of the municipality. The John Galt Engineering Company, Winnipeg, Man., are interested in the scheme.

BUILDINGS AND INDUSTRIAL WORKS.

Collingwood, Ont.—The Dominion Government will construct an efficient biological laboratory to be used in connection with the whitefish hatchery to be erected at an early date.

Edmonton, Alta.—Plans and specifications are now being prepared by Messrs. Van Siclen and MacComber for a ten story hotel to be erected on Peace Ave. The cost of this structure will be about $350,000. Mr. E. W. Chambers is representing a syndicate that are supplying the capital for this enterprise.

Guelph, Ont.—There is a strong probability of the Dominion Casket Company locating a plant in this city.

Halifax, N.S.—A report states that the Canadian Pacific Railway will erect a large hotel in this city.

Hespeler, Ont.—The Dominion Government will erect a new post office at a cost of $10,000.

Medicine Hat, Alta.—A report states that the management of the Canada Cement Company are contemplating the erection of a million dollar plant in this city for the purpose of meeting the demands of Western Canada.

Montreal, P.Q.—The municipal council will erect one public lavatory on Jacques Cartier Square, and if the same proves successful five or six more will be constructed.

Montreal, P.Q.—A report states that the Canadian Northern Railway, by reason of recent purchases, intend to make extensions to the Moreau Street Station. The yards at this point will be enlarged to twice their present capacity.

Moose Jaw, Sask.—There is a probability of a new immigration hall being erected in this city.

Port Colborne, Ont.—Work has started on the new plant of the Canadian Union Furnace Company.

Regina, Sask.—Messrs. Storey and Van Egmond have prepared plans for a new steam laundry to be erected for Messrs. Whitmore Bros. The building will be 50 x 100 feet of brick and steel construction, 3 stories, and the cost will be about $100,000.

St. Catharines, Ont.—The damage to the Welland Canal by reason of the recent accident will amount to $7,000.

Toronto, Ont.—The management of the Adams Harness Manufacturing Company have purchased a site on Logan Avenue, and on the same will erect a factory for the manufacture of blankets and horse collars.

Vancouver, B.C.—Mr. A. G. Ferra, Italian Consul, will erect a six story apartment house on Hastings Street. It will be of brick and terra cotta 50 x 122 feet. Mr. F. H. Perkins, of Vancouver, B.C., is the architect.

Vancouver, B.C.—Mr. W. McPherson is erecting a four story mill construction warehouse 100 x 50 feet. Messrs. Townsend and Townsend are the designers.

Victoria, B.C.—Mr. Jesse M. Warren has prepared plans for a church building to be erected by the congregation of the First Baptist Church. The materials are pressed brick and cut stone. The structure will cost about $100,000.

BRIDGES, ROADS AND PAVEMENTS.

Dauphin, Man.—The engineering department of this municipality will shortly call tenders for the superstructures of eight bridges. Mr. J. A. Gorby is secretary-treasurer of this town.

Hull, P.Q.—The City Engineer, J. P. A. Laforest, is preparing plans for a concrete bridge to replace the present structure at the pump house. The bridge will have a length of fifty feet and will cost about $1,500. If the plans are approved by the council the work will be commenced this season.

Irishtown, N.B.—The provincial Public Works Department will erect a new concrete bridge and undertake considerable road work in this section.

Lindsay, Ont.—The municipal council will call tenders for cement sidewalks.

Listowel, Ont.—The municipal council are considering the matter of street paving, and it is probable that tenders will be called in the near future. W. Climie is mayor of this town.

St. Catharines, Ont.—The municipal council have decided to construct a concrete bridge, 800 feet in length, across the old canal. The cost of this work will be $65,000. R. D. Brown, City Engineer.

St. Catharines, Ont.—Property owners in the vicinity of St. Paul Street will petition the municipal council to have a bridge constructed across Lock No. 3 of the Welland Canal.

Toronto-Hamilton, Ont. — A committee composed of W. A. MacLean, E. A. James, A. F. McCallum, W. D. Platt and Mayor T. L. Kennedy, president of the Good Roads Association, will secure information as to the best class of pavement and the probable cost of constructing a permanent highway between these two cities.

York County, Ont.—The County Council have adopted a by-law to raise $50,000 for the continuance of the bridge building programme.

