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Contents of this issue on page 221

The Canadian Engineer

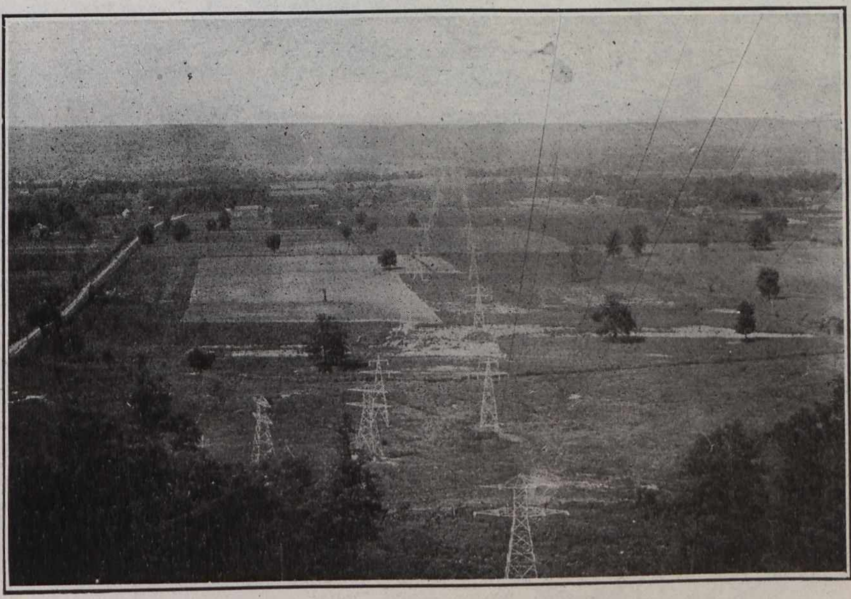
An Engineering Weekly

THE HIGH TENSION TRANSMISSION SYSTEM OF THE HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO.

Description of the System.

The high-tension steel tower transmission system described herein is, perhaps, the most prominent example of high-tension transmission in the world. The system operates at a potential of 110,000 volts, and was designed and constructed by the Hydro-Electric Power Commission of Ontario, a government corporation appointed by the Provincial Legislature to provide for the development, generation and distribution of hydro-electric energy at cost to the various municipalities of the province.

Ultimately, the commission plans to extend its system over the entire province; particular attention being given the central and northern districts, where the available water powers have an aggregate horse-power of more than twice that of the Niagara district, although the latter district is the only one that has been developed to date by the commission.



General View of High Tension Transmission lines in Dundas Valley.

System.—There are 281 miles of steel tower line sectionalized as shown in Table I., and twelve transforming stations. The general map shows the extent of the system.

It will be noticed that while two circuits have been erected in Sections A and B, only one circuit has been erected throughout the rest of the system. The reason for this is apparent upon examination of the accompanying map. All the stations beyond Dundas, with the exception of Toronto and St. Thomas, are on a loop circuit and as a result may be served from Dundas in either direction around the loop. Under normal operating conditions, the direction of current flow is from Dundas to London on the south side and from Dundas to St. Marys on the north side of the loop, the line between St. Marys and London being held in reserve.

The main step-up transformer station of the system is located at Niagara Falls, Ontario, where the energy, purchased from the Ontario Power Company and supplied at 12,000 volts, 25 cycles through a 2,200-foot conduit line, is stepped-up to 110,000 volts for delivery to the three-phase high-tension lines. The present installed transformer capacity at this station is 27,000 kw.

The transmission voltage is later stepped-down to 13,200 and 6,600 volts for local and low-tension distribution at the following sub-stations, the installed transformer capacity being as follows: Dundas, 2,250 kw.; Toronto, 7,500 kw.; London, 3,750 kw.; Guelph, 2,250 kw.; Preston, 2,250 kw.; Berlin, 2,250 kw.; Stratford, 2,250 kw.; St. Marys, 2,250 kw.; Woodstock, 2,250 kw.; St. Thomas, 2,250 kw.; Port Credit, 3,750 kw.

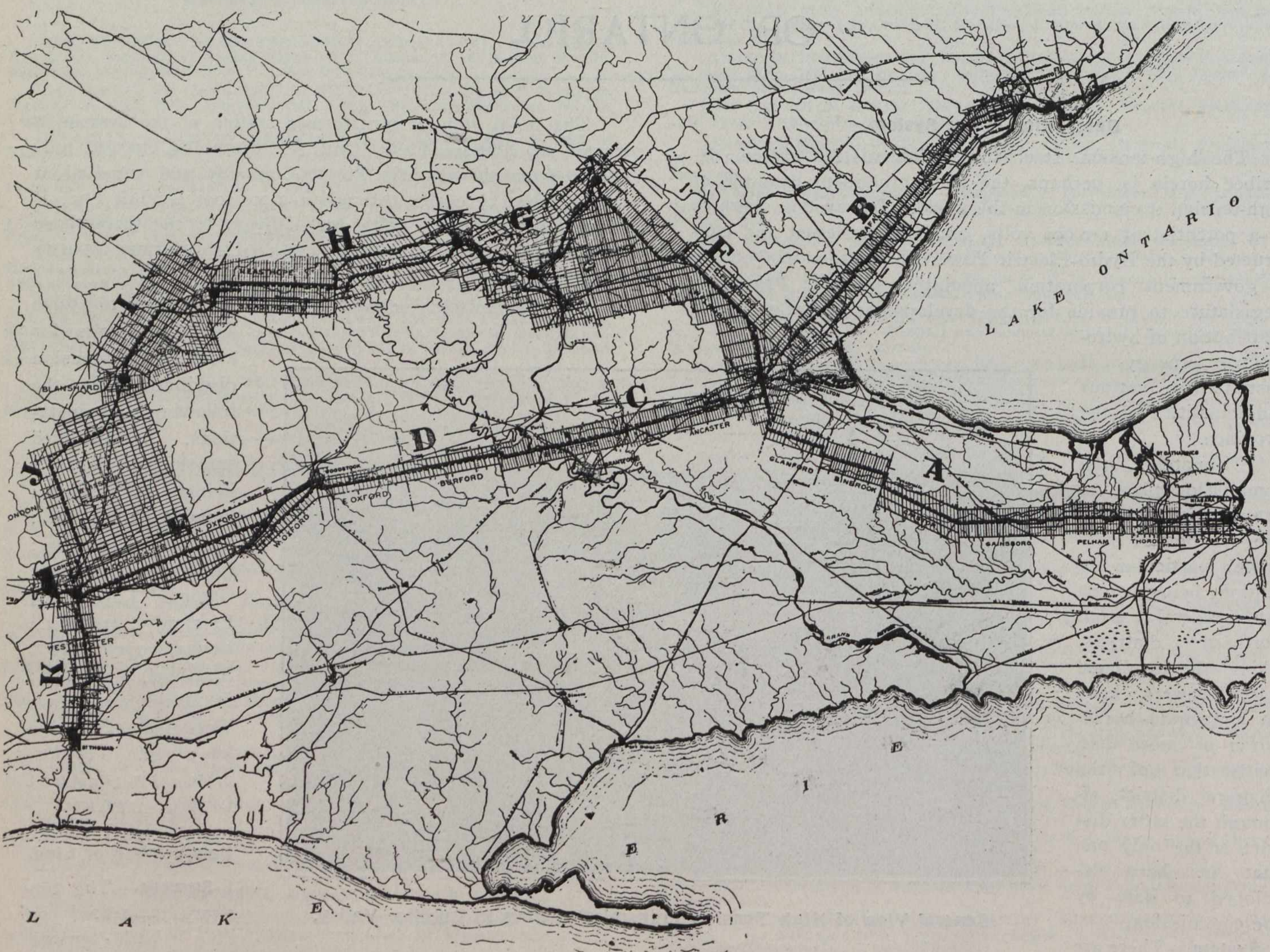
Construction of Line.

Surveys.—The territory embraced by the high-tension transmission system was first covered by reconnaissance to determine the most feasible route for the line. The preliminary examination was performed with the primary intention, wherever possible, of adopting a route parallel to travelled roads, in order to reduce the transportation, maintenance and patrol costs to a minimum. In selecting the route care was also taken to avoid any sections of country subject to electric storms, and some projected and otherwise favorable routes were abandoned as a result of information supplied by telephone and telegraph companies already operating in these vicinities.

After the route has been selected an instrument survey was made. No profiles were, however, necessary, for the towers were located and staked in the field, and the locations

Table I.—High-Tension System of Ontario.

Nomenclature of Sections.	Miles.	Towers.	Circuits at present erected.
Section A, Niagara Falls-Dundas	51.4	Double-circuit	2
Section B, Dundas-Toronto	39.1	Double-circuit	2
Section C, Dundas-Paris	22.6	Double-circuit	1
Section D, Paris-Woodstock	21.8	Double-circuit	1
Section E, Woodstock-London	25.4	Double-circuit	1
Section F, Dundas-Guelph	25.3	Double-circuit	1
Section G, Guelph-Berlin	19.1	Double-circuit	1
Section H, Berlin-Stratford	25.1	Double-circuit	1
Section I, Stratford-St. Marys	13.5	Single-circuit	1
Section J. St. Marys-London	23.6	Single-circuit	1
Section K, London-St. Thomas	13.4	Double-circuit	1



Map of Transmission System.

thus established were plotted on the plans. These plans were employed by the commission while purchasing right-of-way, and later by the contractor to locate the towers. The tower locations were staked by small transit parties sent into the field ahead of the construction gangs. They first set a hub marking the centre of the tower base and then two offset hubs along the tower tangent marking the centre of the opposite sides of the square tower base. A reference stake was also driven, upon which was marked the number, type and chainage of the tower.

Right-of-Way.—The transmission line right-of-way was acquired through easements, which give the commission the privilege to enter upon property and to construct, maintain, operate, repair and patrol their transmission line for a period of thirty years. Every property owner along the route signed an agreement whereby, for an amount mentioned therein, these rights and privileges were conferred upon the commission. The remuneration included compensation for all trees, houses, barns or other obstructions which were permanently removed from the right-of-way. Patrol rights were purchased only on cross-country sections, since they were not needed where the line parallels the highways. The patrol paths are four feet wide and are provided with light steel gates at intersecting fences.

The commission has the right to renew these agreements at their expiration for an amount equivalent to the original compensation or one settled by mutual agreement or arbi-

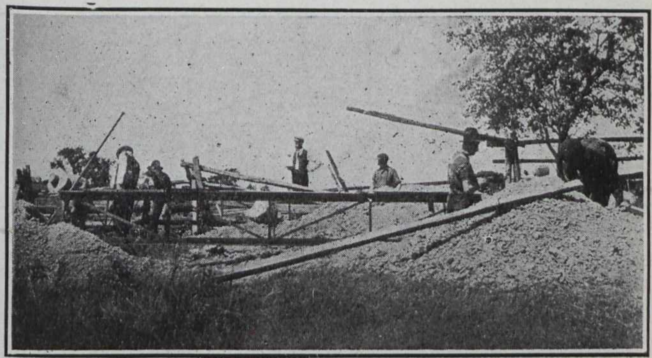


Fig. 1.—Setting of Tower Footing, Showing Templet.

tration. This method of acquiring right-of-way dispensed with the necessity for fencing the land beneath the line and also permits of its cultivation.

Footings.—The standard tower footings consist of rivetted-steel grillages 28 inches square, embedded in the soil at a depth of about seven feet and horizontally bolted to an eight-foot leg angle protruding from 12 to 15 inches above the natural surface of the ground. Similar footings are employed for long span and corner towers, but the steel is heavier and the grillages are 42 inches square.

The grillages are shop-rivetted and the leg angles bolted to them in the field. The footing steel was not galvanized, receiving instead two

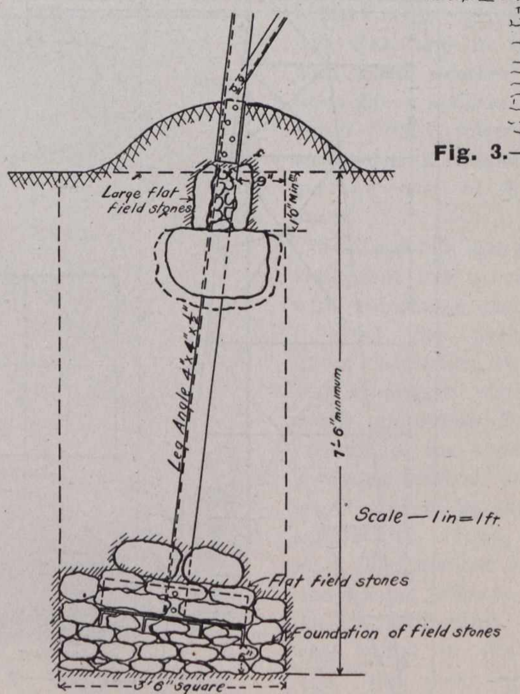


Fig. 2.—Setting of Standard Tower Footing in Earth.

coats of special protective paint. Approximately 1,000 tons of footing steel were utilized in the construction of the line.

The four footing pits for each tower were blocked out by two men with a light wooden templet from the three hubs previously located by the transit party and a gang of laborers excavated the pits to a minimum depth of 7 feet 6 inches.

Closely following came a gang of twelve men and a foreman. They carried a steel templet with corner posts having the same slope as the leg angles of the towers. This gang placed the footings in the pits, bolted the leg angles securely to the corner posts of the templet, (Fig. 1) lined the templet in with the three hubs set by the locating party, levelled the four sides with a spirit-level, placed the field stones, back-filled and watered the pits and thoroughly tamped the replaced earth with iron tamping bars, as shown in Fig. 2. This gang, under favorable working conditions, could prepare an average of five sets of footings a day. The labor cost on the standard footings in moist or dry soil ranged from $15 to $25 a set. This included the cost of excavation, setting and back-filling.

In locations where quicksand, rock or very wet soil was encountered special construction was necessary and another gang was employed for this purpose. In swamp, where good bottom was within reach, the pits were shored and the soft material removed. The shoring was left in place and the

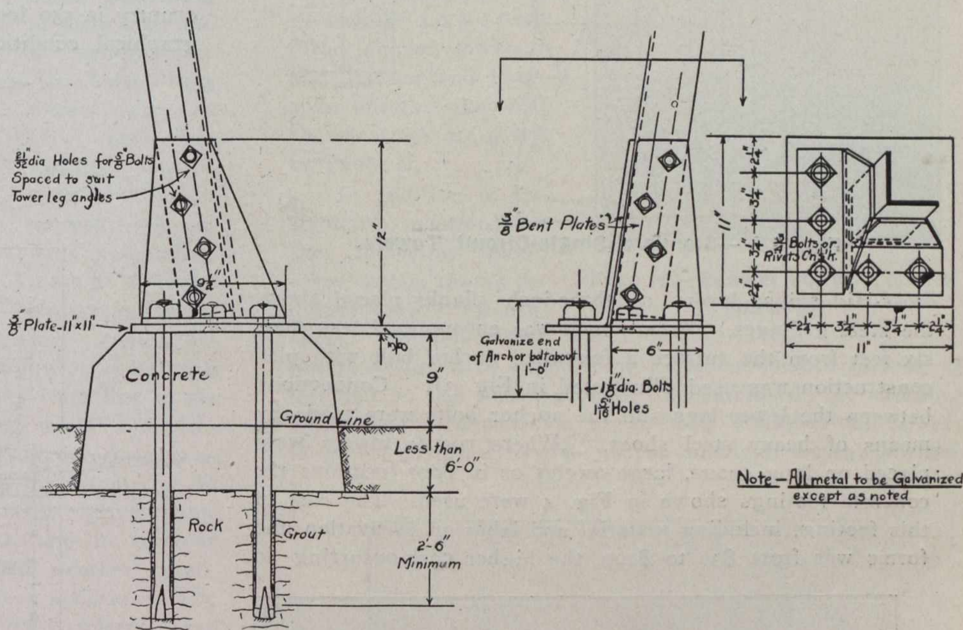


Fig. 3.—Tower Footing Where Rock Occurs Less Than 6 Ft. Below Earth Line.

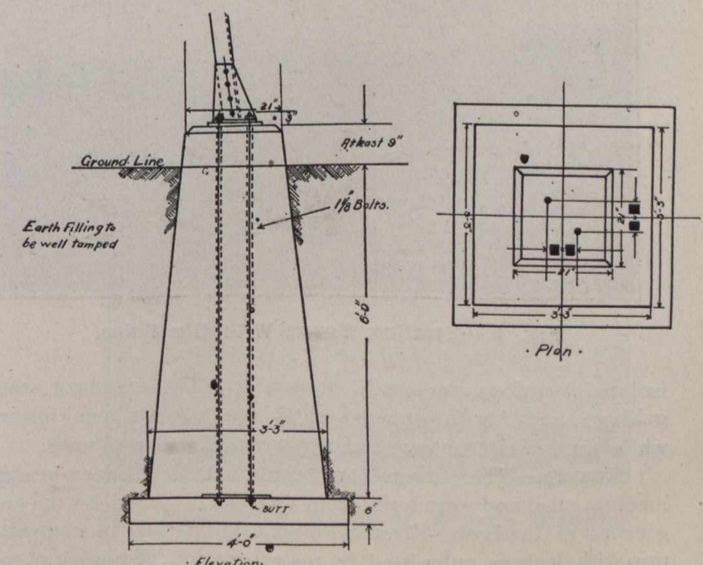


Fig. 4—Concrete Footings for Heavy Anchor Tower.

pits refilled to the proper depth with good material. The footing was then set in the usual way. In permanently wet clay or clay loam auxiliary grillages were placed above and below the ordinary steel grillages to further distribute the bearing pressure and increase the upheaval resistance. This auxiliary grillage consisted of two cross-laid spiked layers of four-inch planks five feet in length placed below, and four

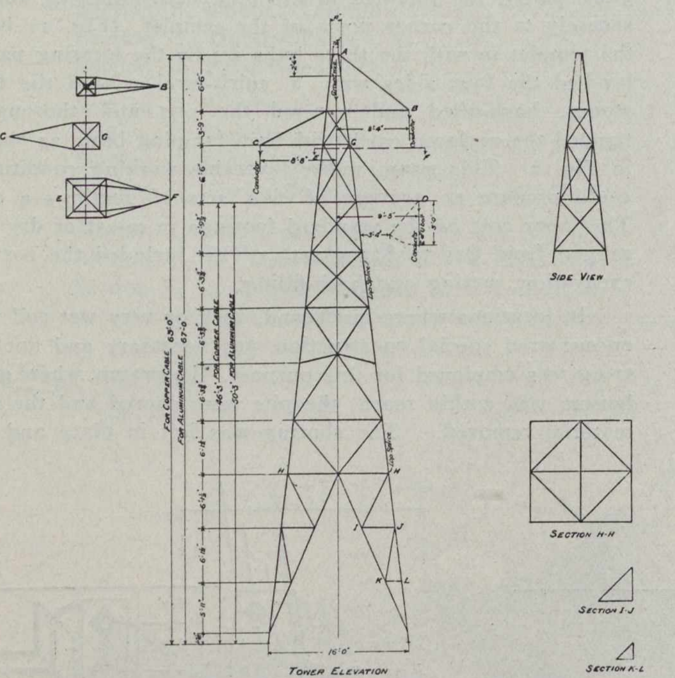


Fig. 5 A.—Standard Single-Circuit Towers.

cross-laid spiked layers of three-inch planks placed above the steel grillages. Where rock was encountered less than six feet from the surface a fox-tailed anchor bolt with pier construction was used (illustrated in Fig. 3). Connections between the lower legs and the anchor bolts were made by means of heavy steel shoes. Where corner towers were placed on long spans, large angles or in poor locations the concrete footings shown in Fig. 4 were used. The cost of this footing, including material and labor on excavation and forms was from $50 to $190, the higher cost occurring in

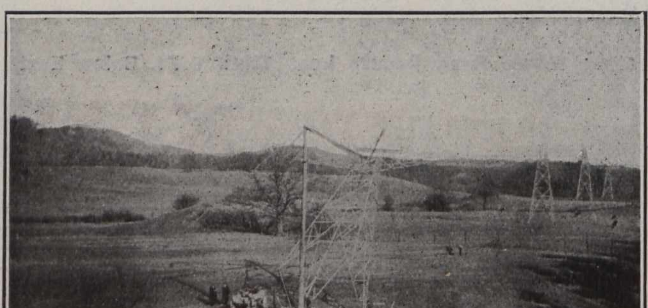


Fig. 6.—Erecting Tower With Gin Poles.

isolated locations not easily accessible. The standard steel grillage and leg angles weighed 690 pounds per tower, while the special heavy footings weighed 1,830 pounds.

Towers.—The towers are constructed of open-hearth medium steel and were built from designs prepared by the engineers of the Hydro-Electric Power Commission in competition with designs submitted by the contractor. Sample towers were built from both designs, and exhaustive tests at the shops of the tower manufacturers proved that the tower built from the commission's design was the stronger tower of the two, (Fig. 5). This tower withstood, without appreciable injury, a horizontal stress of 20,000 pounds at the centre of the lower cross-arm, and finally failed at 20,950 pounds.