FIRES.

Canning, N.S.—The business section of this town was badly damaged by fire. The loss is estimated at $100,000.

CURRENT NEWS.

Montreal, P.Q.—A section of the pavement on Sherbrooke Street gave way beneath a steam roller weighing twelve tons engulfing the machine to a considerable depth. This is the third time that a similar accident has happened on this street, an automobile and a steam wagon being in the former mishaps.

North Toronto.—Mr. E. A. James, engineer of this municipality, has prepared the following estimates as a guide to the ratepayers voting on the question of double tracking the lines of the Metropolitan Railway:—Storm sewer, $25,000; curbing both sides, $14,520; paving, $155,200; special foundation under rails, $72,000; total, $266,720.

Toronto, Ont.—At the meeting of the Ontario Municipal Association which met in this city last week, Mayor George H. Lees, of Hamilton, was elected president of the association. Other officers were elected as follows: Vice-presidents, J. G. Richter, London; W. A. Clarke, York Township; Mayor G. J. Thorp, Guelph; R. C. Chown, Belleville; and W. Lane, Goderich; secretary-treasurer, K. W. McKay, St. Thomas; Executive Committee, Mayor Geary, Toronto; Mayor Lemon, Owen Sound; W. B. Doherty, St. Thomas; City Solicitor Wm. Johnstone, Toronto; F. R. Waddell, K.C., Hamilton; J. H. Dewey, Brockville; A. K. Bunnell, Brantford; Dr. Fairbank, Petrolea; S. Baker, London; S. R. Armstrong, Peterboro; S. H. Kent, Hamilton, and W. C. Campbell, St. Thomas.

TRADE ENQUIRIES.

The following were among the inquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ending June 10th, 1912:—

A Manchester firm of printing, stationery and advertising contractors are desirous of acting for Canadian firms who may wish to open business in Great Britain.

An Australian merchant house at present importing large quantities of United States goods of various descriptions, is prepared to do business with Canadian manufacturers.

A London correspondent desires to obtain agencies for the sale of Canadian goods.

A London firm make inquiry for the names of Canadian manufacturers of baking powder open to import supplies of tartaric acid, cream of tartar and citric acid.

A German firm interested in a patent potato digging machine desire to appoint reliable Canadian agents.

From the branch for city trade inquiries, 73 Basinghall Street, E.C.:—

A London company manufacturing athletic goods, and also leather travelling bags and trunks, and similar lines, are desirous of finding a resident Canadian representative to act for them upon a commission basis.

CANADIAN NORTHERN RAILWAY WORK FOR 1912.

The following is an itemized list of the principal works on the construction programme of the Canadian Northern Railway:

Number of miles to be started this year, 1,053 miles.

Location of lines in actual construction this year:

Montreal to Hawkesbury, 58 miles.

Ottawa to Ottawa River, 32 miles.

West from Ruel, Ont., 100 miles.

East from Port Arthur, 108 miles.

Branch lines, and extensions in Alberta and Saskatchewan, 400 miles.

British Columbia, 75 miles.