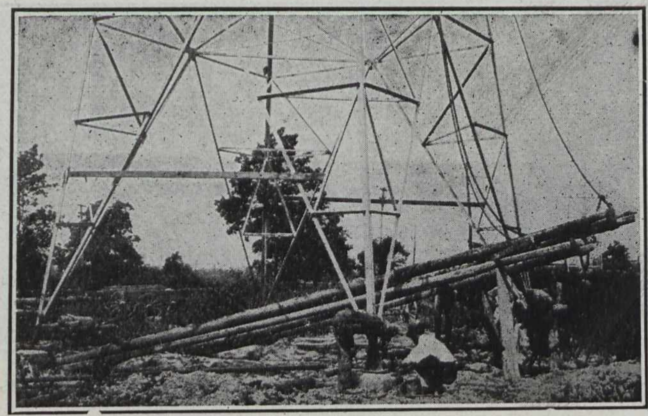


Fig. 7.—Erecting Tower With Shear Legs.

The average cable span length on tangents for level country is 550 feet. This is varied elsewhere to suit topographical conditions. Approach spans to angles in the

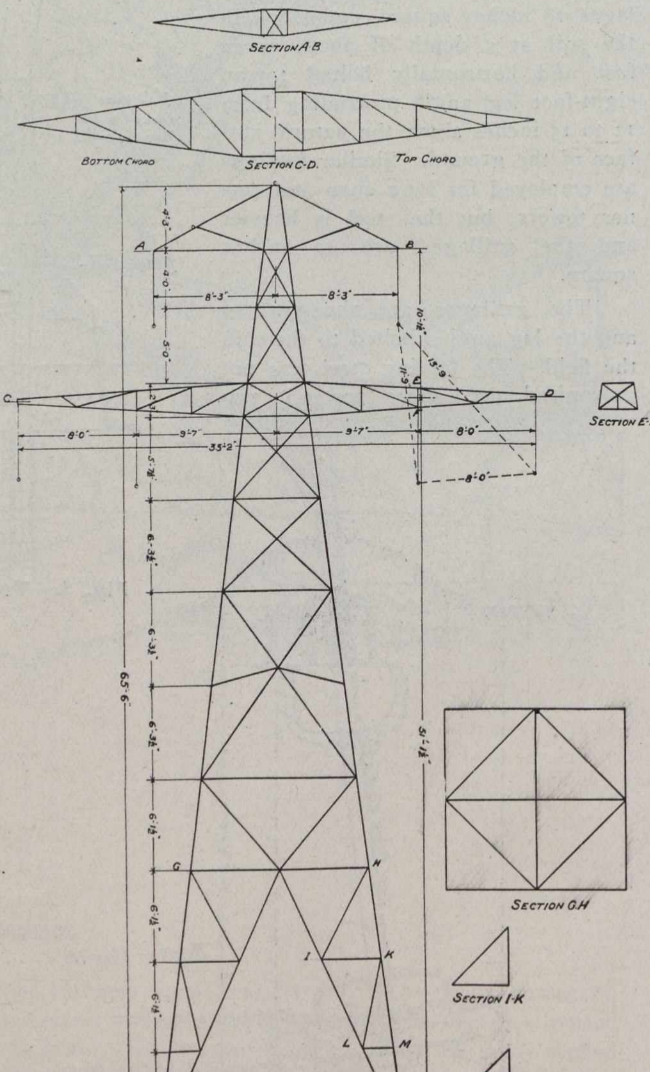


Fig. 5 B.—Standard Double-Circuit Towers.

centre line vary from 400 feet on angles up to 8 degrees, to 100 feet on angles of 45 degrees, the maximum angle turned on one tower. The towers were delivered "knocked down" in bundles to various railway sidings and transported by team to the line. All connections were made by means of galvanized bolts, the required number being delivered with each tower.

An assembling gang, usually consisting of eighteen men including a foreman and sub-foreman, followed the footing gang. Two men from this assembling gang went ahead to break out the bundles and lay out the towers on the ground. The main gang assembled the body of the tower, while the cross-arms were assembled by a gang which followed consisting of three men and a sub-foreman. All bolts were drawn tight and the projecting threads burred with a hammer or centre-punch. This assembling gang working winter and summer could assemble an average of three and one-half towers a working day. Under favorable summer conditions from five to six towers a day were assembled. The average winter and summer labor cost for assembling a double-circuit tower was $10; the maximum cost in winter with heavy snow was $24, and in summer with good weather conditions $6.25 a tower. The single-circuit towers were assembled in summer at an average cost of $7.35 a tower.

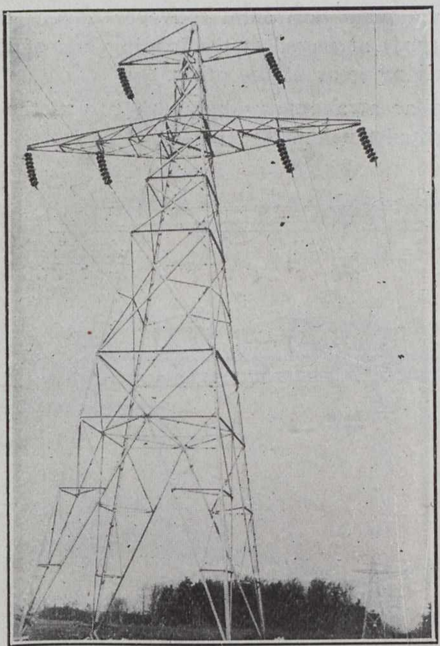


Fig. 8.—Standard Double-Circuit Line Tower.

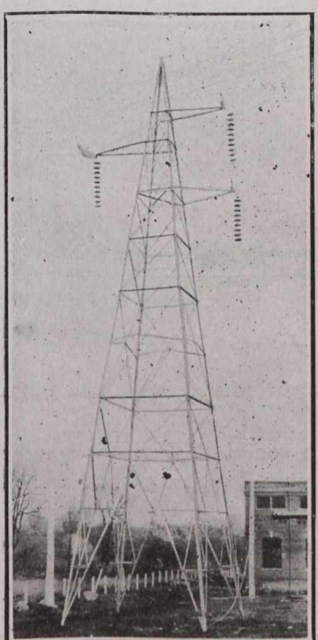


Fig. 9.—Standard Single-Circuit Tower.

The erection gang, consisting of five or six men with a foreman and team, followed the assembling gang. Gin-poles, A-frames and shear-legs were variously employed for the erection of the towers, the shear-leg method, however, was found to be the most satisfactory. (Figs. 6 and 7). The method of erection was as follows: Temporary stiffening struts were bolted to the tower legs; the shear-legs were placed in a vertical position about the centre of the tower base and the toes securely snubbed; a heavy line leading from a set of double blocks was then carried over the shear-legs and attached to the tower just below the lower arm; the blocks were snubbed to "dead-men" and the tower drawn into a vertical position by a team, after which stiffening struts were removed and the tower legs bolted to the footing angles. The average rate of erection under various conditions was about four towers a working day. During the summer and in good country eight towers a day could be erected in straight runs by the erection gang. The average labor cost for erecting double-circuit towers was $4.75 a tower, the minimum cost $2.45. Single-circuit towers were erected at an average cost of $3.50 a tower. All work on single-circuit towers was done in the summer and early autumn.

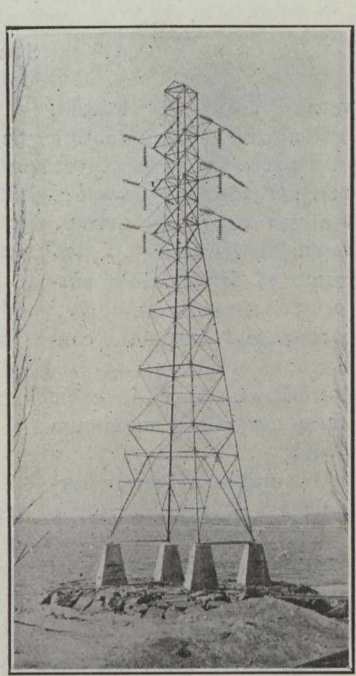


Fig. 10.—Special Tower, Toronto Entrance.

The double-circuit towers, of the general design shown in Fig. 8, are classified as "standard towers," "line anchor towers," and "corner and long-span towers." General specifications are given in Table II.

In addition to the standards mentioned on the following page, other special towers required were: Twenty-eight double-circuit towers designed to support the lower conductors 50 feet, 55 feet and 70 feet above ground, and employed for crossing high-tension transmission lines; forty double-circuit towers (Fig. 10) designed to give 70 feet conductor clearance above ground, employed within the corporate limits of Toronto; two double-circuit towers giving 150 feet navigable clearance over the Welland Canal, and thirty-six horn-gap towers 19 feet in height at station entrances.

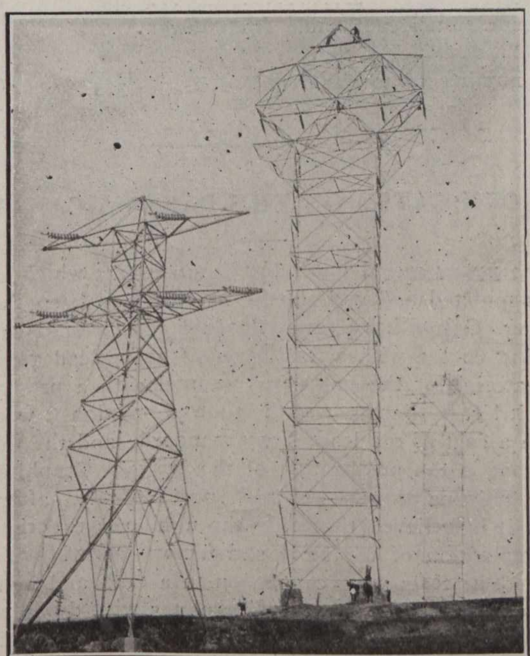


Fig. 11.—Special Tower at Welland Crossing.

The towers used in crossing the Welland Canal (Fig. 11) weighed 25 tons each and were erected on specially designed reinforced concrete footings. The complete system required in all 3,040 towers, and the total weight of galvanized material ordered was 6,200 tons.

Table II.—Specifications for Double-Circuit Towers.

	Standard towers.	Line anchor towers.	Corner and long-span towers.
Average assembled weight, galvanized without footing	3995 lb.	4560 lb.	5020 lb.
Total over-all height	65′ 6″	61′ 4″	61′ 4″
Total spread of upper-arm..	16′ 10″	17′ 6″	17′ 6″
Total spread of lower-arm..	35′ 2″	39′ 6″	39′ 6″
Dimensions of base	17′ sq.	18′ sq.	18′ sq.
Height of lower cable suspension from ground.....	45′	45′	45′
Spacing and insulator connections	9′	10′	10′
Minimum distance of cable from tower leg; maximum swing	3′ 6″	5′ 10″	5′ 10″
Total number of towers required	2295	105	176

The single-circuit towers, of the general design shown in Fig. 9 are classified as "standard towers" and "anchor towers." General specifications are given in Table III.

Table III.—Specifications for Single-Circuit Towers.

	Standard towers.	Anchor towers.
Average assembled weight, galvanized, without footing	3200 lb.	3450 lb.
Total over-all height	64′ 6″	67′
Total spread of arms..................	18′ 3″	18′ 3″
Dimensions of base	16′ sq.	16′ sq.
Height of lower cable suspension from ground	45′	45′
Minimum distance of cable from tower leg	6′	6′
Total number of towers required......	335	62

LOCK-GATES ON THE PANAMA CANAL.

The upper guard gates for Gatun Locks which are almost completed and will shortly be closed to keep the water of rising Gatun Lake from flooding the lower lock levels, are being coated with a final layer of heavy lead gray paint. The material for the gates was painted with a priming coat before it left the factory; at the time of erection it was covered with a coat of red lead, Navy standard; and the third and outer coat is the preparation of the Detroit Graphite Company. This paint was selected provisionally, after tests. though it is believed that only through long experience will the composition of the most satisfactory covering be ascertained. The tests were carried on in a tank and in the culverts below the locks, by painting plates with different kinds of paint, applying coats varying in number and thickness, and exposing in air and water. The light color was selected, in order to minimize the heating of the upper parts of the gates, the expansion from which might cause slight distortions which would interfere with the accurate adjustment of the leaves. This paint will be used on all of the lock gates, with the exception of the seawater gates, which will be covered with an antifouling paint to keep off barnacles.

SOME NOTES ON BAND CONVEYORS.

By F. Tissington.

(SECOND ARTICLE.)

The following eleven diagrams show different arrangements for these band conveyors.

Fig. 1 indicates a plain horizontal conveyor having the tension end (screw type) arranged at the loading end of the conveyor and the driving gear at the other.

Fig. 2 is a similar arrangement but with two methods indicated for a weighted tension.

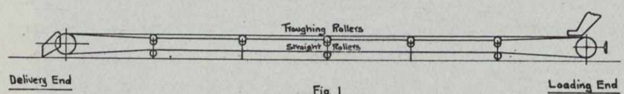


Fig. 1

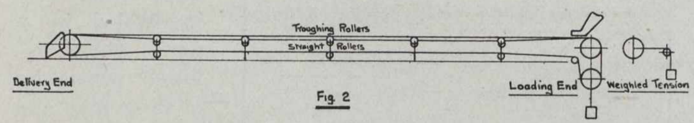


Fig. 2

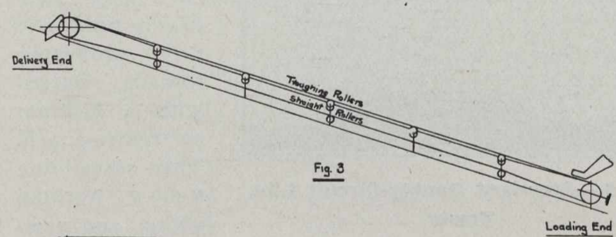


Fig. 3

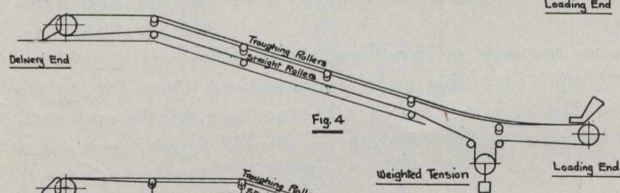


Fig. 4

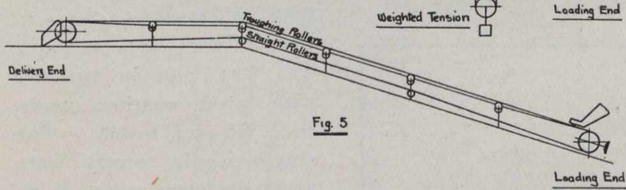


Fig. 5

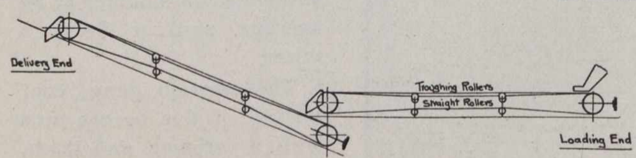


Fig. 6

Fig. 3 is an inclined conveyor with driving and tension ends similar to Fig. 1.

Fig. 4 is another type of a combined horizontal and inclined conveyor with one or more loading points and this shows a weighted tension arranged at an intermediate point between the two ends. The pulley at the loading end being mounted in fixed bearings.

Fig. 5 is type of a partly inclined and part horizontal conveyor with a screw tension.

Fig. 6 shows two conveyors, one horizontal and delivering on to the second, which is inclined.

Fig. 7 indicates how the driving gear may be arranged if required to be placed other than at the two ends.

Fig. 8. This arrangement is a modification of Fig. 6, and, if required, may be driven from one of the pulleys in the centre of the belt.

Fig. 9. This shows an ordinary horizontal conveyor fitted with a throw-off carriage or tripper. The latter may be either stationary or arranged to travel along the length of the belt.

Fig. 10. This is a similar arrangement to the previous one, but indicates that two trippers may be used on the same belt, and if this is done one of them usually has a special spout to return material carried to the band when required.

Fig. 11 shows a reversing conveyor which may be loaded from each end alternately and by means of the tripper the material may be delivered at any point along its length. Other combinations may be arranged to suit any particular scheme, and these diagrams are simply given to indicate a few of the various arrangements that may be made.

Driving Gear.—Usually the first set of gear is supplied with the conveyor, including countershaft and bearings, and the latter, together with the bearings for the drum shaft,

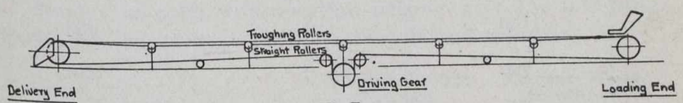


Fig. 7

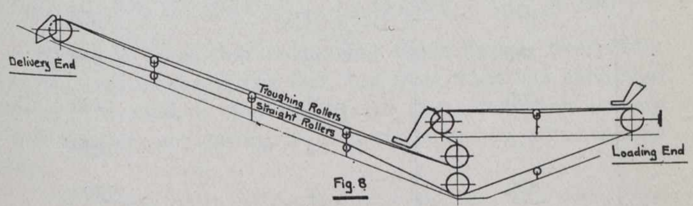


Fig. 8

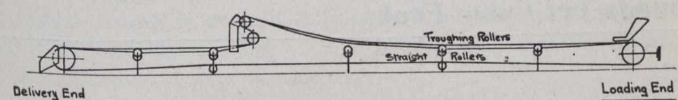


Fig. 9

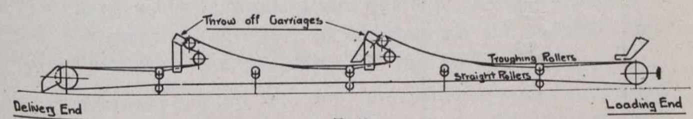


Fig 10

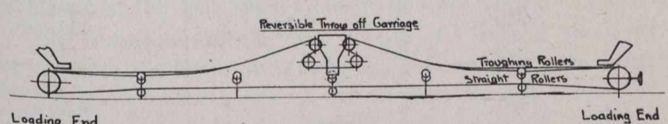


Fig. 11

are mounted on a combined sole plate, either of cast iron or a short length of I-beam. The terminal pulleys should all be about one inch wider than the width of the band for widths up to about eighteen inches. Above this the extra width should be at least two inches more. This is done in order to prevent the edge of the belt being cut through or getting ragged at the edges, which would probably happen if the belt overlapped the pulley due to the tendency all belts have to travel sideways slightly.

The pulleys may be made of either cast, wrought iron, steel or wood. Cast iron pulleys are very seldom used now on account of their weight and greater liability to damage. The wrought iron or steel rim pulley, with wrought iron round spokes rivetted to the rim, and with a cast iron boss, either solid or split, is the general practice. These give very good results, are cheap, and there is very little danger of breakage, also the weight is comparatively small. For the wider belts it is necessary to introduce double arm pulleys or otherwise put two or three single arm pulleys side by side on the same shaft to make up the width. If, however, this latter is done the pulleys should be faced up in the lathe mounted on the shaft in position in order to produce a true and even surface without ridges.

All wood pulleys are now made in large quantities, are very serviceable, and, further, have the advantage of an increased coefficient of friction, which gives them a slight advantage, but in the writer's opinion this is more than counteracted by the shorter life they possess, especially if used in a damp situation or a moist climate.

Sometimes the pulleys are covered with a rubber face, in order to gain an increase in the coefficient of friction and thereby add to the driving power, and, roughly, it may be said that this gives something like an increase of about 7 per cent. to 10 per cent. over and above the power obtained by the use of a plain-faced pulley.

Like the use of the wood pulley, this practice also has an objection, namely, that if any gritty material is being carried it is likely to get on the underside of the belt, and, sticking in the rubber facing of the pulley, cause rapid wear to take place.

The bearings for the drum shaft can be of cast iron fitted with adjustable gun metal bearings, and provided with large-sized grease lubricator.

Some engineers specify self-oiling bearings of the ring type, but this seems quite a needless expense, for the drum shaft at any rate. These self-oiling bearings are, however, very desirable when the revolutions of the shaft are rather high, which may be the case with the countershaft very often.

Tension Gear.—If this is of the adjustable screw type it is preferable to arrange the screws in tension if possible, and perhaps the best type is the one with the screw fixed in relation to the frame, but free to revolve in bearings and having a nut mounted on the screw, which is located in the pedestals, or filbows carrying the drum shaft. Then the screw is fitted with a small hand-wheel which, on being turned, traverses the bearings along the screw either backward or forward. Occasionally the two tension gears are coupled together with gearing, so that there is no likelihood of one side traveling in advance of the other and so causing the belt to run out of true. This, however, is purely a requirement for which there should be little necessity if the attendant is at all careful.

It was stated in the previous article that there was certainly a great danger of overstressing the fabric with this type of tension gear, and that the weighted tension was likely to give better results. On account of the extra cost, however, these seem to be avoided in most cases, particularly for the narrower and shorter belts.

This other type of tension gear consists of two fixed pulleys (one of which may be the end drum) and one other pulley mounted on a shaft free to travel up and down in guides and loaded with sufficient weight to produce the necessary tension in the belt for driving.