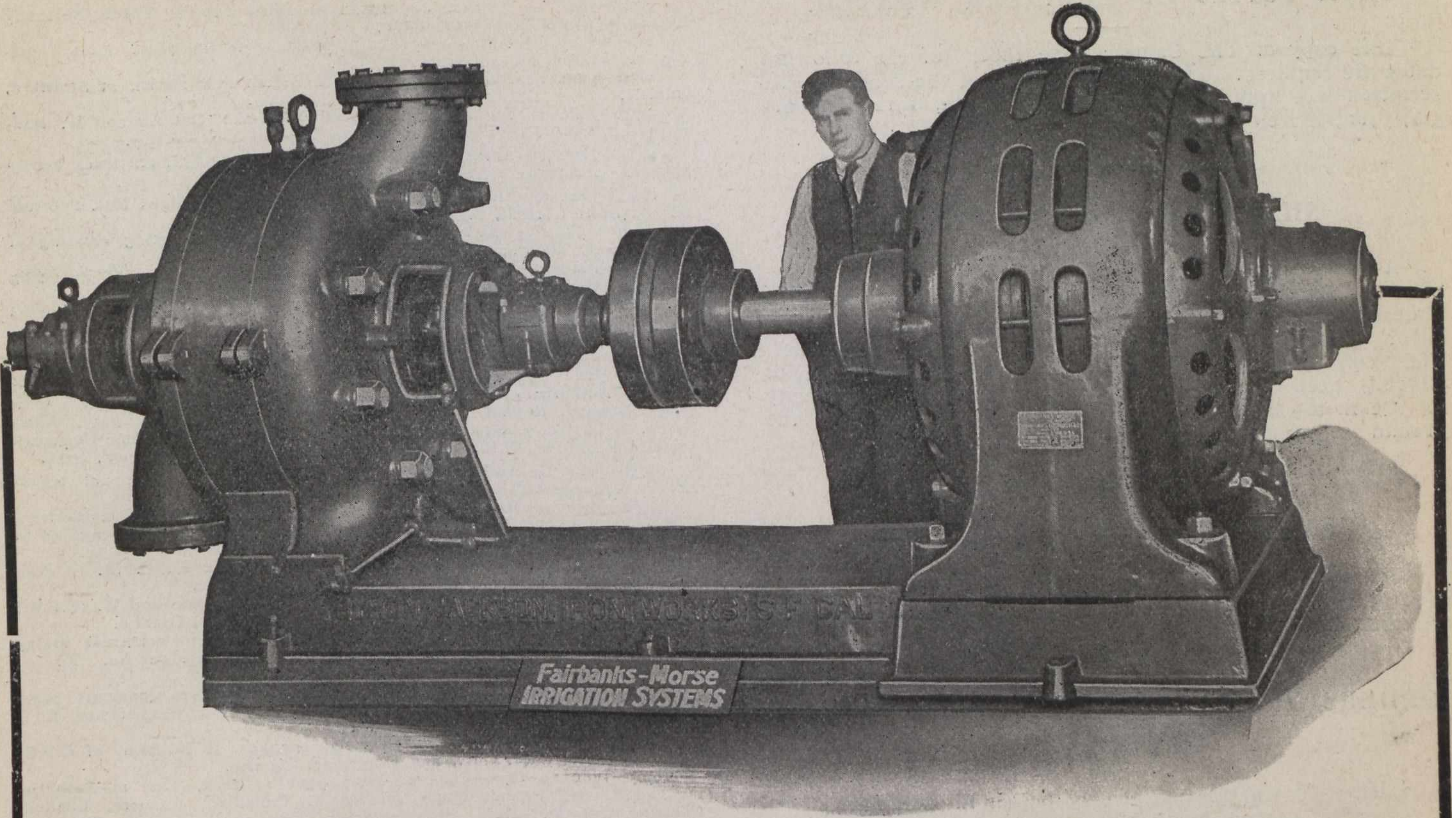
Sydenham, Ont., to Ottawa, 80 miles.

Relaying track on main line west, 200 miles.

Approximate number of men employed on construction, about 20,000.

Approximate amount of steel required for new tracks this year, 125,000,000 pounds.

Amount of new equipment to be installed this year, estimated cost, $8,000,000 to $9,000,000, including 136 engines, 4,050 box cars, 1,184 flat cars, 400 convertible construction cars, 70 cabooses, 6 snow plows, 1 rotary plow, 82 passenger cars, 35 mail and baggage cars, 3 dining cars, 4 parlor cars, 16 sleepers.



The Largest Direct Connected Centrifugal Pumping Unit in British Columbia.

The Vancouver Power Company have recently installed at their works at Coquitlam Dam, B.C., the largest direct connected centrifugal pumping unit in British Columbia. This outfit is to operate in parallel with a number of other pumps that are to furnish water under pressure for sluicing into place the material for their new dam.

This pump is a 10-inch, class "F," two-stage centrifugal, with bronze inpellers and renewable bronze diffusion vanes. It has a normal capacity of 1833 imperial gallons per minute when operating at 1160 r.p.m. against a total head of 355 feet or an equivalent pressure of 154 lbs. per square inch. It is mounted on a common sub-base with a 300 h.p. type "B," Fairbanks-Morse squirrel cage, induction motor, 2200 volts, 60-cycle, 3-phase, 1160 r.p.m. at full load, being direct connected thereto by means of a flexible leather link coupling

The motor possesses a feature in rotor construction that is unique. The end rings are welded on to the rotor bars by a new process, making a perfect joint, free from the troubles common to the purely mechanical or riveted joint, such as oxidation, working loose, and solder-throwing. This improvement marks a long step forward in the elimination of rotor trouble.

Our Vancouver Branch supplied and assembled this complete pumping unit. We are in a position to quote on the necessary equipment for any pumping requirements on receipt of specifications.

The Canadian Fairbanks-Morse Co., Limited

Fairbanks Standard Scales, Fairbanks-Morse Gas Engines
Pumps Safes Vaults

MONTREAL, ST. JOHN, OTTAWA, TORONTO, WINNIPEG,
CALGARY, SASKATOON, VANCOUVER, VICTORIA.

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BACK COPIES OF ENGINEER WANTED.

One copy of The Canadian Engineer of the following dates are required. The usual extension of the sender's subscription will apply in this case: April 4th, 1912; January 5th, 1911; March 23rd, 1911.

SILVER IN NEWFOUNDLAND.

A silver miner, lately returned to his home at North Shore, Cape Breton, from the west is said to be about to undertake the examination of what appears to be a valuable silver deposit in Newfoundland not far from the tide water. The shipping facilities are excellent and a river capable of yielding 4,000 horsepower for the generation of electricity for use in the mine milling of the ore and smelting on the ground is available on the property.

CEMENT IN WESTERN CANADA.

Up to the middle of June about 100,000 barrels of cement have been ordered from the United States from the province of Alberta.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

16710—June 4—Approving revised rule relating to Baggage of Excess Size as follows:—"Commencing July 1st, 1912, for any piece of baggage of any class (except immigrant baggage checked at port of landing, and whips in canvas or leather cases), the greatest dimension of which exceeds forty-five inches, there will be an additional charge for each additional inch equal to the charge for five pounds of excess baggage."

16711—June 7—Authorizing G.T.R. to construct additional team tracks along and across Esplanade St., Toronto, Ont.

16712—June 8—Authorizing C.N.O. Ry. to cross public road on Lot 11, Range 2, Twp. of Clarendon, Ct. Pontiac, Que.

16713—June 8—Authorizing C.P.R. to open for carriage of traffic double track from mileage 92.4 to Carberry, Man., at mileage 105.7, Manitoba.

16714-15—June 6—16716—June 5—16717—June 7—Authorizing C.P.R. to construct spur for T. D. Robinson and Sons, Winnipeg, Man., for M. Rumely Company, Saskatoon, Sask., for International Harvester Co., Lethbridge, Alta., and for Three Rivers Harbor Commissioners, at Bureau Wharf, Three Rivers, Que.

16718—June 8—Authorizing C.P.R. to cross Saskatchewan Ave., Edmonton, Alta., by overhead bridge and across Hardisty Avenue, by grade crossing.

16719—June 1—Approving location of Lake Erie & Northern Ry. from Grand River to Colborne St., Brantford, Ontario.

16720—June 10—Approving change in location C.P.R. station at Vancouver, B.C.

16721—June 10—Authorizing C.N.O. Ry. to open for carriage of traffic its line from Trenton to Deseronto and rescinding Orders 15211 and 15940, Oct. 28, and Feb. 13th, 1912.

16722—June 14—Directing G.T.R. to re-locate loading siding east of Vineland Station, Ont., and to erect fruit shed.

16723—June 11—Approving location of Algoma Eastern Ry. Co. across Little Current Channel, between mileage 79.80 and 80.69, Ontario.

16724—June 4—Approving plans of G.T.P. Ry. for freight shed at Mission Terminals, Fort William, Ont.

16725—June 11—Approving plan of C.P.R. (G. B. & S. Ry.) for interlocker in swing bridge over Trent Canal, mile 44, Ont.

16726—June 13—Approving plan of Kettle Valley Ry. for 250-foot deck-span over Trout Creek, near Penticton, B.C.

16727—June 8—Authorizing G.T.P. B.L. Co. to open for carriage of traffic its Tofield-Calgary Branch from Red Deer, mileage 83.5 to Trouch, mileage 121.4, Alberta.

16728—June 10—Authorizing G.T.R. and approving stress sheets of Bridge 189, and No. 77 Northern Division and Ottawa Division, Ontario.