A modification of this can be arranged with one of the drum shafts free to move horizontally to which is attached a wire rope which passes over a pulley and to the other end of the rope are attached weights of sufficient capacity as before. The diameter of the terminal pulleys should not be less than the following:

3-ply	belts	from	18 to 24	diam.,	according	to	width	of belt
4	"	"	24 to 32	"	"	"	"	
5	"	"	30 to 36	"	"	"	"	
6	"	"	36 to 42	"	"	"	"	
7–8	"	"	42 to 48	"	"	"	"	

TABLE I.
CAPACITIES OF TROUGHED BELT CONVEYORS

Material Weighing 125 Pounds per Cubic Foot

Width of Conveyor Belt Inches	Speed, 200 Feet Per Minute.		Speed, 400 Feet per Minute		Speed, 600 Feet per Minute	
	Largest Size of Cube that can be carried. Inches.	Number of Tons Per Hour.	Largest size of Cube that can be carried. Inches.	Number of Tons per Hour.	Largest size of Cube that can be carried. Inches.	Number of Tons per Hour.
10	1½	10	½	25	¼	35
12	2	15	½	40	¼	55
14	2½	25	¾	60	½	75
16	3	40	1	85	¾	125
18	4	50	1½	115	¾	175
20	5	75	2	150	1	250
22	5	95	2	190	1	350
24	6	125	3	250	1	475
26	6	160	3	325	1½	600
28	7	200	4	410	1½	750
30	7	250	4	500	2	900
32	8	300	5	600	2	1100
34	8	350	5	710	2	1300
36	9	450	6	850	2	1500

Material Weighing 100 Pounds per Cubic Foot

10	1½	8	½	20	¼	28
12	2	12	½	32	¼	44
14	2½	20	¾	48	½	60
16	3	32	1	68	¾	100
18	4	40	1½	92	¾	140
20	5	60	2	120	1	200
22	5	76	2	152	1	280
24	6	100	3	200	1	380
26	6	128	3	260	1½	480
28	7	160	4	328	1½	600
30	7	200	4	400	2	720
32	8	240	5	480	2	880
34	8	280	5	568	2	1040
36	9	360	6	680	2	1200

Grain Weighing 60 Pounds per Bushel

Width of Conveyor belt, inches	16	18	20	22	24	26
Flat belts, bushels per hour	2500	3250	4000	4750	5500	6250
Troughed belts, bushels per hour	3500	4800	6000	7000	8500	9500

Width of Conveyor belt, inches	28	30	32	34	36	40
Flat belts, bushels per hour	7000	7750	8500	9250	10000	13000
Troughed belts, bushels per hour	10500	11500	12500	14000	15000	19500

Gripping pulleys should never be less than 12 inches diameter, and should exceed the width of the belt by the same amount specified for end pulleys.

Bands.—These may vary from about 10 to 42 inches in width and the general width per ply will average about five inches, although, of course, heavier bands may be required for some conveyors in order to give the necessary strength to transmit the horse-power required. The average weight of rubber covered conveyor belts is as follows:

3-ply .15 lbs. per in. of width	6-ply .30 lbs. per in. of width
4-ply .20 lbs. per in. of width	7-ply .35 lbs. per in. of width
5-ply .25 lbs. per in. of width	8-ply .40 lbs. per in. of width

The tensile strength of rubber belts varies from about 35 lbs. to 60 lbs. per inch width per ply. But for usual practice not more than about 25 lbs. per inch width per ply should be utilized; this being calculated from the maximum tension on the tight side of the belt.

Makers of solid woven cotton belting give the following figures for the average tensile strength and weight:

	Average Tensile Strength. Per inch width	Average Weight per inch width 100 1/0 length.
Single belt ¼ in. thick......	1,300 lbs.	10 lbs.
Extra stout ⅜–7/16 in. thick..	2,300 lbs.	15 lbs.
Triple ½–9/16 in. thick......	3,000 lbs.	20 lbs.

It would seem that comparing these figures everything was in favor of the cotton belt, but from what has been said before it is evident that the life of the cotton belt is very much shorter, and owing to this, the apparent advantage is lost.

The length of these conveyors sometimes run over 1,000 feet, but usually they do not exceed 500 to 700 feet, and if a longer length is desired it is generally better and cheaper in the long run to split it up into two or more sections driving each conveyor separately.

Endless belts are sometimes made for the shorter conveyors, but in the writer's opinion there is not much to be gained by their use, as they make erection work very awkward in most instances, and further, there are plenty of good fasteners of one sort or another on the market, thus doing away with the necessity for the endless belt.

The ideal fastener is one that develops the maximum amount of strength without forming projections or producing flat surfaces in the bands when passing round the pulleys, as the amount of lost arc of contact reduces the driving power of the belt when it is in this position.

The troughing of the belt should not exceed about 25 degrees with the horizontal, although rollers have been made with inclination as high as 35 and 40 degrees, but unless the belts are very flexible no contact will be made with the middle horizontal rollers, and greater wear will result at the edges of the belt.

Some makers advocate the flat band pure and simple, but this is likely to lead to the use of wider bands to get the required capacity, or else a greater danger of spilling.

The maximum amount of slope or inclination that should be given to a plain belt carrying coal, ore, stone, sand and similar material is about 20 degrees, although 25 degrees may be used in special cases if the material is not of a nature that will slip or roll easily. The former is the safer figure, as an increased inclination is likely to occur owing to the belt sagging between the supporting rollers or idlers due to the weight of material carried. If, however, throw-off carriers or trippers are used the maximum inclination should be reduced to 10 or 15 degrees on the portion of the belt leading up to the top pulley on the carriage, and this may be regulated by placing a set of idle rollers on the back end of the carriage.

The speed of the belt depends entirely on the nature and size of the smallest pieces to be carried. Generally, however, the speeds should be kept as low as possible, consistent with other features, as with high speeds there is a danger of spilling and slipping at the loading end, particularly if the belt at this point is inclined. Further, beyond a certain point it is impossible to obtain a greater capacity in any reasonable ratio of the speed as the material cannot be fed quickly enough to the band and, therefore, the stream thins out. If there is any quantity of fine dust in the material it will be found that about 200 feet per minute is the limit, because, with higher speeds the fine material has a tendency to leave the belt and float in the atmosphere, due to the resistance of the air. If, however, ore, stone, coal or other material in lumps is being handled, 600 feet per minute may be safely used without any bad results.

Large lumps cannot be satisfactorily carried on narrow belts without the danger of a good percentage dropping off, and the figures given in Table I. show the practice adopted by the Dodge Manufacturing Company in this respect.

It will also be noticed that capacities for the different belts are given for two different classes of materials in addition to grain, one of the substances weighing 125 lbs. per cubic foot and the other for 100 lbs. per cubic foot, and that

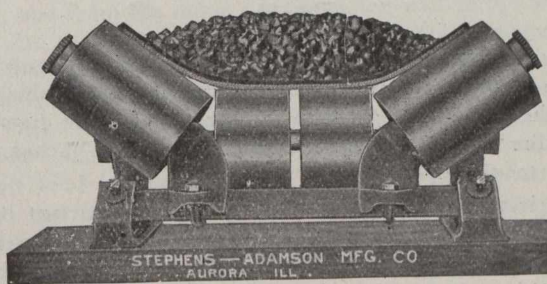


Fig. 12.

three different sets of figures are given corresponding to 200, 400 and 600 feet per minute belt speed.

It may be said that the most economic designing will be obtained by increasing the width of the belt and keeping the speed at a moderate amount, because it is impossible to load a belt the full width across, and as the amount of clear space will not vary much, whatever the width of the belt, it will be seen that the percentage of lost capacity on this account will be much greater on a narrow than on a wide belt.

Idler Rollers.—The spacing of these should be to a large extent regulated by the material to be conveyed. If the latter is very heavy then the rollers should be put fairly closely together. For most work, however, about four to five feet apart on the carrying side will be suitable for belts up to about thirty inches wide, beyond this they should be about three feet six to four feet. The return strand should be supported about every eight or ten feet, or generally twice the distance of the top rollers.

Both top and bottom rollers should be long enough to leave about one inch margin on each side of the belt for a similar reason to that stated for the end pulleys.

If the top rollers are of the troughing type the design should be carefully laid out to prevent the pinching of the band between the sectional rollers forming a set. That is, no large opening should be left between each section so that the belt can be forced down in between by the weight of the material on top.

The writer has heard of a case where a band was practically cut into two parts longitudinally owing to a circumstance of this sort happening, thus causing a severe loss.

Rough castings for rollers should be avoided. These should either be turned or the rollers made from cold drawn tube and fitted with bearings to revolve on. These latter make a first-class job, and if the parts are made in automatic machines they can be produced very cheaply.

Each set of rollers is mounted on a cross member or stretcher either of wood or steel, and these are generally provided by the contractor, with the rollers all fitted up in position ready for the stretcher complete to be erected in its correct place in the structure. The angle of inclination for

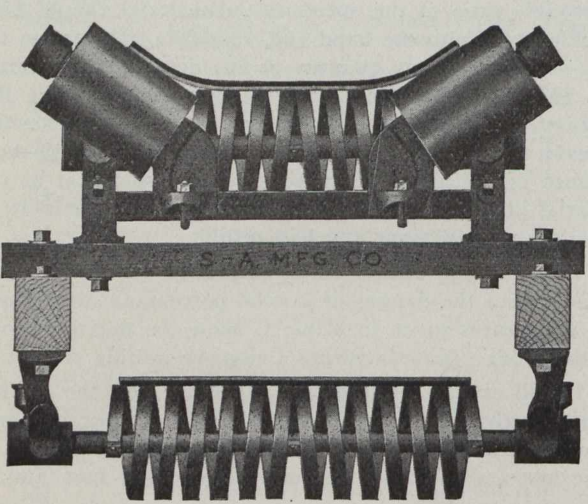


Fig. 13.

troughing rollers has already been mentioned in connection with the band, but should not be confused with the inclination of the whole conveyor with the horizontal. The diameter of the idler rollers is generally from four to six inches, according to the speed of the belt.

Lubrication of these rollers is quite an important item, as the revolutions will vary anything from two to four hundred per minute. A common way to arrange for this is to mount the rollers on a hollow spindle and drill these tubes at right angles at several points along the bearing of the rollers. The ends of the tubes are then closed with grease lubricators of the screw or spring type, which force the grease down the tube and through the holes into the bearings. This leaves the tubes full of grease all the time and practically makes the bearings dust-proof and prevents overheating, as a small percentage rise in temperature will liquefy the grease and cause it to run into the bearings automatically. The length of the bearings or journal of the roller should be of a generous amount to allow for wear, and for most lengths of rollers should be shorter by not more than about 1½ to 2 inches. Thus, for a roller five inches long the bearing should be from three to three and a half inches in length.

Cast iron brackets support the hollow spindles which are secured by means of set screws or other suitable means, and the shape of the bracket will depend somewhat on local conditions and the nature of the stretcher which carries it.

Fig. 12 shows a cross section of the band with the material carried when occupying its natural position in transit This gives a very good idea of how the belt may be loaded.

Fig. 13 shows a patent carrier troughing roller, the middle roller on the top being made in the shape of a helical spring, and a similar roller is utilized for the flat roller on the return side of the belt.

Fig. 14 indicates a usual arrangement of rollers for a flat belt. It will be noticed that these are of very simple construction.

Fig. 15 shows a special troughing roller arranged to get a maximum capacity out of the conveyor and to give a nice easy sweep to the belt.

The roller sets shown in the last four figures are manufactured by the Stephens-Adamson Manufacturing Company, and the writer is indebted to both this firm and the Dodge Manufacturing Company for the loan of the litho blocks given in this article.

It should be noticed that the roller sets shown in the last four figures are mostly made in sections, that is, they are not carried on one set of spindles in a single set of bearings. This enables the troughing rollers to be adjusted eas'ly.

They are quite an important item of the installation, and on them depend to a large extent the proper transportation of the material and the life of the belt.

First and foremost, care should be taken to avoid any direct contact of the shoot with the band itself, as the constant rubbing on this would soon destroy the best fabric. At least one inch clear should be arranged at the loading end and for the delivery end a similar amount, if possible. To properly load the belt the shape of the shoot at the loading point should conform as nearly as possible to the direction of flow of the material at the instant it hits the band. If this is done easy loading and little spilling will be the result.

It will be found a good plan to provide ears on the sides of the shoot projecting along the path of the belt for about eighteen inches to two feet. These will have a tendency to keep the material in the centre of the belt until it has had a chance to settle down into its new direction.

Don't, on any account, try to feed the material on to the band at right angles to the latter, but arrange in such cases for the end of the shoot next the band to be curved round so as to get the flow in the same direction as the belt travels as nearly as possible.

Throw-off Carriages.—These are made in many ways and may be either of the fixed design, hand-gear propelled, or automatic power driven, the power being furnished by the band itself. They are used in cases where more than one point of delivery is required, namely, that at the end of the band. If only one additional point is needed then the stationary type can be used. If, however, it is necessary to deliver into several different hoppers in the line, then the traveling type becomes necessary, and if movement is only necessary at long intervals, the hand-geared traveling type will be found suitable.

Where, however, a small quantity has to be delivered at a number of different points in succession or a continuously moving carriage is necessary, then it will be found more advantageous to use the power driven carriage.

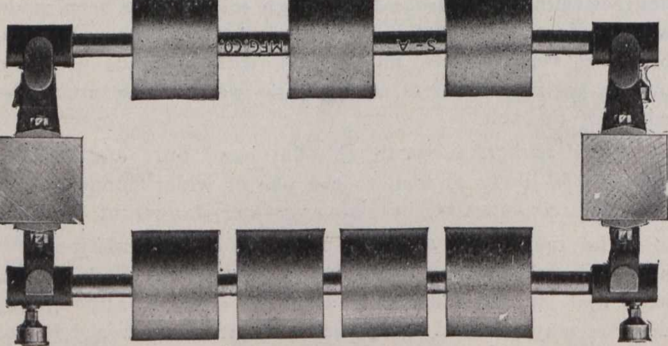


Fig. 14.

It will be an easy matter to settle which of these various types will prove the best for a given set of circumstances. These carriages consist of two pulleys, the shafts of which are mounted on a hinged frame and placed in such a position so that it is possible to throw the pulleys clear of the band when they are not required. One pulley is arranged under the band and the other over. When it is required to use the carriage the hinged arm is revolved, the pulley on the top depressing the band and the one underneath raising it, thus making this portion of the band into the form of an ordinary meat hook shape or letter S.

On the carriage is mounted a shoot either of the single, breeches or three-way type, according to where it is required to deliver the material. If it is a breeches shoot, then the two legs straddle the band, the ends of the shoot being deflected enough to allow the band running away from the bottom of the S shape to pass between.

Sometimes the arms carrying the pulleys are not hinged but fixed in the delivery position all the time. In fact, it is possible to make a large number of arrangements to fit any particular circumstance. The traveling carriages are mounted on tee or bulb rails with ordinary flanged wheels to keep them on the track. Fig. 14 shows a tripper or throw-off carriage made by the Dodge Manufacturing Company, and Fig. 15 one by the Stephens-Adamson Manufacturing Company. The latter is of the reversible type.

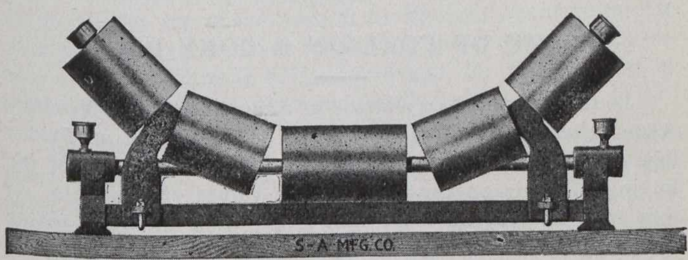


Fig. 15.

Distributors.—Sometimes it is necessary, owing to local conditions, to construct a hopper at the delivery end of the belt of square section, and if the dimensions are fairly large it is then sometimes a problem to utilize the full capacity of the hopper. There are various ways of doing this. For instance, the conveyor can be arranged at a suitable height above the top of the hopper, so that the natural slope of the material will fill it. Or, the conveyor may be run right across the hopper in one direction with points of delivery arranged all along by means of a throw-off carriage.

Or, again, another conveyor at right angles may be put in to divide the hopper into four equal parts.

Another ingenious contrivance consists of a revolving plate on the centre of which the material is fed from the conveyor. The plate is arranged horizontally and due to the action of centrifugal force throws the material outwards as it spins. The speed at which these plates should be run can be found by practical experiment for a particular material. It will readily be seen, however, that they will be of little use for large lumps of material, and for very fine a great deal of dust will be created. The use of these special appliances, however, is determined more by local conditions than anything else.

Expansion has marked the operations of the British Columbia Electric Railway Company during the past few years, the latest move being the purchase of additional land in New Westminster at a cost of $123,000 for car shop purposes. The company has found it very difficult to get delivery of cars from the manufacturers in the east, and it is proposed to manufacture cars here on a larger scale. With the big system it now has in hand, a very large number of new cars are constantly needed, for extensions are being steadily made and increasing traffic requires quicker schedules on the older established lines, necessitating more cars.

THE HEATING OF BUILDINGS.

A paper entitled "Observations on the Conditions of Guarantees," presented by Mr. A. H. Barker at the summer meeting of the Institution of Heating and Ventilating Engineers held at Southport, dealt with the methods at present in vogue for calculating heat losses from buildings, especially in their relation to the corresponding methods in current use for guaranteeing results.

Calculation of Heat Losses.—The method of determining heat losses now adopted consisted of calculating the amount of heat supposed to pass by conduction through walls, windows, doors, ceilings, etc., adding to this calculated loss another quantity supposed to represent the heat carried away by interchange of air, and estimating the radiating surface from the total number of B.Th.U. so found. The fundamental conditions assumed for the calculation were that the heat delivered to the interior of the room had been continued for so long a time that a constant rate of transmission had been established; in other words, that the amount of heat given by the radiator to the inner air in any one hour was not only equal to that given by the air to the inner surface of the wall, and in succession communicated by conduction from the inner to the outer surface of the wall, and from the outer surface of the wall to the outer air, but also that this flow of heat was constant as between any one hour and the next or any succeeding hour. It was also assumed that there should be no change in the conditions so long as the experiment lasted—that the outside temperature should be absolutely constant and that there should be no wind and no rain. But in practice the conditions did vary, and from this fact alone it followed directly that calculations for rate of heat loss from a room were purely imaginary, that such calculations did not, and indeed that no practicable calculations could, in fact, determine what the rate of transmission of heat actually was at any one time in any circumstances such as ever arose in practice. At the best such calculations only gave what would be the mean transmission in certain imaginary conditions. A still greater difficulty was the effect on the temperature at any one time of the heat capacity of the walls of a building. The amount of heat retained by walls of quite a moderate thickness enclosing a room of moderate dimensions was so considerable that even assuming the whole of the heat given off by a radiator in the middle of the room did not escape but was wholly absorbed in warming up the walls to a temperature half-way between the inside temperature and the outside temperature, it would commonly take several days at full power merely to warm up the walls. Then it was necessary to inquire what was the effect on the temperature of the wall when the outside temperature varied up and down within wide limits as it always did in practice. Obviously the flow of heat into and out of the wall from the inside as well as from the outside would be so irregular that no conceivable process of calculation could determine beforehand what the result would be at any particular time, for the data could not possibly be known in advance. If the exact value of the external and internal temperature throughout a long period of time could be known with some accuracy, the mathematician could probably make the calculation if he had a week to spare to do it in, but in no other circumstances would it be possible, and no person but an expert mathematician could make the calculation at all. Further, the output of heat from the radiator or other warming apparatus in the room was not constant but irregularly intermittent, the furnace was allowed to go down two or three hours during the day, and almost always during the night it was banked up so that it gave off very little heat. This additional factor added enormously to the complication of the problem.

The Question of Guarantees.—The main object of the author was to show how entirely absurd from a practical or scientific point of view were the guarantees which an engineer was accustomed to give to a client or an architect in regard to the efficiency of his apparatus, and how wholly such guarantees were dissociated from the facts and conditions on which the engineer based his calculations. The standard guarantee stated that the apparatus would maintain the room at a temperature of 60 deg. when it was 30 deg. outside. If the engineer was very scientific he added that the rate of interchange of air should not be more than perhaps twice per hour, and sometimes as an additional precaution he claimed that the outside air should be still. The real meaning of the guarantee, strictly construed in accordance with the facts of science, was that if the outside temperature remained constant, the air dry and still, for a sufficient time, say a fortnight, and if the apparatus was maintained at full power day and night all the time, the internal temperature would gradually approximate to a point at least 30 deg. above the outside temperature, whatever that temperature might be. On the other hand, the client expected the guarantee to mean that if at any time within a few hours of starting the apparatus he fixed two thermometers, one inside and the other outside the rooms heated, the latter would read 30 deg. higher than the former, irrespective of conditions. Suppose the outside temperature had for a fortnight been 50 deg., and on the day of the test suddenly dropped to 30 deg., the difference in the temperature of the same room on the two occasions might be 30 deg. if the same apparatus had been continually at work all the time at the same power in each case and although the external temperature at the time of the observations was the same in each case. The difference in the result would be entirely due to the amount of heat retained in the walls of the buildings. Yet of this all-important factor the orthodox calculations and the orthodox guarantee and the orthodox test (if there was such a thing) took no account whatever.

The author's own opinion was that the only satisfactory solution of the problem was that the engineer should guarantee only that he would furnish a scheduled number of B.Th.U. to each room, and that the test should consist of a careful measurement of the temperatures in the flow and return pipes, the surface of the radiator, and the difference between the temperature of the room and of the radiator at the time. The B.Th.U. emitted in such conditions should be calculated from standard co-efficients. When the scheduled numbers of B.Th.U. had been delivered to each room according to this calculation, then and not till then, the engineer should be entitled to be paid, irrespective of the weather conditions at the time, and irrespective of the temperature in the room, which was measured only to determine the number of B.Th.U. given off from the radiator. This guarantee could then be safely combined with a guarantee of fuel consumption, and such a guarantee would be strictly a guarantee only of the efficiency of the engineer's own apparatus and not of the quality of the customer's building. This method emphasized the distinction between the two entirely separate parts of the problem. The one was the supply of a certain number of B.Th.U. to each part of the building, at, if desired, a guaranteed maximum fuel consumption. This was strictly the work of the heating engineer, and he would have no reasonable ground of complaint when held strictly to this guarantee. The other part was the question whether that number of B.Th.U. would maintain the desired temperature. This question depended solely on the quality of the building. It was entirely the client's own responsibility and had nothing whatever to do with the heating engineer as such.

One obvious objection to these proposals was that the client cared nothing about B.Th.U; he only wanted his house warmed to a certain temperature. A client might as well say that he did not mind how much food he paid for; he only wanted his children properly fed. This argument would be all very well if the cost both of apparatus and upkeep was a matter of insignificance, and the heating engineer might very well be held responsible altogether if he were an insurance company who would make an expert examination of the premises with the insurance in view and charge a premium for the insurance. But the trouble was that the lack of understanding of this problem was so complete that at present the engineer took the risk without getting the premium, and very often it was to be feared did not even know that he was taking the risk.

VALUE OF COAL ON A COKE BASIS.

In the course of an address at a meeting of the Waverley Association of Gas Managers, held at Edinburgh on Friday last, Mr. J. W. Napier, of Alloa, raised the question of the buying of coals on the basis of the values of residuals. It was well known, he said, that coals from different seams varied in the percentage amount of what might be termed natural water. If they took the average amount of water present in coals at 5 per cent., this was equal to 13.44 gallons, or 134.4 lbs. of water per ton of coal. A coal with 12 per cent. of water would contain 269 lbs. of water per ton and, compared with the standard of 134 lbs., would show an excess of 135 lbs of water. At 12s. per ton purchase price, the plus quantity of water cost fully 8d. per ton, and this extra charge for mere water was appreciable.

Coke was justly looked upon as the most valuable of all the residuals. With a selling value of 10s. per ton for coke, a difference in yield of 1 to 2 cwts. of saleable coke between different coals made an appreciable difference in the revenue account. The amount of coke produced from coal could easily be determined, even in the smallest works. It required only a weighed quantity of coal to be carbonized in the retort and the coke produced weighed.

In the analysis of a number of coals that had passed under his examination from time to time, in ascertaining the coke produced per ton of coal, he had been struck with the difference between what he might call the "analysis" value and the "saleable" value of the coke produced, and more particularly from nuts and so-called coking dross. For example, one material which gave a yield of 13.1 cwts. of coke, which on analysis showed carbon 96.65 per cent. and ash only 3.35 per cent., would be taken as of excellent value. On putting the material through a trial test in the retort and examining the coke produced, the following results were obtained:—

Saleable coke per ton of coke produced..........	12¾ cwts.
Breeze " " "	7¼ cwts.

Percentage of breeze = 36.

This was an extreme case, but the example was valuable as showing the need for ascertaining the absolute market value of the coke. Another example was the following:—Coke per ton of coal, 12.5 cwts.; carbon in coke, 88.71 per cent.; ash, 11.29 per cent. On further examination, to ascertain the saleable amount of coke, the following was the result:—

Saleable coke per ton of coke made..............	16.33 cwts.
Breeze " " "	3.68 cwts.

Percentage of breeze = 18.4.

The third example was as follows:—Coke per ton of coal, 12.7 cwts.; carbon in coke, 91.4 per cent.; ash, 8.6 per cent. Examination for value of saleable coke resulted as follows:—

Saleable coke per ton of coke made.............	19 cwts.
Breeze " " "	1 cwt.

Percentage of breeze = 5.

The breeze was determined by the amount passing through a ¾-inch mesh riddle.

Again, it would be observed that though gas-making material yielded a satisfactory weight of coke, on submitting the coke to a critical examination, a very serious loss to the purchaser would result. With coke selling at 12s. per ton, the breeze at 2s., or a difference in value of 10s., each hundredweight of breeze produced was equivalent to a loss of 6d. per ton of coke, one coke compared with another. It could easily be seen, therefore, how a difference in value of 1s. to 2s. per ton of coal might be brought about from this source alone. He had not referred to the presence of an excess amount of breeze being unsuitable for the working of producers, but this would undoubtedly be the case.

In carrying out the tests referred to the physical character of the coke was noted as of importance, some of the cokes produced being soft and easily broken. Incidental to the amount of breeze produced in gasworks where coke-handling appliances were at work, the physical character of the coke was all-important, as upon this depended the amount of breeze produced, and he had endeavored to show that great loss might accrue from this direction, to which, he ventured to think, sufficient attention had not been devoted. The amount of saleable coke per ton of coal was of vital importance at the present time, not only because of the higher price to be paid for coal, but also on account of the fact that coke might be expected to yield an extra value of about 3s. per ton.

Before departing from the subject of coke, it might be of interest to compare coke made in vertical retorts with what was known as "malting" coke, which realized a high price. The vertical retort coke was produced from the coal ordinarily used at the Alloa Gasworks, and was a sample from a trial test in the experimental vertical setting at Temple Gasworks, Glasgow.

	Vertical retort coke. Per cent.	Malting coke. Per cent.
Carbon	89.20	91.25
Volatile matter	1.05	0.80
Water	0.35	0.15
Ash	9.40	7.80
	100.00	100.00

The sample of malting coke was made from the well-known Bannockburn coal. Malting coke was at present selling at fully 20s. per ton, and vertical retort coke of almost the same quality—as the above analyses showed—should command a high price. This advantage of vertical retort carbonization was best seen by a comparison of the prices of coke produced by that system and coke made in horizontal retorts, selling at only 12s. per ton. He ventured to say that the vertical retort would enhance very much the value of coke, at least in the particular market referred to.

Tar was realizing a high price at present, having increased from 11s. to 17s. per 100 gallons during the last twelve months. The latter price was equal to 2d. per gallon, and the difference in value between coals of high and low yield of tar could at once be appraised.

SELECTION OF ELECTRIC LOCOMOTIVE FOR INTERURBAN FREIGHT HAULING.

In selecting a locomotive and its equipment for interurban freight service, the characteristics of the track, curvature, grades, and the rail weight, strength of bridges, etc., must be considered. The following information is abstracted from a bulletin published by the Railway Department of the Westinghouse Electric and Manufacturing Company. The maximum current which the locomotive can safely take from

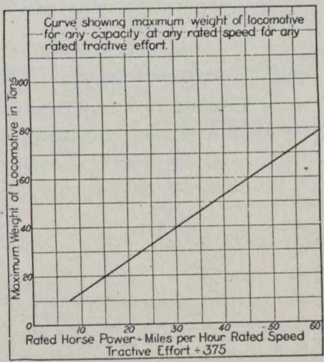


Fig. 1.

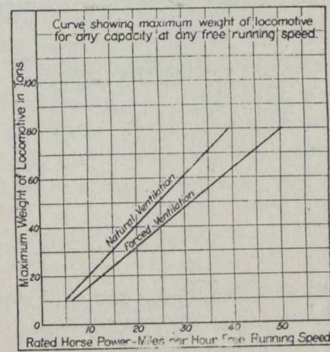


Fig. 2.

the substations should be known. It is also advisable to know the probable tonnage to be handled daily in each direction, and at what points it will originate and be delivered. From this information the locomotive can be selected.

The examples given in paragraphs that follow indicate an approximate method of procedure. The curves of Figs. 1 to 7 are used. These give, approximately, maximum locomotive weights and minimum capacities. Results for any specific case may be materially altered by local conditions. In using the curves it should be observed that the gear ratio must be so chosen that the desired speeds will result. In general, the lowest speed gear that an equipment will take is found most suitable for locomotives.

Case I.—Practically Level Road. Horsepower of Motors and Speed in Miles per Hour Known. Find Weight of Locomotive and Trailing Load. Assume that a spare equipment of four 60-horse-power motors is available for locomotive service and that the speed of the equipment at its rated horse-power and voltage is 11 miles per hour. What is the maximum weight of locomotive suitable for this equipment? The rating of the locomotive is 240 horse-power. The rated

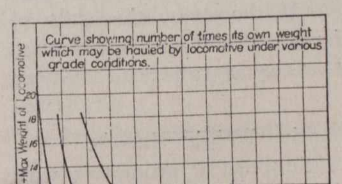


Fig. 3.

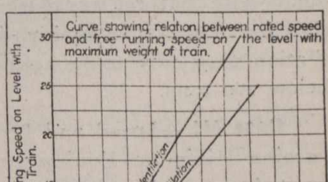


Fig. 4.

horse-power divided by the rated speed is 240 ÷ 11 = 21.8. From Fig. 1 it is evident that when the horse-power divided by rated m.p.h. is 21.8, the maximum weight of locomotive is 28.5 tons.

The next question is, what load can this locomotive haul? To answer this definitely requires an exact knowledge of the profile of the road. Suppose that the road is practically level except for some over-crossings where there are grades of 2 per cent. for 1,500 to 2,000 feet. The curve for short grades on Fig. 3 is used. At 2 per cent. this curve shows that the locomotive can haul 9.6 times its own weight or the maximum trailing load is about 9.6 x 28.5 which equals 273 tons. The average loaded freight car in many sections is of from 35 to 40 tons gross weight, so it appears that this locomotive can haul seven or eight average loaded cars.

The above determination of tonnage should be checked against the load which the locomotive can handle continuously under average conditions. The assumption was made

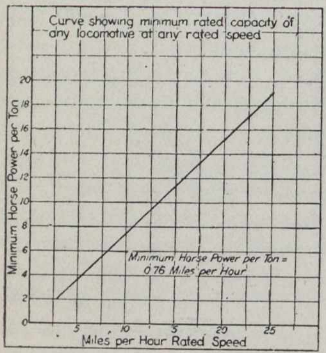


Fig. 5.

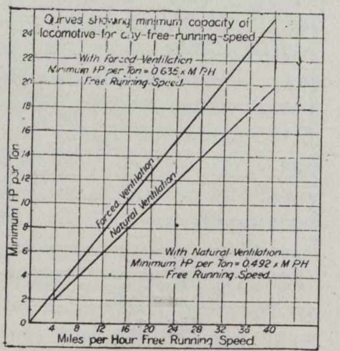


Fig. 6.

that the road was practically level. Assume further that the motors are naturally ventilated (no blowers used). The curve on Fig. 3 for continuous natural ventilation shows that at 0 per cent. grade (level) the locomotive will haul 11 times its own weight or 313 tons. Hence, in this case the short 2 per cent. grade is the feature limiting the tonnage. To find the speed running free on the level with the maximum tonnage use Fig. 4. This shows 17 m.p.h.

Case II.—Rolling Profile. Horse-power of Motors and Speed in Miles per Hour Known. Find Weight of Locomotive and Maximum Trailing Load. Suppose the road is not practically level, but is in a rolling country and that in addition to the short 2 per cent. grades, there are a number of grades of 1.25 per cent., each being from 2 to 2.5 miles in length. Fig. 3 shows that the maximum trailing load on long grades of 1.25 per cent. is 7.7 times the locomotive weight, or 220 tons. If, under these conditions, the two ends of the road have nearly the same elevation, the equipment will probably haul the load of 220 tons continuously with natural ventilation. If, however, the ends of the line have considerably different elevations, forced ventilation may have to be applied or the average load reduced below 220 tons.

Case III.—Speed and Locomotive Weight Known. Determine Minimum Equipment. Suppose a locomotive with a rated speed of 14 m.p.h., is desired and that the construction of the roadway limits the weight of 47 tons. What is the minimum equipment for such a locomotive? Fig. 5 shows that at 14 m.p.h. the minimum rated horse-power per ton is 10.6. Hence, the rating of this 47-ton locomotive should not be less than 500 horse-power and the equipment not less than four 125-horse-power motors. The performance of this equipment under the conditions pertaining to the road in question may be determined as previously described. If it is not sufficiently large more powerful motors may be applied up to the point where the dimensions and weight of the equipment would require a locomotive having a minimum weight of 47 tons.

Case IV.—Profile and Trailing Load Known. Find Weight of Locomotive. Assume long and short grades as in Case II. What weight of locomotive will be required to handle 500 tons trailing load? Further, assume that the nature of the road is such as to be equivalent to a continuous pull up a 0.3 per cent. grade. What is the minimum equipment for a locomotive if forced ventilation is used and the free running speed on the level is 12 m.p.h.?

The short grade curve in Fig. 3 shows that a locomotive will handle 9.6 times its weight on the maximum grade. The continuous forced ventilation curve of Fig. 3 shows that on a 0.3 per cent. grade, the locomotive will haul 10.7 times its own weight. Hence, the short 2 per cent. grade fixes the locomotive weight and this should not be less than 500 ÷ 9.6 = 52 tons. Fig. 5 shows at 12 m.p.h. with forced ventilation, the minimum equipment should have 7.6 horse-power per ton. Hence, the locomotive should rate (7.6 x 52) 395 horse-power. The equipment should be four 100-horse-power motors, geared for 10 m.p.h. rated speed and provided with forced ventilation.

The current demand for a freight train depends primarily upon the speed, train weight and grades, and secondly upon the alignment, average weight of car, frequency and duration of stops, etc. The size of locomotive, speed and train weight should be adjusted to the capacity of substations and line in so far as the demands of the traffic will permit. The curves on Fig. 7 will be found useful in selecting the maximum weight of train to be handled within any fixed current limit.

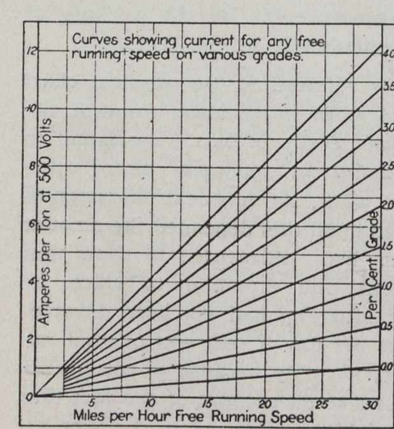


Fig. 7.

Example.—Suppose the maximum grade on a road is 3 per cent. for 1.5 miles and it is so located that all the power for climbing it must be taken from a 500-ampere substation. A speed of 8 m.p.h. is desired on this grade. For such a grade, the substation may work at 50 per cent. overload; i.e., deliver 750 amperes. Fig. 7 shows that at 8 m.p.h. on a 3 per cent. grade 2.5 amperes per ton are required. Hence, the maximum weight of train at this speed is 750 ÷ 2.5 = 300 tons, including the locomotive weight. If 6 m.p.h. were sufficient speed, 415-ton trains could be operated. If 12 m.p.h. were desired, the train weight would be limited to 200 tons. So the effect of speed on power demand is apparent. For any specific proposition, therefore, the choice lies between speed and tonnage in a single train.

NEW SHAPE OF RAILROAD RAILS TO PREVENT BREAKING.

Engineers of the Harriman lines in the United States have found that the base of a regular 90-pound rail tends to become bowl-shaped in cold weather, and the pounding of the wheels causes surface fractures. By broadening the base of the rail and making it heavier, the breaks are reduced to a minimum. Mr. Kruttschnitt is reported as saying: "We find that the rail with the heavier base gave only two breakages to the 100 miles in the winter months (as compared with 23 breakages in the regular rail), the same rate as during the summer months, so that, so far as the Harriman lines are concerned, the rail problem is solved. We feel that we have solved the problem for all the roads."

OZONE: ITS PROPERTIES AND COMMERCIAL PRODUCTION.*

By Milton W. Franklin.

The importance of ozone as an industrial factor in certain lines of engineering is becoming appreciated quite rapidly. The relatively large number of patents which are being applied for the increasing number of advertisements which are appearing and the character and standing of the electrical manufacturers who have entered the field, all point to a realization of Berthelot's prediction that ozone was destined to enjoy a great vogue in its application in the arts and sciences. The commercial future of ozone may be regarded as assured. The many actual applications which have already been made and the numberless fields for its logical invasion, together with recent developments of perfected ozone generators all indicate the growing consideration which this reagent is gaining for itself.

Ozone has been known since 1785, when Van Marum noted the peculiar smell which resulted whenever a static electrical machine was operated, and while its identity was fully established by Schoenbein in 1845 and a method for its analytical determination was developed by the same investigator, it has not enjoyed any extensive application, excepting on an experimental scale, until approximately within the last ten years. This delayed recognition may be attributed to the lack, at the time, or perfected ozone generating apparatus and to the absence of commercial electricity.

The primitive ozone apparatus was designed to produce a phenomenon, the discharge of electricity through air, which, it had been noticed, was ordinarily accomplished by the production of ozone.

It was seen early that the amount of ozone produced in the naked arc, either high or low tension, was relatively small as compared with that due to the brush or "silent" discharge, and the constructional and manipulative difficulties accompanying the production of and operation of static condensers are probably responsible for the introduction of a solid dielectric interpolated between the statically charged plates if the modern ozone generator.

There does not appear to have been any very erudite opinion on the modus operandi of ozone generation among the early designers and the prevalence of the type in question, viz., that with smooth electrodes and solid dielectrics, seems to be due to a desire to produce an electric field of considerable extent, in which the discharge should be uniformly distributed.

It has also been apparent for some time that, at certain elevated intensities, the appearance of noxious nitrogen oxides became manifest, and the objectionable circumstances was ameliorated by lessening the potential difference and increasing the interpolar spacing of the electrodes.

The scientific design of ozone generators as distinguished from the purely empirical method is of very recent inception and its beginning, naturally, is somewhat obscure. There have appeared creditable machines for the purpose, in advance of any theoretical information as to the principal involved.

Production of Ozone: Ozone Generators.—Ozone may be produced by chemical means, by the electrolysis of water and by the action of the electrostatic field on air or on oxygen.

Slow oxydations, as of phosphorous, produce ozone. The process is a curious one and has been studied by Schoenbein, who noticed that when certain substances are oxidized by air a portion of the oxygen combines directly with the substance undergoing oxidation, while another portion of the oxygen forms ozone. Thus ozone is formed during the oxidation of numerous substances. Schoenbein also enunciated the law that precisely the same amount of oxygen is converted into ozone as combines with the substance oxidized. This law has been verified by several other observers for phosphorous, aldehyde, triethylphosphine, turpentine, amylene and numerous other organic substances, and for sodium sulphite, ammoniacal cuprous oxide, etc., in the process of auto-oxidation.

About the only practical application, however, of the chemical production of ozone, has been by means of fluorine. Moisson has obtained fluorine by the electrolysis of anhydrous hydrofluoric acid. Fluorine attacks powerfully all organic materials and decomposes water, combining with its hydrogen to form hydrofluoric acid and at low temperatures, the oxygen forms ozone. The reaction is as follows:

$$3\ H_2O + 6\ Fl = 6HFl + O_3$$

In the preparation of ozone by the decomposition of water by fluorine, the fluorine is introduced in a thin stream into the water which is maintained at a temperature of 0°C.

Recent improvements in fluorine generators have made the method practicable but it does not compare in economy with the electrical methods of ozone production.

The Electrolytic Production of Ozone.—Ozone is formed along with the oxygen in water electrolysis. The presence of ozone accounts for the low reading for oxygen obtained when the electrolyte is too strong in sulphuric acid and the current density too high.

The first recorded observation of ozone in water electrolysis was by Schoenbein in 1840. More recently ozone has been obtained by alternating current electrolysis of acidulated water.

In some of the electrolytic processes at Niagara Falls the presence of ozone has been strongly manifest, though there is no recorded mention of its having been used for any industrial purpose.

In the production of ozone by electrolysis, the anode must be of some substance not oxidizable, such as platinum, gold, etc., and the electrolyte must contain no matter which is capable of combining with the ozone.

In certain special applications, ozone prepared by electrolysis seems to be more active and suitable than that prepared by the commoner electrical methods, but the reasons are obscure and the cases uncertain. The method is not economical and has found no general application though higher concentrations are obtainable than by other ordinary procedures.

Electrostatic Production of Ozone.—The common method of ozone production for industrial purposes is by the action of the electrostatic field on air or oxygen.