16729-30—June 10—Relieving V. V. & E. Ry. from erecting and maintaining fences from Blaine to Colbrook, and from Colbrook to Brownsville, British Columbia.

16731—June 11—Extending until July 15, 1912, time for C.N.R. to put tracks at Saskatoon, Sask., in good shape, etc.

16732-33-34—June 11—16735—June 10—Directing Dominion Atlantic Railway to within 60 days to install improved type of electric bells at four street crossings in town of Windsor, N.S. 20 per cent. of cost of same from Railway Grade Crossing Fund.

16736—June 11—16737—June 13—Approving revised location of C.N.O. Ry. through Township of Torbolton and Fitzroy, Ct. Carleton, Ont., mileage 27 to 37.01 from Ottawa; and through Twps. of Fitzroy and Onslow and Bristol, Ct. Pontiac, Que., mileage 36 to 40 from Ottawa, Ontario.

16738—June 14—Authorizing C.N.O. Ry. to construct across Leamy Creek, Twp. of Nepean, Ct. Carleton, Ontario.

16739—June 12—Approving revised location of C.N.O. Ry. through Twps. of Barron and White, Dist. of Nipissing, Ontario.

16740—June 14—Authorizing C.N.R. to cross with its Vonda Northerly line 11 highways in Saskatchewan.

16741—June 14—Authorizing G.T.P. Railway to construct across highway mileage 194.8 Cassiar District, B.C.

16742—June 13—Approving location of G.T.R. new station at Stratford, Ontario.

16743—June 14—Authorizing Campbellford, Lake Ontario and W. Railway (C.P.R.) to cross two highways in Twp. of East Whitby.

16744—June 13—Authorizing C.P.R. to construct additional track across highway at mileage 107.38 on Cascade, S.D.

16745—June 12—Authorizing C.P.R. to reconstruct bridges Nos. 17.0 and 17.9 on Swift Current, S.D.

16746—June 15—Relieving C.P.R. from further protecting crossing of Main Street, Walton, Ontario.

16747—June 15—Directing Central Vermont Railway to extend its siding at Stone, Que. Complaint Shippers of N. Stanbridge, Que.

16748—June 17—Authorizing G.T.R. to construct two sidings across William Street, Kingston, Ontario.

16749—June 8—Authorizing C.P.R. to take lands at Leaside Junction for new station site, etc., and approving new station site.

16750—June 13—16751—June 11—16752—June 13—16753—June 14—16754—June 13—Authorizing C.P.R. to construct spurs for following:—Alaska Bedding Company, Regina, Sask., J. McDiarmid Company, Calgary, Alta., American Lumber Company, Sumas, Jct., B.C., Canadian Sardine Company, Chamcook Station, N.B., Saskatoon Lumber Company, Saskatoon, Sask.

16755—June 14—Authorizing C.P.R. to construct two additional tracks across road allowance at mile 176.57 Calgary, S.D.

16756—June 14—Rescinding Order 16713 June 8, 1912, and authorizing C.P.R. to open for carriage of traffic its double track from mileage 98 at Melbourne to Carberry, mile 106.

16757—June 10—Extending until July 15, 1912, time for C.P.R. to complete fencing ordered by Order 15864 February 1st, 1912.

16758—June 15—Authorizing Campbellford, Lake Ontario and W. (C.P.R.) to cross 12 highways Twps. Bedford and Hichinbrooke, Ontario.

16759—June 8—16760—June 15—Authorizing C.P.R. to construct bridge 0.3 over Sask. River, Calgary, S.D., and reconstruct bridge No. 124.4 on Muskoka Subdivision.

16761—June 13—16762—June 17—Authorizing C.P.R. to construct additional track across highway at Westminster Jct., New Westminster, B.C., and at Kyle Street, Port Moody, B.C.

16763-64—June 14—Approving proposed changes in location of C.P.R. stations at Plaisance, Que., and Hammond, Ontario.

16765—June 15—16766—June 13—16767—June 13—16768—June 10—Authorizing G.T.R. to construct spurs for British Canadian Canners, Limited, Cobourg, Ontario, Dain Manufacturing Company, Limited, Twp. of Humberstone, Ontario, The London Concrete Machinery Company, Limited, London, Ontario, Alaska Feather and Down Company, Limited, Montreal, Quebec.