The types of machines that have been devised are almost without number, ranging from those utilizing the high frequency discharges of the Oudin and Tesla resonators to those making use of the "effluve" or the silent discharge of a leaky condenser with or without solid dielectrics. The variations and the combinations of the fundamental types are too numerous to mention, even, and only a few or the more useful and striking examples will be described.

The ultimate theory of the electrical formation of ozone is still somewhat obscure and it may be said that whatever definite information there is on the subject is rather of a negative than a positive character: e.g., Warburg and Leithauser have shown that the process is not an electrolytic one. The equivalent weight of ozone is 24, and, therefore, if the process were an electrolytic one it would require the

* A paper presented at the Schnectady meeting of the American Institute of Electrical Engineers, Schnectady, N.Y., May 17th, 1912.

electrochemical equivalent, 96,540 coulombs, for the production of one mole, 24 gm., of ozone. In actual practice, however, as much as 130 gm. per kw. hr. has been obtained, which, under the conditions of the operation, corresponds with 240 coulombs only, or the equivalent of ozone has been obtained with about 44 coulombs. This number is far too different from the electrochemical equivalent to be a matter of experimental variation.

The view is generally held that the process is one of ionization and recombination. There appears a disassociation of the oxygen as soon as the action of the electrostatic field becomes sufficiently intense to cause ionization by collision, and there result numbers of ions from the disassociated molecules. These ions attach themselves to the molecules with which they must inevitably collide and thus form ozone which, on this view, may be composed of aggregates of odd numbers of atoms of the general formula, $O_{(2n + 1)}$.

The relation between the quantity of ozone produced and the quantity of current has been the subject of considerable speculation, but no perfectly satisfactory hypothesis has been advanced. Warburg has advanced the theory that the ozone is formed by those electrons which have attained a certain critical velocity, viz., that at which luminosity appears.

Ozone is an endothermic compound and, therefore, the equilibrium concentration is greatly increased under certain circumstances, as for example, the influence of the electrostatic field, especially if the temperature is kept low so as to lessen the destructive forces as compared with the constructive forces.

The silent discharge or "effluve" of the French writers, is the conduction of electricity through gases at low and moderate pressure. The phenomena vary with the electrical and physical dimensions, and with the conditions generally, of the electrical and gas pressure. The discharge is quiet and the gas attains a dark violet luminosity. If the pressure is comparatively low the discharge between a point and a plate will be of this nature but the electrical polarity of the point exerts an influence. The discharge between plane parallel or curved concentric surfaces is generally of this character, and when a dielectric is interposed between the plates, the formation of sparks is effectually prevented.

The question as to whether or not a dielectric should be used has been the cause of considerable experimentation and discussion but the general consensus of opinion at present is that the use of the dielectric increases the efficiency of the ozonator.

Forms of Ozonators.—One of the first ozonators with which experiments on anything like a large scale were carried out was introduced by Berthelot in 1876. This ozonator (Fig. 1) consists essentially of the two concentric glass tubes a b closed at one end and forming between them the free annular space c, which is closed at the top by welding the two tubes together. Air or oxygen is admitted to the annular space by the inlet tube, d, and withdrawn at the outlet tube e. The inner tube b is filled with dilute sulphuric acid, and the outer tube, a, is plunged into a vessel containing the same, thus enabling the temperature of the system to be controlled.

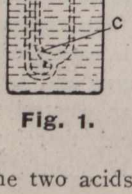


Fig. 1.

The poles are formed by the fluid in the inner tube and that surrounding the outer tube. The electrical connections are made by means of two platinum wires dipping into the two acids respectively and connected to the terminals of the sources of current. When the potential difference is sufficiently high there is a luminous silent discharge in the gas in the annular space between the tubes and there is the formation of ozone.

The general principles of this ozonator have been retained in some of the later commercial types, e.g., the Gerard ozonators.

The Siemens and Halske ozonators (Fig. 2) consist of a central metallic cylinder surrounded by an annular air space in which the electrical discharge takes place and through which the gas to be ozonized is passed. The outer boundary of the air space is a cylinder, concentric with the central core and in turn surrounded by a water jacket which serves to keep the temperature within proper limits. The potential is applied between the central core and the water surrounding the outer wall of the air space, and the latter may be of glass or of metal. In the latter case there is supplied a lining of glass which forms the dielectric. This type of ozonator has had considerable commercial application and is used in the installations at Wiesbaden-Padderborn, St. Petersburg, etc. The whole oxonator is enclosed in a metallic case which is furnished with inlet and outlet tubes for the air and the ozone.

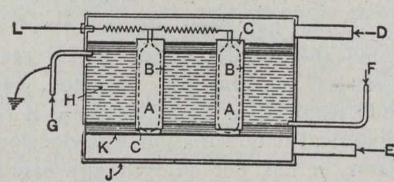


FIG. 2.

A—inner electrode, *B*—outer tube, *C*—ozone space, *D*—air inlet, *E*—air outlet, *F*—water inlet, *G*—water outlet, *H*—water, *J*—outer casing, *K*—partition, *L*—high-tension lead.

The Gerard ozonator has appeared in several commercial forms which differ from each other in minor constructional details. It consists essentially, of two concentric glass tubes about one meter in length, and the outer tube has a diameter of approximately 8 cm. The annular space between the tubes in which electrical phenomena take place varies from three to five mm. in the various modifications. The electrodes are metallic coatings affixed to the outer surface of the outer tube and to the inner surface of the inner tube respectively.

An example of an ozonator without dielectrics is that of De Frise, (Fig. 3). This consists of a trough, semicylindrical in cross section and furnished with a water jacket for cooling. A glass cover closes the trough and from this are suspended a number of semicircular metallic disks which may have smooth or serrated edges. These disks are arranged in parallel planes and are spaced at about one cm. The flat edges are fastened to the glass cover and the curved edges together form a ribbed semicylindrical surface, which, when in position, comes to within five mm. of the bottom of the trough, with which it is concentric. The electrical discharge takes place between the edges of these disks and the bottom of the trough, and the air to be ozonized is drawn through the space which intervenes.

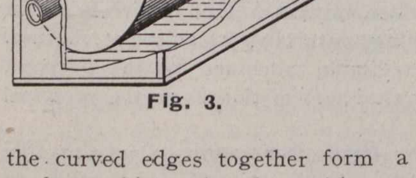


Fig. 3.

There have appeared from time to time, ozonators with devices for obviating the necessity for the solid dielectric. Otto has designed several in which the electrodes move with respect to each other, or in which one moves and the other remains stationary. Fig. 4 is a diagram of one of these. It consists of a metallic casing which forms one of the electrodes, and a series of metallic disks mounted parallel on a shaft by which they are rotated. The disks each have two sectoral windows, diametrically opposite each other, cut from them, and when assembled, form the other electrode. The disks are beveled at the edges, and the windows are staggered with respect to the disks which are adjacent. This arrangement assures that if a spark forms at any point, it will be drawn out and ruptured by the rotation of the disks.

Ozonators without solid dielectrics and with rotating electrodes have as yet enjoyed no very extensive application. The absence of the dielectric seems to favor the production of nitrous oxides notwithstanding the precautions to the contrary, and the extra power required to rotate the electrodes does not seem to be compensated for by any corresponding gain in another direction.

Besides the ozonators which have been mentioned there have appeared numerous others, as those of Andreoli, Tisley, D'Arsonval, Tindal, Otto, Vosmaer, etc., but all of the successful commercial types have tended to the same general design, namely, metallic electrodes with smooth surfaces and interpolated solid dielectrics.

All the ozonators which have been mentioned above are for the production of ozone on a large scale and at relatively high concentrations, and are in general intended for the purification of drinking water and for analagous industrial applications. Latterly, however, the subject of purifying and refreshing the air of localities which suffer from overcrowding, inadequate ventilation, and the introduction into the air of the noxious products of industrial activity, has engaged the attention of sanitarians to a considerable extent. From a consideration of the theoretical causes of the objectionable character of such air and the essential properties of ozone it has become evident to many experts that ozone offers a remedy for the conditions, and one which possesses many advantages of simplicity, efficiency and economy. There has resulted, in consequence, the development of numerous ozonators for the specific purpose of treating the air of populated spaces.

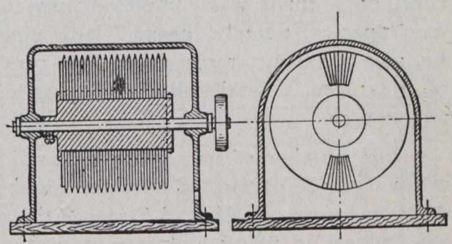


Fig. 4.

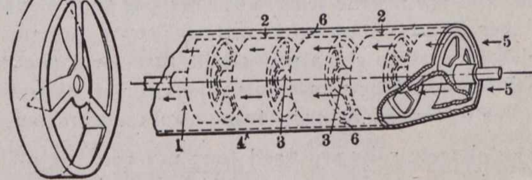


Fig. 5.
1—glass tube; 2—aluminum cylinders, inner electrode; 3—spacing collars; 4—metal coating, outer electrode; 5—direction of air flow; 6—air-gap; 7—enlarged view of 2.

The requirements in these small ozonators differ in several important particulars from those demanded in the larger machines. The instruments are, in general, put into the hands of unskilled persons and they must, therefore, be simple, durable, self-contained and automatic to the greatest obtainable degree. They must be small, fireproof, free from danger and reliable in operation, and all of these properties must be possessed in a measure far surpassing that required in the larger machines intended for operation by skilled electricians. Under no circumstances must they produce nitrogen oxides and this prohibition also precludes the employment of means for removing the objectionable by-products after they have been formed in the machine.

Most of these desiderata such as safety, durability, simplicity, space economy, etc., etc., may be obtained by operating at low voltages. To employ low voltages at the frequencies commonly met with in commercial installations, and at the same time to obtain the electrostatic field intensities requisite for the production of ozone, the length of the field in a direction normal to the electrode surfaces must be shortened. This shortening ordinarily has the disadvantage that it lessens the volume of air that may be treated with respect to a given area of electrostatic field and consequently affects adversely the consideration of space economy. Fig. 5 shows a method by which the field has been shortened to a value limited only by the inability of the glass-blower to produce more accurate tubes, without at the same time curtailing the ozone production capacity of the ozonator. The cut represents one form of unit used in the General Electric air ozonators, an assembled machine being shown in Fig. 6.

Referring to Fig. 5, the potential is applied between the metallic coating of the glass tube, 1, and the metallic inner electrode, 2, which is formed of a series of cups of a special design. The electrostatic field is formed in the space, 7, which has a clearance of the order of 0.4 mm. so that with comparatively low voltages the potential gradient may be extremely high. The air to be ozonized is blown along the axis as shown by the arrows, 5, and the peculiar vane shape of the spokes of the cupped electrodes causes a constant intercommunication between the new air and that which has been ozonized in the ozone spaces.

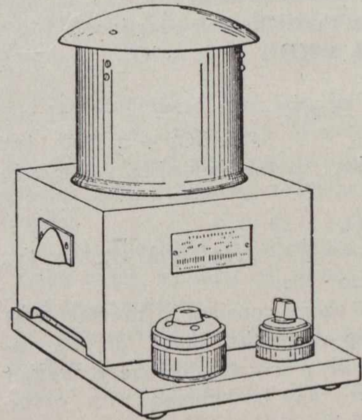


Fig. 6.—Alternating-Current Household Ozonator.

Ozone is an allotropic form of oxygen with the formula O_3, as was established by Schenbein. The nature of ozone was for a long time debated but the researches of Andrews and Tait, Marignac and De la Rive, Brodie, Fremy and Becquerel and particularly those of Schoenbein showed conclusively that when oxygen was converted into ozone, the volume was reduced one-third, and analysis failed to show the appearance of combinations with other elements. Ozone is a faintly bluish gas with a characteristic smell and it was this circumstance that led to its discovery. It has never been obtained in the pure state but it is always mixed with ozygen from which it is derived.

Hautefeuille and Chappuis, on compressing ozone to 125 atmospheres at the temperature of boiling ethylene (— 103 deg.) have obtained a dark blue liquid with highly magnetic properties. The compressed gas above the liquid was also of the same intense blue color, and both the compressed gas and the liquid were highly explosive. When the pressure is removed and the temperature allowed to rise, the liquid soon evaporates.

Ozone is relatively stable at ordinary temperatures when remote from organic or other oxidizable substances, but becomes unstable at elevated temperatures and decomposes into ordinary oxygen. The decomposition is instantaneous at 260 deg.

Ozone possesses enormous chemical activity as compared with ordinary oxygen, for the reason that it parts with the extra atom of oxygen very readily. It is an endothermic compound and the endothermic heat has been investigated by numerous chemists including Berthelot, van der Meulen, Jahn and others. The mean value of the endothermic heat as obtained by numerous methods is 33.380 calories per grammolecule.

Ozone is only slightly soluble in water. Recently, E. Maufang has investigated the subject and found that the solubility of ozone in water is proportional to the temperature and pressure, and conditioned by the chemical composition of the water; a concentration of 1.5 to 10 mg. per liter of water may be regarded as the solubility coefficient at ordinary temperatures (2 deg. — 28 deg.)

The chemical analysis and the volumetric determination of ozone as worked out by Schoenbein in 1845 was the subject of some difference of opinion and discussion, but in 1872, Brodie verified the results and established the theory. Later, 1901, the discussion having again arisen, Ladenburg and Quasig covered the same ground with the same result, though they appear to have been unacquainted with the work of Brodie. Treadwell and Anneler, in 1905, checked all previous results and finally established the correctness of the method of analysis which is now in general use.

The analysis depends on the following reactions:

$$2\,KI + O_3 + H_2O = 2\,KOH + I_2 + O_2 \qquad (1)$$

and

$$2\,Na_2S_2O_3 + I_2 + 2\,KOH + H_2SO_4 = Na_2S_4O_6 + 2\,NaI + K_2SO_4 + 2\,H_2O \qquad (2)$$

which in actual practice reduce to the following volumetric equation:

$$1000\text{ cc.} \frac{N}{10} Na_2S_2O_3 = \frac{O_3}{20} = \frac{48}{20} = 2.4\text{ gm. } O_3. \qquad (3)$$

The commercial value of ozone consists in the fact that it is so powerful an oxidizing agent that many of the reactions of oxidation which take place with ordinary oxygen only on the addition of heat, may be effected with ozone without previous heating, and in a much shorter time.

The many applications of ozone have been adequately treated in previous publications and aside from the purification of air and water they are of general interest to the chemist rather than to the engineer, and will not be dilated on here.

The fact that there was transacted about seven million dollars' worth of business in ozone apparatus in Europe last year indicates the trend of modern thought with respect to ozone.

CROSS-TIES USED BY RAILWAYS

There were 9,213,962 cross-ties, costing $3,535,628 purchased in 1910 by the steam and electric roads of Canada. This represents a decrease of 4,964,279, or 35 per cent. from the number purchased in 1909, due to the decreased purchase of ties for new steam railway lines.

This decrease was general throughout the important species except with Douglas fir. The average cost of these ties at the point of purchase was 38 cents, being an increase of one cent over the cost in 1909.

The data upon which the report, compiled by Mr. H. R. Macmillan, of the Department of Forestry, is based, were furnished by the steam and electric railways of Canada. The value given for the ties was the cost at the point of purchase.

Three kinds of wood supplied 77 per cent. of all the ties purchased. These were cedar, jackpine and hemlock. Though not as many cedar ties were purchased in 1909 as in 1910 cedar is still the chief species used in Canada. In 1910, it furnished 40 per cent. of the ties purchased by Canadian roads, as against 29.8 per cent. in 1909. Nearly all the cedar used is eastern cedar (Thuja occidentalis), as western cedar (Thuja plicata) is too soft for satisfactory use as cross-ties, except for electric lines where the traffic is light.

Jack pine is the second in importance in cross-tie production. In 1910 it supplied 23.5 per cent. of the ties used in Canada, which was practically the same percentage as used in 1909.

Hemlock, supplying 13.8 per cent. of the total consumption, occupied third position in 1910. Hemlock has now for the first time passed tamarack as a tie-producer. The advance of hemlock from the fourth position, which it previously held, is due not to an increase in the use of hemlock, but to a decrease in the use of tamarack. Douglas fir formed 9.6 per cent. of the ties purchased in 1910 as against 4.6 per cent. in 1909. About 232,000 more Douglas fir ties were purchased in 1910 than in 1909. This species was used to a greater extent by both steam and electric railways. Tamarack ties have dropped from third place in 1909, when they formed 19.8 per cent. of the total, to fifth place in 1910, when they formed only 7.1 per cent. In 1910 only 663,922 tamarack ties were purchased, compared with 2,811,820 purchased in 1909. This great decrease of 2,147,898 ties is found entirely in the number used by steam roads, and is due to the fact that the purchase of ties for the eastern half of one of the new transcontinental roads was completed previous to 1910. The above five species, namely, cedar, jack pine, hemlock, Douglas fir, and tamarack, represent 94 per cent. of the total number of ties used. Nearly all the remainder is made up of oak and spruce.

The number of oak ties purchased in 1910 was 264,647, or an increase of 230,258 over the number purchased in 1909. This is due to one United States Railway, operating in Canada, which is using a great proportion of durable woods. Aside from this road the railways of Canada use oak ties chiefly for switch ties. The use of spruce, one of the cheapest ties, has fallen off greatly, 657,871 ties less being purchased in 1910 than in 1909. The decrease in the purchase of spruce is due to the same reason as that ascribed to tamarack.

The remaining species, cypress, chestnut, and white pine, are used to a small extent for ties. All the cypress and chestnut ties and practically all the oak were imported from the United States. Red pine and yellow pine, which were used in 1909, were not reported in 1910. The average price of ties in 1910 was 38 cents as compared with 37 cents in 1909. Of the important woods oak cost the most, 74 cents per tie, and spruce the least, 28 cents per tie. Cedar cost 41 cents per tie, as compared with 45 cents per tie in 1909. Douglas fir cost 30 cents per tie in 1910, or 4 cents less per tie than in 1909. The remaining woods, or all excepting these two, have advanced in price from 3 to 12 cents per tie.

The electric railways used four per cent. of all the ties purchased in 1910. In 1910, 195,411 more ties were used by electric roads than in 1909, representing an increase of 182 per cent., mainly in the use of cedar and Douglas fir. This is due to much increased construction. Nearly 50 per cent. of the total number used were cedar ties at a cost below the average, namely, 37 cents.

Douglas fir constituted 32 per cent. of the total. Jack pine, being at a distance from the electric railways, was used only to the extent of 0.6 per cent., the ties costing 51 cents each. In steam roads 23 per cent. of the ties used were jack pine, and they cost only 33 cents each. Very little spruce and no chestnut or white pine were used in the construction of electric roads. Over 10,000 cypress ties were imported at an average cost of 40 cents each. This is the first report of cypress ties being used for electric roads.

The average cost of ties used in 1910 by electric roads was 41 cents, as compared with 47 cents in 1909. This is due largely to the decrease of 2 cents per tie in the cost of cedar ties and 12 cents in the cost of Douglas fir ties. It is an interesting fact that, although the average tie used by electric roads is smaller than that used by steam roads, the price paid for it is generally greater, viz., 3 cents per tie more in 1910. This is due not only to the disadvantages incident to contracts for smaller quantities of material, but also to the fact that the electric roads are more likely to purchase ties at points where the price includes railway transportation charges. This is shown by the electric roads paying not less than 37 cents for their ties, while many used by the steam roads were bought for 27 cents per tie.

POWER FACTOR, ITS INFLUENCE AND VALUE.*

By D. H. Ross.†

Considerable time has been devoted to the study of load factor and its importance and the improvements this study has brought about have been very beneficial to central stations. But, little attention has been paid to the importance of high power factor and the necessity of including it as a basis of rates which will be fair not only to the operating company, but to the many classes of consumers as well.

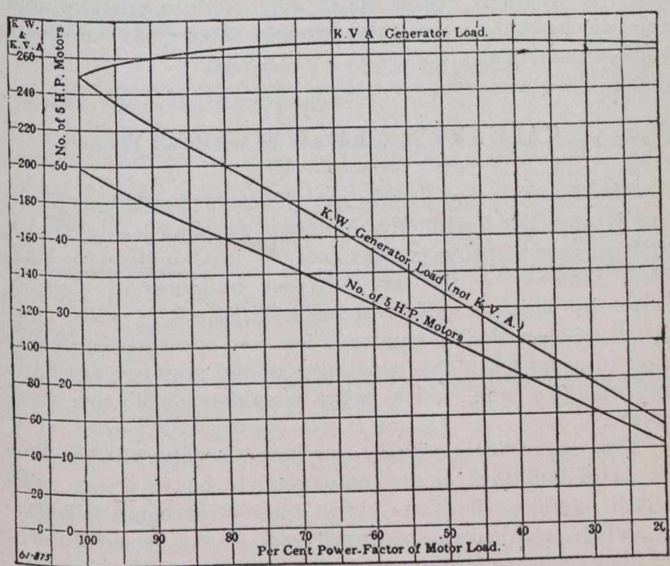


Fig. 1.—Effect of Power Factor on Generator Capacity.

The recent invention, however, of unity power factor motors has turned the attention of the operating companies to the possibilities of saving in cost of service, reduction in over-head charges, etc., to be derived by improving the power factor of their systems. A careful analysis of this subject by the engineering or cost departments of a company will convince the management of the necessity of constant improvement in this respect.

Consider that to supply a given kilowatt load at a low power factor involves:

(1) Unnecessarily large, then hence, expensive generating machines, which are rated according to their current capacity.

(2) Similar expense in generating station, transforming and switching equipment.

(3) Large increase of transmission line, copper cost and distributing transformers.

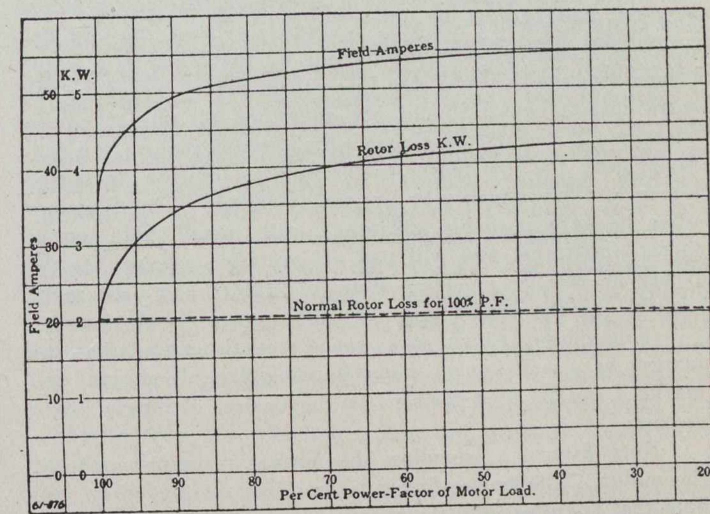


Fig. 2.—Effect of Power Factor on Field Current and Rotor Loss.

(4) Increased core loss in transformers.

(5) Poor regulation of generators on low power factor.

(6) Underloaded prime movers, hence unnecessary capacity and decreased efficiency in their operation at low loads.

(7) Increased maintenance charges due to size and, in many cases, number of units of transformers, switch gear and transmission.

The actual reduction in generator capacity as the power factor is reduced is shown in Figure 1. The lower curve shows the number of 5 h.p. motors which may be operated from a generator of 250 k.v.a. capacity at the different power factors. You will note that at 100 per cent. power factor the

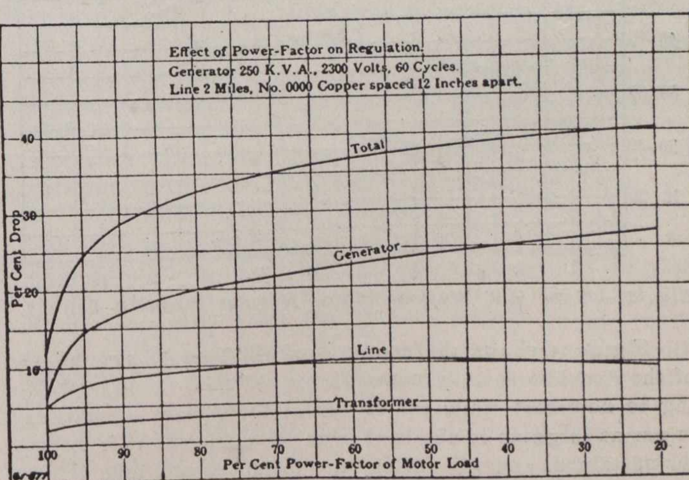


Fig. 3.—Effect of Power Factor on Regulation.

generator will drive 50 five h.p. motors, but at 50 per cent. power factor 25 motors only may be carried on the generator and transmission system. Note also that the generator load has increased from 250 to 270 k.v.a., due to the effect of poorer regulation at low power factor.

Referring to Figure 2 you will find that not only does the actual productive load to be carried decrease with low power factor, but in itself causes a decrease in efficiency of the generating station, as the field loss is greater owing to the increased excitation, and the exciter sets are either overloaded or larger than is necessary, besides adding to the total loss.

* Paper presented at the twenty-second annual convention of the Canadian Electrical Association, Ottawa, June 19-21, 1912.

† Of Wagner Electric Mfg. Co., of Canada.

Figure 3 clearly shows the serious effect of power factor on the regulation, and it is interesting to note that while the slightest increase in power factor is highly desirable, it becomes increasingly important as unity is approached.

From these considerations it is evident that power factor and costs of service are very intimately related, the cost depending almost proportionately one on the other in a water power development and also in a steam plant, except for the extra cost of coal. Should not, therefore, all rate schedules contain a power factor clause which would require the customer with the low power factor to pay for the increased losses and investments as previously listed? The customer when he finds it to his advantage will install high power factor apparatus, and will pay an equitable amount for the power he receives. This state of affairs has been made possible by the production of a unity power factor motor.

This motor, which has been recently placed on the market by a well known manufacturing firm, is unique, and marks a radical step forward in the design of single phase motors.

Note Figure 4, showing the normal running curves of the motor. The power factor is most interesting. You will note that running idle, the motor draws a leading current of 30 per cent., which falls off rapidly as the load comes on, and is practically unity from half load to load and a half. In cases where it is desired, this motor can be connected over compensated, i.e., it will give a leading current of 5 per cent. to 10 per cent. at full load, and 40 per cent. to 50 per cent. running idle. Note also that the slip is practically negligible, being about 1½ per cent. at full load.

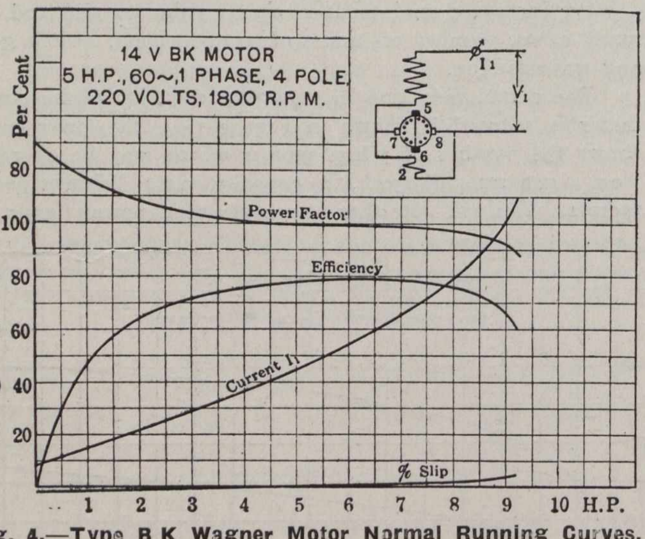


Fig. 4.—Type B K Wagner Motor Normal Running Curves.

Figure 5 shows the comparison of speed torque curves of the Arnold and unity power factor motors. It is interesting to note that while the torque at the instant of starting is not as large as is obtained in the Arnold motor, it is better sustained, and will bring up to speed any load it will start, which the Arnold type motor will not do, owing to the torque falling off rapidly as the speed increases. The new motor may at first sight appear to be somewhat complicated, but in reality it is very simple mechanically and electrically. This motor is not radically different in operation from the repulsion type motor, i.e., it is started by simply throwing in a two-pole single-throw line switch, and the motor automatically takes care of the rest, giving the speed torque results shown.

Many of the power companies now recognize that single-phase distribution is the most economical for the smaller customers, and make it a rule that all installations of less than 7½ h.p. will be single-phase. Accepting this as correct from an economical and engineering standpoint, the importance of these unity power factor motors will be inestimable as a means not only of saving to the central station in installation, maintenance, metering, etc., over a polyphase

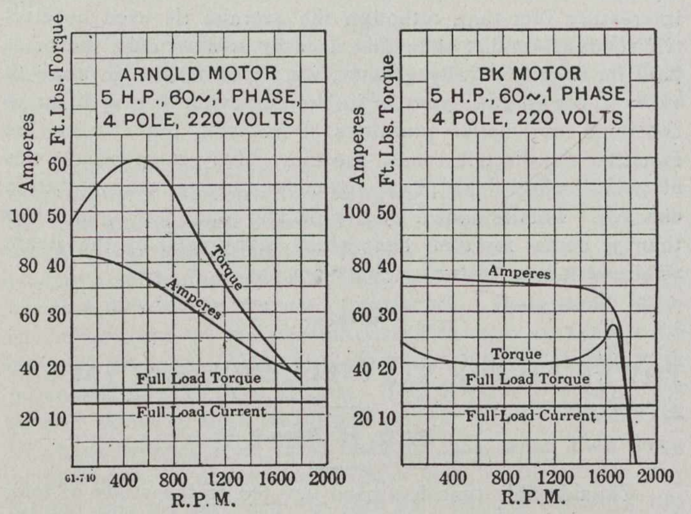


Fig. 5.—Comparison of Torque Characteristic Curves of Arnold and Unity Power Factor Motors.

installation, but maintaining a system of practically unity power factor.

This paper is not attempted as a treatise on this subject, rather as a rough outline which may serve to promote valuable discussion among the members interested in central station economies.

CALGARY'S NEW UNIVERSITY.

Mr. Dunnington Grubb, the Toronto landscape artist who is associated with Mr. Mawson, the English landscape artist in several projects, was recently in Calgary with landscape sketches of the grounds and buildings of Calgary University which provide for the building which, when completed, will provide accommodation for students for many years to come when the population of the province has more than doubled, and which when completed will cost $15,000,000.

Two magnificent sketches prepared by Mr. Grubb show the main building of the university to be in a line with Eighth Avenue. The arts block, library museum, dormitories and the residence of the professors is also provided for in the plans and are laid out with the greatest of care and skill both from utilization and artistic viewpoints. Work on the coonstruction of the building will be commenced as soon as the plans are approved by the building committee. This building alone will cost $5,000,000.

The university will have a campus of 30 or 40 acres and an athletic field of seven or eight acres on which a stadium in amphitheatre shape will be placed with capacity for several thousand spectators.

Several attractive drives and walks have been arranged for in the plans and they also call for handsome flower beds and other plots for outdoor ornamentation.

CANADIAN INDUSTRIAL EXHIBITION, WINNIPEG.

A visit should be paid to the Canadian Industrial Exhibition at Winnipeg, one of the finest exhibitions on the continent. The prospects are for a better show than even that of last year, which is strong testimony to its merits and attractions. The exhibition will be in full swing until next Saturday.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the
CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

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CONTENTS OF THIS ISSUE.

Editorial: PAGE

Leading Articles:

THE FACULTY OF APPLIED SCIENCE AND ENGINEERING OF THE UNIVERSITY OF TORONTO.

The growth of engineering education has been tremendous during the last twenty years, and particularly in the last ten years. From departments of comparative insignificance in University curricula the faculties of engineering have become so important that they are now taking first place in the minds of university authorities. The Faculty of Applied Science and Engineering of the University of Toronto very well exemplifies this growth and change of sentiment. In a recent article by Prof. H. E. T. Haultain, of that Faculty, on "Mining and the University," a résumé of the history of the Faculty was given. It affords most interesting reading. Perhaps the most striking feature of the article is the emphasis laid on the work done by the present Dean of the Faculty in developing the different courses which are now the several departments of the Faculty's work.

Dean Galbraith was appointed Professor of Engineering in 1878, and for the first few years of the School's existence he did all the engineering teaching. It is a noteworthy fact that the main features of the course, as then laid down, still control the policy of the Faculty. As Professor of Engineering, Dean Galbraith held that the practice of engineering should be learned in the field, and that the course in the School should consist of a groundwork of pure mathematics, and a broad training in principles, followed by illustrations of the applications of the principles. He believed, and has consistently followed his belief in directing the trend of development, that everything should be made subservient to the idea of the application of principles. His oft-reiterated statement: "We do not make engineers; we prepare them to become engineers," is worthy of record.

The consistent growth and the wonderful success of this department of the work of the University of Toronto is largely due to the man, John Galbraith. Too much credit cannot be given him when one knows of the early struggles of the School before it became an integral part of the University. On the placing of the School of Practical Science under the University of Toronto, Professor Galbraith was appointed Dean. Of the men who have been associated with engineering education in Canada, he is, without doubt, the outstanding figure. He ranks as an engineer, as he does as an academician and educator. The report of the Royal Commission on the Quebec Bridge stands to the credit of Mr. Holgate, Mr. Kerry and Dean Galbraith. With such a record of achievement, it is hard to understand the attitude of the Board of Governors of the University of Toronto as shown in their last report. There we see that several others of the University staff are getting salaries far larger than that allotted to the Dean. Aside altogether from his personal record, the position of head of one of the most important faculties of the University demands recognition at least equivalent to the other members of the University staff. When this question was brought to the attention of the Board of Governors recently, they stated that the present financial condition of the University would not allow the matter to be adjusted. It is hard to understand their position in this matter when it is remembered that on the first of June last the Professor of Biology was allowed to retire, in full health, five years before his regular time, and was allotted an annual allowance of nearly three-quarters of the Dean's present salary. Certainly in giving this $14,000 the University did not feel in very straitened financial circumstances.

UNITED STATES RAILROADS IN CANADA

A despatch from New York states that Newman Erb, president of the Minneapolis and St. Louis Railroad, has left for a trip, during which he expects to complete the incorporation of a new company to build branches to the Canadian border. The southern terminal of the new line is to be Watertown, S.D. Plans for these extensions, which, it is said, will eventually mean a new Canada-to-the-Gulf line, by a connection with the Missouri, Kansas and Texas, were interrupted some time ago by the sudden death of Edwin Hawley. This is another reminder of the growing and natural tendency of United States railroads to extend to Canada, and vice versa. The United States railways have 1,485 miles of track in Canada, while the Canadian railways have no less than 7,197 miles of track in the United States, divided as follows:—

	Miles.	
Grand Trunk Railway—		
Grand Trunk Western Railway	336	
Detroit, Grand Haven and Milwaukee Railway	191	
Toledo, Saginaw and Muskegon Railway	116	
Cincinnati, Saginaw and Mackinaw Railway	53	
Pontiac, Oxford and Northern Railway	100	
Central Vermont Railway	612	
Island Pond to Portland	150	
Detroit and Toledo Shore Line Railway	78	
		1,636
Canadian Northern Railway—		
D.R.L. and W. (Fort Frances to Duluth)	170	
		170
Canadian Pacific Railway—		
D.S.S. and A. System	614	
Soo System	4,295	
Spokane International	140	
Sumas to Seattle	125	
Megantic to Vanceboro (Maine)	217	
		5,391
Total		7,197

The Grand Trunk had a big fight to obtain admission into New England, but its efforts were successful. The main purpose of extending that road into the rich traffic territory of New England is, according to the Grand Trunk's own contentions, to balance their business between the Eastern and Western States. The Grand Trunk's double track main line lies across Canada like an arm, the elbow at Montreal, the forearm across Ontario, the hand upon five fertile and productive States, with Chicago, the great traffic centre, in its palm. The fingers of this hand are the feeders, which will bring through this American gateway the traffic of the West, the North-West, and the South-West. The trend of this traffic, eliminating the Grand Trunk, is to the Atlantic seaboard. With the system, the traffic organization, and friendly connections at Chicago, the Grand Trunk gathers a vast volume of this freight, and carries it eastward across Canada. When they do this they contribute not only to the earnings of the Grand Trunk, but to the prosperity of the Dominion,

The interchange of traffic in the two countries recalls the suggestion of the late Judge Mabee, when chairman of the Dominion Railway Board, that an International Railway Board should be formed. The former Minister of Railways had correspondence with the United States government on this matter. It is claimed by shippers that importers on both sides of the line are often compelled to pay two local sales: one to the border from the place of shipment and the other from that point to destination. Under existing conditions neither the Canadian Board nor the Interstate Commerce Commission has power to make a through rate, and it was suggested that an International Board be formed, made up of members from the two boards mentioned, and that this international body be given power to make through rates. A draft arrangement was discussed on both sides of the border. To this proposed agreement the railway companies took exception. There are prospects, however, that the consideration of the matter will be continued by the two governments concerned.

STEEL INDUSTRY FOR BRITISH COLUMBIA

The opening of the Panama Canal will develop the coal industry in British Columbia. That in turn may draw greater attention to the iron deposits in the province, and later mean the establishment of iron and steel works on our Pacific coast. Important bodies of high-class magnetite are known to exist, the most familiar being Texada Island, Bugaboo Creek, on the west coast of Vancouver Island; at Qwinsam, near Campbell River, and on Louise Island, of the Queen Charlotte group. Of these, Texada Island is considered the most important, as the quality is high grade and as the quantity is large. Its situation is such that with moderate equipment it could deliver ore on ship at tide water at a very low figure, possibly not to exceed 70 cents per ton. At Quinsam a crew has been kept on development all winter. Little has been done on the other properties, but mining engineers had spoken highly of them, both with respect to quality and quantity.

In the opinion of Mr. R. R. Hedley, one of the foremost mining experts in Canada, and a particular authority on British Columbia, the building of a plant on our Pacific Coast to manufacture iron and steel is not only justified, but required. There is a large increase in the use of structural steel and reinforced concrete. Railway construction and maintenance and the general rapid progress of the country are also good reasons for the construction of such a plant. During the last quarter of a century the Union Iron Works of San Francisco have made the best of pig iron at Irondale, Wash., from Texada ores. More recently the Western Steel Corporation, with modern plant at the same place, made pig iron, using Fernie coke costing $10 per ton. This was intended as the nucleus of structural iron and steel works, but it was found that Chinese pig iron could be laid down at a cost of $10 per ton, and smelting of local ore was abandoned. With equipment none too good from the economy point of view, the costs were reasonable, but the enterprise was not properly financed, and operations ceased. Given a good quality of metallurgical coke costing not more than $5 per ton, which it is reasonable to expect in the near future, there is no reason why British Columbia pig iron should not take the place of Chinese, and a profitable industry be established on our own side of the line. Cheap power is also available.

EDITORIAL COMMENT.

This week there will be found the first instalment of a series of four articles on the high-tension transmission system of the Hydro-Electric Power Commission of Ontario. In the light of the recent very successful operation of the system as compared with private companies, this series will be of particular interest to our readers.

In a recent issue of the Yorkton "Enterprise," of Yorkton, Sask., a firm of real estate brokers state in an advertisement that they handle real estate collections and civil engineering, and are financial agents. They add that they have numerous pieces of valuable "inside" and "outside" property, suitable for business houses, etc. It is hard to see in what particular way this firm are interested in carrying on the profession of civil engineering. Some users of the term, like the above, do much towards detracting from the dignity and standing of the profession. There is at present, however, no means of taking the matter up in the courts, and this is one argument at least for making the profession a closed one. At present the term is a most convenient one for those who wish to use it.

LETTERS TO THE EDITOR.

A WARNING TO ALL CIVIL ENGINEERS.

Sir,—The following is a word of warning to all civil engineers when being engaged by a certain class of corporations that they should be most careful to have a note in writing of the amount of their salaries, because some engineers have appointed assistants and then gone back on their word and thought to settle the matter of a salary by a reduction of 20% of the amount previously arranged. When engineers cannot trust each other there is little confidence of the public in such representatives of the engineering profession. The writer has seen three-quarters of this world, and except in the Dominion of Canada, he has never encountered such underhand practice as outlined above, and has found that the members of the profession have always upheld the standard of straight and clean dealing amongst themselves and in their dealing with public affairs.

DISGUSTED A.M.I.C.E.

* * * *

ENGLISH ENGINEERS FOR CANADA.

Sir,—I should like, as an engineer living in England, to put before your readers the case of the hundreds, probably thousands, of English engineers of all kinds who are anxious to settle in Canada, but are unable to do so because they can hear of no jobs there. We are told in England that if a man wants work in Canada he must go there to look for it and take the first job that comes along.

I, myself, have written from time to time to several large firms, railway companies and consulting engineers in Canada, stating my qualifications and asking for the promise of a few months' trial in any fairly paid engineering capacity; a not unreasonable request, as the risk is practically all on my side. I received courteous replies in, I believe, every case. One railway company offered me a job, as they kindly said, to go on with until I could find something better, but at half the salary I was getting. Another firm said they could make use of me, but did not commit themselves to anything more definite. The other people all regretted that they had no vacancies, but at the same time several of them advised me to come to Canada, as they had no doubt I should get a good post there.

Now, this is well enough, as far as it goes, but it does not go far enough. It would go far enough for a man who could absolutely find no work in England, or for a single young fellow who had enough money to keep himself for some months in Canada while he was looking for a job, but the men I have in mind are those who are already in berths, steady, hard-working fellows, ambitious to get on, but seeing very little prospect before them in England and, therefore, turning their thoughts to other parts of the Empire.

Many of these men have a wife and young family to keep on a small salary and have no private means of their own and no rich relations to help them. However much such a man might wish to try his fortune elsewhere he feels that he is not justified in doing so merely on speculation. He has no money to leave with his family in England while he goes to Canada, and he dare not take them with him unless he has other work to go to at once.