16769—June 11—Authorizing G.T.R. to reconstruct bridge at M.P. 20.56 on 22nd. Dist., Twp. of Waterloo, Ontario.

16770—June 13—16771—June 15—Authorizing G.T.P. Railway to cross highways (2) in Cassiar and Coast Districts, British Columbia.

16772—June 8—16773—June 15—Authorizing G.T.P. B.L. Company to construct station at Prongua on its Cutknife Branch, Saskatchewan, and approving location of station at Rowatt, Saskatchewan.

16774—June 13—Authorizing G.T.P. Railway to cross highway at Mileage 90.5 District of North Alberta, Alberta.

16775—June 17—Authorizing G.T.P. B.L. Co. to take possession of C.P.R. land for right-of-way, Tofield-Calgary Branch.

16776—June 10—Authorizing Algoma Eastern Ry. to construct swing bridge at Little Current, between Goat and Manitoulin Islands.

16777—June 17—Authorizing Algoma Eastern Ry. to connect with C.P.R. (Soo Branch) and Huronian Spur of Canadian Copper Co., in Twp. of Drury, Ontario.

16778—June 11—Authorizing Algoma Central & H.B. Ry. to cross highway between Cathcart St. and Wilde Ave., Tagena, Algoma, Ont.

16779—June 11—Approving plans of subway at Jasper Ave., and bridges at McKay and Victoria Avenues, Edmonton, Alta., C.P.R.

16780—June 10—Authorizing C.N.O. Ry. to cross 8 highways in Twps. of Ross and Westmeath, County of Renfrew, Ontario.

16781—June 15—Authorizing C.N.O. Ry. to cross Nicholas Creek, in Township of Marlborough, County of Carleton, Ontario.

16782—June 17—16783—June 15—Authorizing C.N.R. to cross with its Alsask, S.E., 13 highways, and with Swift Current Extension, 6 highways, in Saskatchewan.

16784—June 8—Approving by-law No. 12, British Yukon Ry., authorizing O. L. Dickeson, president, to prepare and issue tariffs.

16785—June 15—Approving clearances for V.V. & E. Ry. dock and warehouse at Burrard Inlet, British Columbia.

16786—June 14—Authorizing T.H. & B. Ry. to construct spur into premises of Geo. Frid Co., Ltd., Hamilton, Ontario.

16787—June 10—Authorizing Vancouver, Nanaimo Coal Co., to use and operate bridge where it crosses Esquimalt & Nanaimo Ry. Mountain District, Vancouver Island, B.C.

16788-89—June 15—Authorizing C.P.R. to construct spur for Gorman, Clancy & Grundley, Ltd., Edmonton, Alta., and for Oliver Lemire, Cabane Ronde, Quebec.

16790—June 10—Authorizing C.P.R. to alter location of existing tracks and to make alterations in bridges across Mountain, Aqueduct & Guy Streets, Montreal, Que.

16791—June 13—Authorizing G.T.R. to construct siding for Dominion Canners, Ltd., Simcoe, Ontario.

16792—June 15—Authorizing C.N.O. Ry. to cross McCawley's Creek, in Township of Nepean, County of Carleton, Ontario.

16793—June 17—Authorizing C.N.O. Ry. to construct bridge on land of Thomas Till, Rosebud Creek, Alberta, within 30 days.

16794—June 17—Amending Order 16061, dated March 2nd, 1912, by striking out words and figures, "Minimum charge 10 cents" at end of paragraph 2 of clause (b), to points not over 300 miles distant. Complaint, Manitoba Free Press, Winnipeg.

16795—June 19—Appointing F. Blois, Mayor, New Carlisle, Que., and David W. Mill, Q.L.S., as arbitrators, between Quebec Oriental Ry. and L. J. Riopel, in re payment for lands.

16796—June 18—Authorizing Essex Terminal Ry. Co. to open for carriage of freight traffic its line through city of Windsor, and Twp. of Sandwich West and town Sandwich, Ontario.

16797—June 18—Amending Order 16706 June 5, 1912, by adding words "and the trolley wire and wires" after first word "Tracks" in third line of second paragraph of Order.

16898—June 19—Extending until 31st October, 1912, time for completion by Toronto Eastern Railway of spur to Durham Rubber Company.