This question does not affect the single man, but as they feel their feet on the first rungs of the ladder they are not willing to give up what they have unless to take something better. They are quite ready to go abroad. and they do go abroad, even to the most dangerous and unhealthy parts of the world, but they want something to go to.

The case of the engineer already in a good position in England, but who wishes to settle in Canada for various reasons, is rather different, although it still turns on the same point.

Take the case of a works manager getting £500 or £600 a year, a good salary from an English engineer's point of view. Such a man may be from 35 to 45 years of age and he probably has a family to whom he is giving the best education he can afford, so that he is not able to save much out of his salary. He may be ambitious and feel that Canada will give him more scope than England; he may think that his children will have better chances there; he may be an imperialist, as very many of us are, and wish to do his little share in building up the newer parts of the Empire, or he may have various other reasons for wishing to earn his living in the overseas Dominions.

He may be able to find enough money to take his family with him to Canada and to keep them there for six months or a year, but unless he has a definite position to go to he has much to make him hesitate. In the first place, his wife will probably object strongly, as the ladies in these cases generally have a firm belief in the old adage that "a bird in the hand is worth two in the bush."

He knows that he has worked hard to attain and to keep his present position, and he also knows that there are hundreds of men ready to take that position, many of them fully as well qualified in every way as he is, and if he gives his job up he may find it impossible to obtain another similar one in England, should he be unsuccessful in finding a suitable post abroad. Such a man would be naturally unwilling to take a less important job in Canada than he had filled in England.

The above are the reasons, I believe, which prevent the best engineers from going to Canada, except to take up positions which have already been offered them. There are really only two main reasons: want of money to go out on spec., and unwillingness to throw up a job until another one is secured.

It is possibly owing to the fact that not enough of the best classes of English engineers have been attracted there that American engineering practice is general in Canada. This seems a pity, as I am Britisher enough to believe that our engineers are at least as good as the Americans. I have no quarrel with American engineers; they talk too much perhaps, and they do not show up to advantage in England, but it cannot be denied that as a body they are quicker and more alert than English engineers, which, however, I believe is due more to the climate of America and to the fact of its being a new country than to anything else.

When we consider that the British Empire embraces a fifth of the entire surface of the globe and more than a fifth of its inhabitants, and that this result has been brought about largely by the help of British engineers, we must admit that they are not quite played out yet.

But, while engineering in Canada is advancing and will advance by leaps and bounds, the engineering trade in England is practically stationary, and will probably decrease in volume in the future owing to the much more severe European competition, so that many of our engineers will be obliged to transfer their services to other parts of the Empire.

I believe that it would be a benefit all round if some kind of exchange or employment bureau could be arranged for English engineers wishing to settle in Canada, and there are various ways by which this might be done.

One way would be through the engineering societies of the two countries. There are, roughly, 15,000 members of all grades in the three English institutions of civil, mechanical and electrical engineers, and as these societies already do something in the way of bringing their members into touch with employers or employees they would no doubt be very willing to work in conjunction with the Canadian Society of Civil Engineers to provide Canadian firms with suitable engineers from England. The English institutions, for instance, might collect the names of all of their members who wished for work in Canada, together with full particulars of each man's career and experience and the salary he desired, and these lists would be forwarded, say, twice a month to the headquarters of the Canadian society, where they would be on view and copies posted to any employer who desired one. The employer could then communicate direct with the man he thought most likely to suit him, making a definite offer for a three months' trial, and by cabling his offer he might have his man in two weeks' time.

This plan would, I believe, work well and the Canadian employer would have some guarantee as to the character and professional abilities of the men whose names were put before him, but there are great numbers of good engineers who do not belong to any of the institutions mentioned above, and who would be left out of such a plan.

Perhaps a better arrangement would be to deal with the question through the Canadian Government Emigration Department. This department, through its chief London office, might invite particulars as to experience, etc., from any English engineers desiring to settle in Canada, by advertising from time to time in some of the English technical and daily papers, and by sending circulars to all the engineering societies. The names and particulars sent in would be tabulated, numbered, and sent to Canada, where the lists would be distributed in various centres, where employers could see them or write for copies.

The essence of the scheme would be that each party took a certain amount of risk. The man from England would pay his own passage to whatever part of Canada he was going to take the risk of suiting his employer and being able to hold his position, while the employer guaranteed to give him a three months trial at a stated salary and to take the risk of him being suitable or otherwise. The risk to the Canadian employer would not be great, as the English engineer already in a berth would not be likely to pay his passage to Canada and probably take his family out on the promise of a three months job unless he felt fairly confident of being able to hold his own, and it could be specified that the employer had power to break the contract by reason of misconduct or gross incompetence.

The time required to get a man over to Canada would be a disadvantage in some cases, but many employers could afford to wait a month, and by giving the applications at the London office consecutive numbers and arranging a few code words the Canadian employer could cable to London giving only his name and address, the number of the man he wanted and the salary he offered, and the London office could communicate with the engineer, who would make his arrangements to sail as soon as possible, or reply at once if he was unable, through any reason, to take the post offered.

I believe that some such scheme as outlined above would be practicable. It would be a boon to a great many engineers in England who are struggling along with very slight prospects of bettering their positions in this country, and it would provide Canada with some very useful citizens.

R. D. SUMMERFIELD,
11 School Road, Moseley, Birmingham.

A MOVING-PLATFORM SUBWAY LINE.

A moving-platform subway line has been laid out in New York City by the Public Service Commission. It is to be a crosstown line on 34th St., from Second Ave. to Ninth Ave., a distance about one mile east and west. The end portions are to form loops, the easterly loop extending through 34th St., Second Ave., 35th St. and Third Ave. to the corner of 34th St. and Third Ave., while the westerly loop, beginning at a point in 34th St. between Eighth and Ninth Aves. passes under 34th St., Ninth Ave. and private property to the point of beginning. The route has been laid out as a result of the proposals of the Continuous Transit Securities Co. (M. E. Schmidt, pres.), which company has been promoting moving-platform proposals in New York City for a number of years past, hitherto without success. In order to provide against the risk of failure of the moving-platform method of operation, the Public Service Commission's resolution laying out the route provides that it may be operated "either by moving-platforms or by separate cars or trains, or by any other device or means in the construction of which stationary means for guiding a conveyance in a definite path and means for propelling such conveyance are necessary elements." In this way the resolution will also cover operation by ordinary rapid-transit trains if this is considered necessary after trial of the moving-platform method.

The proposed moving-platform line will pass through one of the busiest parts of the city, crossing seven north-and-south rapid transit lines (four elevated lines, three subway lines) and ten north-south street-car lines. At Broadway it will be within one-half block of the present northern terminus of the Hudson tunnel system, which communicates with Hoboken and Jersey City and indirectly with the lower part of New York City. At Seventh Ave. it will be within one block of the Pennsylvania R.R. station. The 34th St. district at present contains half a dozen large department stores, and shopping business has in recent years concentrated in this region very strongly. The present theatre district extends north from 34th St., and the principal hotels of the city are grouped along Broadway in this neighborhood.

A NEW ENGINEERING FIRM.

Mr. P. W. Sothmann, recently chief engineer of the Ontario Hydro-Electric Power Commission, has opened a consulting office in the Kent Building, Toronto. The firm name is P. W. Sothmann and Co., and the organization includes Mr. P. W. Sothmann, Mr. J. A. Brundige and Mr. F. P. Mansbendel. The field covered by the new firm will be hydro-electric development, high tension power transmission and other work connected with the generation and distribution of electrical energy.

IRRIGATION PROJECTS OF THE CANADIAN PACIFIC RAILWAY COMPANY IN ALBERTA.

By A. S. Dawson.*

(Continued from last week.)

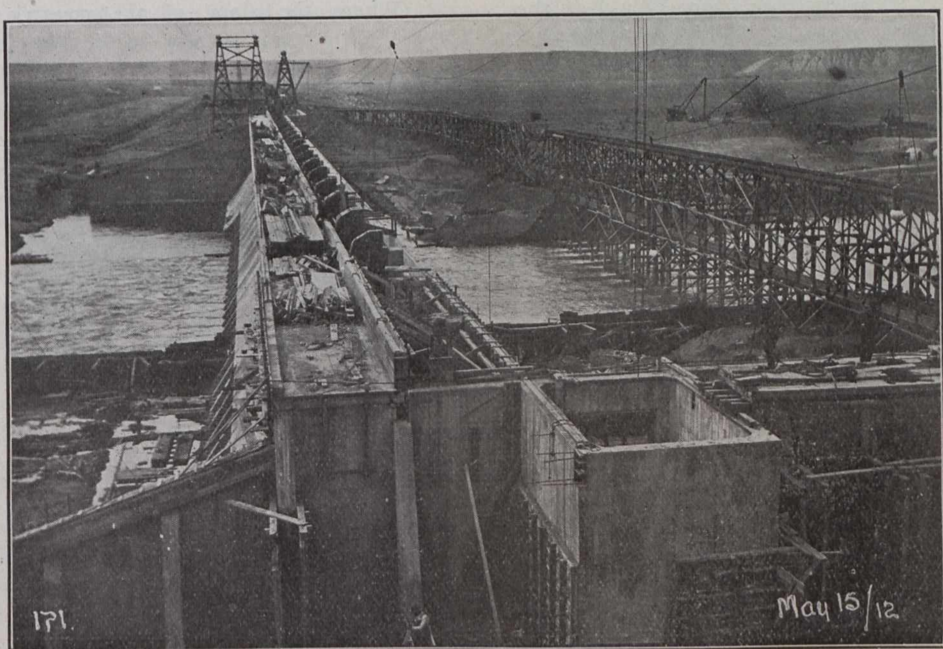
The abutments connecting the spillway with the earth dam are in the form of reinforced concrete retaining walls of the "counterfort" type, with a view of cutting off all possibility of leakage at this point. Provision has also been made for a road bridge on top of the structure.

The gates will be operated by a small power plant consisting of vertical turbines with direct connected generators installed inside the dam for this purpose, as well as for lighting and the operation of other headgates at the end of the main canal about five miles distant.

The canal headgates will form an integral part of the structure at its easterly end, and will consist of five openings each of 20 feet, controlled by "Stoney" sluices. These gates will control the discharge through a main canal of 90 feet bed width, carrying 11 feet of water, with 1 to 1 slopes, on a grade of .016 per cent. This canal is designed to discharge 3,800 cubic feet per second, and has a summit cut of 55 feet at about Station 10.

The contract for the spillway structure was let on October 1st, 1910, and work immediately started, it being anticipated that it will be completed within 18 months from that date.

The earthen embankment referred to is part of a very large contract awarded in June, 1910, which includes the handling of about 20 million cubic yards of excavation in this section of the Block.



Ambursen Type Dam on Bow River, near Bassano, Alta. Headworks of Eastern Section, C. P. Railway Irrigation Block, Alta.

At a point about five miles from the intake, an earth dam 1,280 feet in length, 35 feet maximum height, containing 80,000 cubic yards, was built across the valley, thus forming a tail pool into which the main canal will discharge. This dam has a top width of 12 feet, six feet above high water; has 2 to 1 slopes on the rear face and 3 to 1 on the wetted slope. Its face is paved with heavy rip-rap well bedded in gravel.

From this point two canals ahead—a north and east branch. The north branch with its distributaries will water about 90,000 acres, its dimensions being 29 feet bed width, carrying 6½ feet of water, with 2 to 1 slopes, on a grade of .03 per cent. After crossing the railway line about one mile east of Bassano, its location follows the west flank of a deep valley known as Crawling Valley At a point about eight miles from its intake it drops 18 feet and crosses the valley by about 1,700 feet of flume, and runs northerly, gradually reducing in size until it reaches the Red Deer slope.

The east branch, like the north branch, heads out in the tail pool of the main canal, its size at the outlet being 68 feet bed width, carrying 9.3 feet of water, with 2 to 1 slopes, on a grade of .015 per cent. Near Lathom the first branch takes off, dropping 25 feet to cross the railway and water an area of about 107,000 acres between the Mat-zl-win and the One Tree Creeks. This branch is known as the Spring Hill Canal and is about 35 feet bed width, carrying 7 feet of water, with 2 to 1 slopes, on a grade of .025 per cent.

The east branch continues south-easterly along the northerly flank of the watershed as a 45.3′ by 7.8′ canal with a grade of .02 per cent., reaching the height of land at the head of Antelope Creek, which is crossed by a flume 2,200 feet long with a maximum height of 22 feet. At this point it again forks, the south-easterly branch being known as the Bow Slope Canal, which is about 17 feet bed width, carrying 5 feet of water; and will serve all the land on the Bow River slope of the divide and lying west of the Rolling hills, amounting to about 42,000 acres.

At Cassils a smaller canal to cross the railway is taken off, to serve about 12,500 acres; and just south of Brooks the east branch discharges its waters with a drop of about 17 feet into Lake Newell reservoir, which will be formed in a depression in the Little Rolling Hills, by the construction of a number of earth dams, the largest of which will be about 2,000 feet long and 30 feet in height. This reservoir will be about 9 miles long and 4½ miles wide, and its storage capacity will be about 186,000 acre feet. It will be filled each season after the close of the irrigation period, and was the means of materially reducing the cost per acre of the project as a whole.

A tract of about 50,000 acres south of the reservoir will be served by a canal heading out at the south end. This will be known as the Rolling Hills Canal, of about 19 feet bed width, carrying 5½ feet of water, on a grade of .02 per cent.

The outlet from the north end of the reservoir will serve about 118,000 acres known as the Bantry system, and its dimensions are 44 feet bed width, carrying 7.7 feet of water, on a grade of .01 per cent, and about five miles in length. At its easterly end it will discharge into a reinforced concrete flume 10,500 feet in length with a maximum height of 54 feet and a sectional area of 129 square feet.

*Chief Engineer, Department of Natural Resources, Canadian Pacific Railway Co.

Considerations of storage values fixed the elevation of both ends of this structure, and under these conditions the type of crossing which gave the highest velocity for a given fixed friction head was imperative.

Numerous preliminary studies were made for the purpose of comparative estimates of cost, with the result that a somewhat unique design is likely to be adopted. The actual channel is of the suspended type commonly used in steel flumes. The exact section proposed is the elastic curve or hydrostatic catenary. For the purpose of a flume this curve has the advantage that it is the equilibrium polygon for a liquid filling it to the chord of the arc; the tension is everywhere the same; and there is neither moment nor shear at any point. When the structure runs partially full, there are both moment and shear, and these are the factors which fixed the thickness of the shell. The substructure of the flume will vary with the head, and it is probable that multi-arched design will be adopted, with spans varying from 30 to 100 feet. For the depressed portion under the railway line it is intended, as previously intimated, to use a reinforced concrete siphon; and in order to save excavation and provide means of measuring the discharge it is proposed to form a Venturi meter with a throat section of about 6 feet. The structure as a whole will probably contain about 25,000 cubic yards of concrete and upwards of two million pounds of reinforcing steel.

This flume will carry the water over a broad divide in the water-shed with its summit at a point about three miles south-east of Brooks, and will serve all the country east of that point.

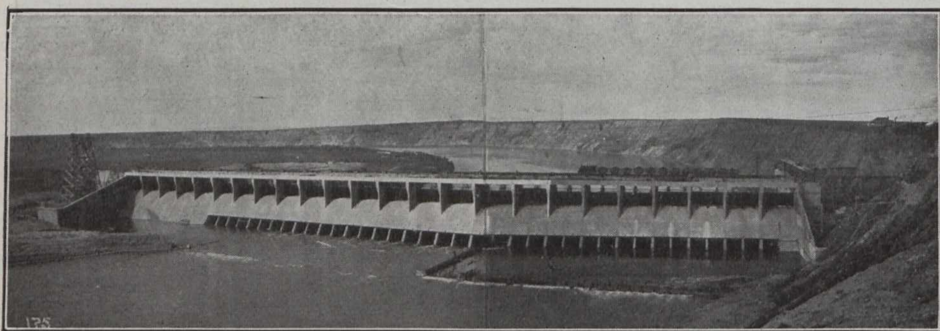


Fig. 9.—Ambursen Type Dam on Bow River, near Bassano, Alta., Eastern Section C.P. Railway, Irrigation Block, Alta.

At the easterly end of the flume the canal section is 44 feet bed width, carrying 7.7 feet of water, on a grade of .01 per cent., and in the north-east quarter of section 23, township 18, range 14 it splits, one branch of 37½ feet bed width, carrying 7.2 feet of water, on a grade of .01 per cent., running north; and another branch of about 16 feet bed width, carrying 5 feet of water, on a grade of .01 per cent., running east and again crossing the railway line.

In section 14, township 19, range 13, the northerly branch again splits into two canals, each about 20 feet bed width,, carrying 5½ feet of water, on grades of .01 per cent., one branch serving north and the other the south slope of the water-shed.

The estimated mileage of canals and ditches to serve this section of the Block is as follows:—

	Miles.
Main canal	5
Secondary canals	475
Distributing ditches	2,020
Total	2,500

The structures, numbering thousands, will include drops, headgates, flumes, siphons and bridges, and to a large extent will be built of reinforced concrete and brick.

Details of construction cannot be gone into with the limited time available.

The different cross sections of canals and ditches are modified to suit conditions, such as discharge, available grade, nature of soil, and transverse slope of the country. On ditches 2½′ by 1′ to 3½′ by 2′, 1 to 1 slopes are used, and on ditches 4′ by 2′ to 4½′ by 3′, 1½ to 1 slopes are standard, with banks 3 feet wide on top and one foot above water level. On small ditches no dependence is placed on banks as part of the canal prism unless the grade is one foot below the under side of the sod, or about 1½′ cut on an average. On larger ditches on level ground the area of the water prism is generally about the cube of the depth; the banks being half the depth of water level, with a maximum of 3 feet; and a width equal to the depth of water on the upper side, and 12 feet on the lower side, where a roadway is required. Where the depth of water is over about 5 feet, 2 to 1 slopes are standard, although this is changed to 1½ to 1 where extreme cross slope exists. Where the depth of water is less than 5 feet, 1½ to 1 slopes are standard under ordinary conditions. Endeavors are made to balance cut and fill, with an allowance of about 15 per cent. for shrinkage, unless it happens that shorter locations with heavy cutting through a ridge would result in a reduction in quantities.,

The grades are so selected as to give a uniform velocity of about 2½ feet per second, and not to exceed 3 feet per second; consideration being given to the character of the soil, and the depth of water in the ditch.

Where the slope of the country is so great that the velocity would be too high if the canal were given a bed slope to correspond therewith, the excess fall is concentrated by vertical drops; and where such drops occur too close to one another for safety or economy, a short section of flume or lined channel is employed for the purpose of overcoming the excessive grade. Losses by seepage and evaporation are allowed for as follows:—

In preliminary projection:

		Per Mile.
Canals	2 to 100 sec. feet	1%
"	100 to 500 "	.5%
"	500 to 1000 "	.25%
"	1000 and over "	.10%

For final projection and design the following formula is used:—

$$P = C W d$$

where P = loss in second feet per mile of canal.
W = the width at full supply level.
d = the depth of water.
C = a constant = .020 for sand
.0185 for gravel and sandy soil.
.0170 for average earth.
.0150 for clay.
.0140 for dense hard clay.

Curvature is carefully considered and on the larger canals curves are regularly run in with transit and chain, the radius allowed on the larger secondary and branch canals being between 15 and 30 times the depth of water. On smaller distributing ditches a radius of 6 to 8 times the depth of water, with a minimum of about 10 feet, is aimed at. As far as possible the land lines are adhered to in laying out the distribution system.

At each point where water is divided by a branch gate, an alternative path is provided to carry off tail water to some drainage channel, the capacity of these tail channels bearing a constant proportionate relation to that of the various irrigation ditches above them. In no case is this less than 2 second feet, and otherwise is 25 per cent. of the capacity of the canal or ditch just above. These tails are located on the land lines as far as possible; otherwise they are made to reach the drainage channels by the shortest possible route.

Cross drainage is provided for in three ways: (1) it is taken under the canal; (2) if small in extent of catchment area, it is taken into the canal system by an inlet; (3) it is carried over the canal. The type of crossing adopted depends to a large extent on the importance of the drainage line; on the character of its channel; and to some extent on the size of the canal. No definite rules can be laid down to meet all cases, but as a rule the cross drainage is handled in the order above referred to, with due consideration of cost. The material chiefly used in connection with the smaller under crossings has been corrugated metal culverts, up to 36 inches in diameter, manufactured from both Ingot and Toncan metal. For larger structures reinforced concrete pipe and arch culverts will be used.

Flooded areas are avoided by the use of double fills or levees, combined with means of taking care of the cross drainage as above referred to.

Spillway or escape channels, with the necessary structures on the canal system, are provided at frequent intervals, averaging about 6 miles where possible, on all secondary and branch canals, their capacity being at least 10 per cent. and not exceeding 25 per cent. of the canal in which they head.

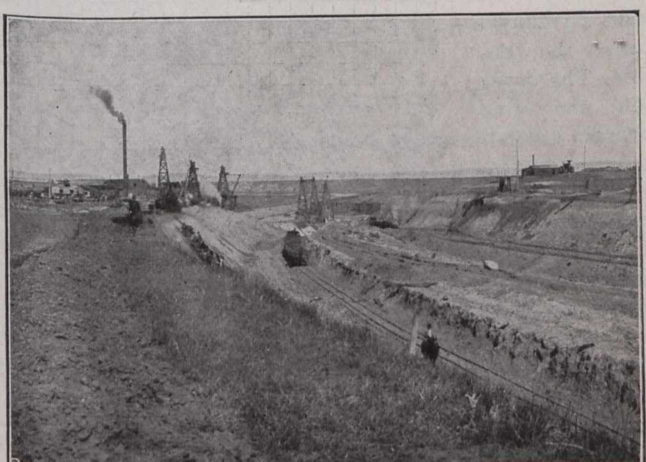


Fig. 10.—Excavation, Main Canal, Eastern Section of Irrigation Block.

Overhaul is calculated by the well-known methods of Mass Curve, the limit of free haul being 100 feet parallel to the canal axis. In case of borrow pits not on the ordinary cross section, the length of haul is measured in a straight line between the centres of gravity of cut and fill.

Necessary waste is used to widen the banks uniformly, and to strengthen the higher fills. Borrowing where necessary is done by (1) deepening the canal; (2) widening it; and (3) both if required. If neither is practicable, borrow pits are made well away from the canal on the high side and so arranged as to drain into the canal. Where side borrow is absolutely necessary, a berm equal to at least the height of the bank is left between the toe of the bank and the edge of the borrow pit.

Embankments are in all cases put up with material from adjacent cuttings or from borrow pits if the former is unsuitable or deficient in quantity. In determining the outer slope, the plane of saturation is considered as sloping from high water level at the rate of 3½ to 1, and this plane is not allowed to intersect the outer slope or to approach the toe nearer than 10 per cent. of the base width. In very high fills where the above requirements lead to excessive material, the slope of saturation is increased by draining the rear or outer half of the embankment, or by constructing the first three feet of the outer third of the bank with sand, gravel or other porous material.

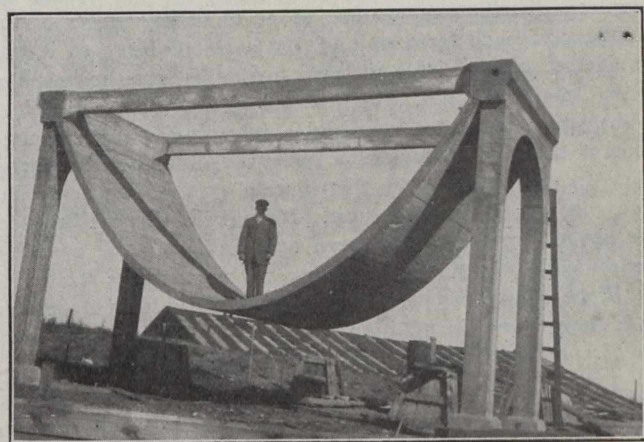


Fig. 11. Test Section, Proposed Aqueduct, 18 Ft. Wide, 9 Ft. Deep, 1,000 Ft. Long. Eastern Section of Irrigation Block.

The under surface of the embankments is bonded when the head against the banks is 2 feet or more, and less than half the top width, providing two furrows and one additional furrow for each extra two feet, with one furrow just inside the upper or wet toe, one under the centre, and the balance, if any, between them. The surface is stripped when the depth against the bank exceeds half its top width; when the cross slope exceeds 1 in 6; in boggy ground; or when the soil exceeds plow depth. The surface is bonded and stripped when the head against the bank exceeds 10 feet; when the surface is hard and dry after stripping; or when the cross slope exceeds 1 in 4. The width of stripping is determined by the plane of saturation above referred to.

This portion of the system is being designed with a view of rotation in supply being adopted, which will result in each individual farmer obtaining a satisfactory head; a fair division of water; and simplification of operating problems. This is a matter which cannot be worked out in detail until the lands are settled, but the system is being designed on the basis of giving parcels of between 80 and 160 acres a supply of two second feet for a period of 96 hours, and parcels smaller than 80 acres a similar flow for 48 hours.

It is the intention that daily records of the receipt and delivery of water and of the outflow through all branches of the system shall be maintained from the beginning; such data being as necessary in irrigation management as is bookkeeping in any commercial institution. The information thus obtained is essential in enforcing proper water economy; in preventing land from being injured; and in keeping farmers from getting into bad habits in using water, which if once acquired, result in reduced crop production, increased cost of operation, and needless annoyance to the management.

World-wide experience in the use of water on cultivated lands under any kind of crops during long periods of years, shows that the duty varies with, (1) the nature of the soil; (2) the age of the soil; (3) the kind of crop; (4) the weather conditions; (5) the slope and condition of the conveying channels of supply; (6) the distance the water is carried in the ditches and channels to the fields; and (7) the experience and skill employed in irrigation. As you are aware, the legal duty in the province of Alberta is fixed by the Irrigation Act as a continuous flow of one cubic foot per second per 150 acres for 153 days between May 1st and September 30th. Measurement of this supply is arranged for by weirs approved of by the Commissioner of Irrigation.

The company has adopted the plan of constructing the complete distribution system so as to deliver water at the boundary of each farm unit of 160 acres or less; as it was considered impracticable to leave to the settlers the building of the smaller ditches, which would have resulted in delays to the work, excessive cost and a retarding of the development of the area, followed by increased difficulties in operation. In constructing the distribution system, 160 acres has been considered the farm unit, although in the western section several colonies have been established on the so-called "ready-made" farms of 80 acres. In the eastern section of the Block about five per cent. of the farm units will be sold as 80-acre farms, in addition to the establishment of a number of colonies on farms averaging from 80 to 120 acres.

The successful outcome of any large irrigation project is only partially solved by good construction; and in some cases the administrative heads of large schemes have failed to realize that the ultimate success of such enterprises cannot be fully brought about without farmers; and that it is their labors which determine the real value of such properties. With this realization, the sale of the lands in this Block warranted the establishment of a very large organization which has extended over all important points in Canada, the United States, Great Britain and parts of Continental Europe; and which has resulted during the past five years in the disposal of over 1,300,000 acres.

Everything that follows in the wake of increased population is an argument in favor of irrigation and the cultivation of small areas; which can only be carried out by this means of farming. Moreover, this results in a better type of farmer, greatly improved living conditions, and correspondingly elevated social conditions.

No practical agriculturist can fail to realize the fact that the scope for irrigation in semi-arid conditions in northern latitudes is very great; and that this system of farming will ultimately become a leading factor, and occupy a vitally important place in the agricultural development of Southern Alberta.

MUNICIPAL EXHIBITION IN BERLIN.

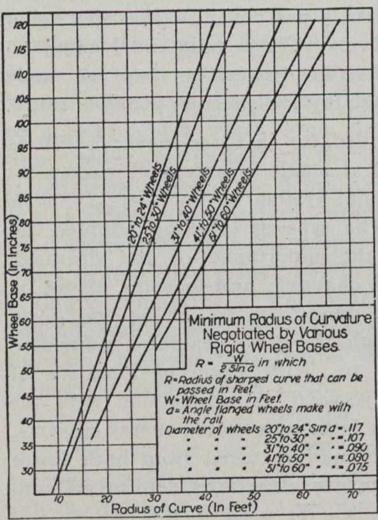
The city of Berlin, Ontario, included in its programme of celebration on the occasion of cityhood a "Made in Berlin Exhibition" which brought to prominent notice of the public the wonderful manufacturing abilities of this young city.

The exhibition was held in the auditorium which was suitably decorated and lighted.

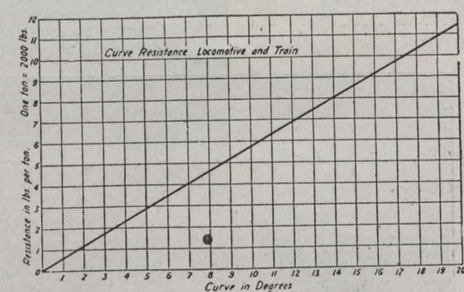
The list of manufactures on show included confectionery, fountain pens, upholstering materials, furniture, vacuum cleaners, cloth covered buttons, leather goods, flooring materials, electrical materials and supplies, pianos, cigars, mattresses, sporting goods, art glass, haberdashery, vegetable ivory buttons, felt, rubber goods and a splendid display of hot-house flowers.

CURVES IN TRACK AND GRADE RESISTANCE.

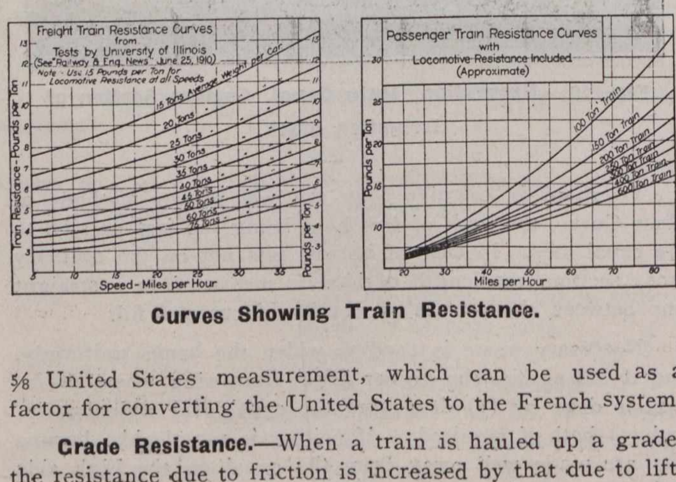
In the United States it is customary to express curvature in degrees, noted by the deflection from the tangent measured at stations 100 feet apart. The following information is abstracted from a bulletin published by the Railway Department of the Westinghouse Electric and Manufacturing Company. The number of degrees of the central angle subtended by a chord of 100 feet represents the "degree curve." One degree of curvature corresponds to a radius of 5730 feet. Therefore, the number of degrees divided into 5730 gives the radius of the curve in feet. Or, the number of feet radius divided into 5730 gives the number of degrees. This assumes that the 100 feet are measured on the arc instead of on the chord, but the error thereby introduced is so slight with curves commonly used that it may be ignored in ordinary calculations.



In English practice it is common to define a curve as one of so many chains (66 feet) radius. Thus the radius of a one-degree curve expressed in chains would be 5730 ÷ 66 equals 86.81, therefore, 86.81 divided by the degrees equals the radius in chains, or 86.81 divided by the radius in chains equals the degrees. The curve shows the value of train resistance on curves.



In the metric system instead of the stations being 100 feet apart they are taken at 20 meters (65.61 feet). The central angle remaining the same, the radius must necessarily be less. This is represented by 65.61 ÷ 100 of 5730 feet for a radius for a one-degree curve or approximately



Curves Showing Train Resistance.

⅝ United States measurement, which can be used as a factor for converting the United States to the French system.

Grade Resistance.—When a train is hauled up a grade, the resistance due to friction is increased by that due to lifting the train against gravity. The amount of this increased resistance is determined as follows:—One mile equals 5,280 feet, and if the grade be one foot per mile, the pull necessary to lift a ton of 2,000 pounds will be $\frac{2000}{5280} = .3788$ pounds.

If the grade is expressed in feet per hundred or per cent., the resistance will be $\frac{2000}{100} = 20$ pounds for each per cent. of grade. Therefore, the grade resistance in pounds per ton = 20 x % grade.

To the grade resistance must be added the train resistance due to speed and friction for level running; i.e., total train resistance on grade equals grade resistance plus train resistance for level running.

The following table is based on the following assumed data:—

Train friction .... 10 pounds per ton
Acceleration .... 20 pounds per ton
Coefficient of adhesion .... 25 %

Weight of Train That Can be Started on a Given Grade.

Weight of Locomotive	TONS WEIGHT OF TRAILING TRAIN				
	GRADE				
	1%	2%	3%	4%	5%
25 tons	225	155	115	90	70
30 "	270	185	135	105	85
40 "	360	245	180	140	115
50 "	450	310	230	180	140
60 "	540	370	270	210	170
70 "	630	430	320	250	200
80 "	720	490	365	280	230
90 "	810	550	410	320	255
100 "	900	615	455	355	285

CONTRACT OBLIGATIONS IN THE STEEL TRADE.*

By E. A. S. Clarke.†

The average buyer of steel has for some years looked upon his contract as an option, the material to be taken if the prices remain satisfactory, but the entire contract to be repudiated if conditions are not favorable. This custom does not apply to all forms of steel, and not at all to raw materials entering into the manufacture of steel. Contracts covering the sale and purchase of ore, coal, coke, pig-iron, and in most cases billets and sheet bars, are practically always strictly carried out. Cancellations of rail contracts are practically unknown. Evidently in the case where the buyer regards his contract as a mere option, a situation arises under which the seller has a heavy tonnage of obligations which he may have to meet, but which the buyer will not take unless conditions are favorable to him. The seller, realizing this, and particularly if the market is advancing, deliberately contracts for the sale of more tonnage than it is possible for him to deliver. The result is dissatisfaction on the part of the buyer at not getting proper deliveries, so that he, in turn, contracts with several sellers for a total of far more than he can use, with the idea that out of the combined contracts he will be able to get the deliveries and amounts that he needs.

As to the causes of this unfortunate situation, the one which in my judgment is chiefly responsible is stated by Mr. J. A. Farrell as follows:—"For the purpose of making a good showing in the volume of sales and contracts, buyers, and particularly the large wholesale merchants, have not infrequently been induced, not to say inveigled, into placing contracts covering as extended a period as possible, for tonnages which they may hope to sell, and in some instances which they can have no reasonable expectation of being able to sell."

Suggested Remedies.—For the correction of these conditions, Mr. Farrell's suggestion that the salesman's remuneration and chance of advancement be made to depend, not upon the volume of his sales and contracts, but upon the profits derived from the goods actually delivered to the buyers, is most excellent. Mr. Bope's suggestion of short-time contracts, no guarantee against decline, preventing the buyer from buying more than he requires for use in any given period, and an equal obligation put upon the seller not to sell more than he can deliver within that period, if properly carried out, would accomplish most of what is necessary, provided that the sales contract contains the elements of mutuality and fairness; and particularly if the seller gives proper heed to his obligations in respect of making deliveries in accordance with his contract.

Investigation shows that the laxity as regards contract obligations which prevails in this country is practically unknown in Europe, and that many of the remedies suggested for the correction of the evil here are in current use abroad. There are in practically every country in Europe certain general sales conditions which vary but slightly between countries and which govern all sales of steel. These fundamental conditions are always stated at the time of making quotations, so that the buyer understands clearly the conditions which will govern the execution of the contract, and there can be no question of some new condition arising after the contract has been signed. These general sales conditions which obtain in Europe seem to the writer eminently fair and reasonable, particularly when stated in advance of signing the sales contract.

A form of sales contract, uniform as to certain fundamental conditions, seems to the writer essential to the proper enforcement of contract obligations. Some of the fundamental conditions which he suggests should be embodied in such a contract are as follows:

(1) The material should be sold for the buyer's use only, and not be re-sold unless first further manufactured. This would have to be modified in the case of sales to merchants or jobbers.

(2) Stipulations as to quality and variations should be clearly stated. In the writer's judgment the best way is to sell the material subject to the seller's standard variations for rolling and shearing, but these should be stated in a list to be published by the seller.

(3) Differentials and extras in the way of price should be clearly understoood, and the seller should publish a similar list covering these items.

(4) Even if prices are quoted at final destination contract delivery should be f.o.b. cars at the seller's works, with freight allowed to destination, the delays and risks of transportation being borne by the buyer.

(5) If the prices quoted include a freight charge, the same should be subject to adjustment in case of increase or decrease in the published freight rate.

(6) Terms of payment and character of funds in which payment is to be made should be clearly stated, and the amount and terms of discount, if any, clearly set forth. It should be made clear that freight charges are to be paid in cash by the buyer, and that they are not subject to discount.

(7) It should be clearly stated that shipments and deliveries under the contract are at all times subject to the ap-

*Abstract of a Paper read at the New York meeting of the American Iron and Steel Institute.

†President of the Lackawanna Steel Company.

proval of the seller's credit department, and that in case of doubt arising as to the buyer's responsibility, further shipments may be suspended until satisfactory assurance as to responsibility is given.

(8) Specifications in detail should be furnished in substantially equal monthly quantities not later than the 15th of the month preceding the month in which delivery is desired; all material to which the buyer is entitled under the contract to be specified at least thirty days prior to the expiration of the contract. Buyer's failure to furnish specifications as aforesaid to be treated at seller's option, and without notice to buyer, as a refusal to accept and receive the unspecified portion of the goods.

(9) The seller should promptly acknowledge receipt of specifications and at the same time advise buyer of the date on which it is expected to begin deliveries against such specifications, and the approximate date at which it is expected to complete the same; such deliveries to begin as soon after receipt of specifications as condition of seller's mill and of its previous sales obligations will permit.

(10) There should be a clause defining the seller's liability for non-performance, and the following is suggested as fair:—"The seller shall not be liable for non-performance of this contract in whole or in part, if such non-performance is the result of fires, strikes, differences with employés, casualties, delays in transportation, shortage of cars or other causes beyond the seller's reasonable control; nor shall these exemptions be limited or waived by any other terms of this contract, whether printed or written; but in the event of unavoidable delay due to fires, strikes or other causes beyond the control of the seller, the buyer may, subject to previously obtaining consent of the seller, cancel the portion of the goods not manufactured or in process of manufacture at the time his request to cancel reaches seller's works. The seller is hereby given the right to have any company in the United States furnish material of the same kind and quality at the same cost to the buyer, in whole or part performance of this contract; and it is agreed that shipments and billing of material by or in the name of such company, as well as any payments made to such company therefor, shall be as effective and binding as if made by or to the seller direct."

(11) The seller's guarantee in regard to defective steel should be clearly stated, and the time and manner in which claims for shortages or other errors, deficiencies or imperfections must be made

(12) All tests by buyer for physical or chemical requirements and all surface inspection, should be made at seller's mills before shipment, and should be final.

(13) There should be a statement that the contract is made and executed in the State in which the seller's works are located, so that in case of disputes the laws of that State shall govern.

(14) There should be a statement that there are no understandings or agreements relative to the contract that are not fully expressed therein, and that no changes shall be made unless reduced to writing and signed by both parties.

Contracts drawn to embody the above conditions if they are made known to the buyer at the time the quotation is made, should leave little chance for dispute, and should be perfectly valid and enforcible; but they can be enforced only if the principal manufacturers of steel believe in so doing and insist upon their enforcement even at the risk of losing a customer. No mere form or set of conditions will make a contract binding unless the conditions are to be enforced, and one of the conditions which must be lived up to scrupulously by the seller is that covering deliveries and shipments; and the seller must stand willing to be penalized if he does not make the deliveries agreed to, just as he expects to penalize the buyer for breach of any of his covenants.

Differentials and Extras.—One custom among European steel manufacturers which has struck the writer as being of great value, is that of publishing very complete lists of differentials and extras, covering not only sizes and quality, but also the quantity of one size or section in an individual specification. From these the buyer can tell just what his material will cost him, and is thus enabled to so design his work as to utilize the lowest priced material. The writer believes that a proper differential in price, for quantity of one size specified at one time, would prove a satisfactory solution to all concerned on the question whether large consumers are entitled to a better price than small consumers. Such a basis of differentials is logical because the extra price is charged on account of extra cost. In other words, the buyer, if he requires more expensive service, has to pay correspondingly for it. The writer believes that if a properly prepared schedule of differentials and extras for size, quality and quantity of individual specification were in force, the base price of steel could be considerably lower than under present conditions, without reducing the profits of the seller.

Mr. J. A. Farrell (President of the United States Steel Corporation) in the discussion remarked that contracts for future delivery of material were in a certain sense a means of insurance accorded by custom from sellers to regular consumers to enable buyers to make provision against the future and resell or consume the material at a profit. It was essential that merchants and consumers should be able to calculate precisely the cost of material, to enable them to manufacture and sell over a fixed period. But this period should be a reasonable one and should be limited, so far as possible, in the case of the merchant trade for re-sale to three months from date of contract, and in the case of manufacturing consumers to six months. It was self-evident that in insisting upon buyers carrying out their contract obligations with the same due regard as they expect from sellers, there should be no guarantees against declines. But if any modification of this rule should at any time be permitted, particularly if any deviation was made in contracting for longer than the recognized period, it should be solely against seller's own decline. And there should be a resonably compensating provision to the effect that if prices should subsequently advance, contract prices should be correspondingly adjusted. It was a distinctly unbusinesslike proceeding to permit buyers to reap any advantage that might accrue from a reduction in the contract price without allowing sellers a similar advantage when there was an advance in price. If contracts were to be made on a fluctuating basis, they should provide for advances during the life of the contract as well as for declines. In other words, the contract should be in all respects mutual. At the time of the formation of the United States Steel Products Company it was found necessary to formulate general conditions of sale. These conditions were made necessary by reason of many practices in vogue in export markets. It might be said that they were acceptable to buyers throughout the world, as an ordinary matter of course, because they clearly defined the obligations of both seller and buyer. Mr. Clarke's suggestion of a uniform sales contract was excellent. The stipulations in such contracts as had been devised by foreign manufacturers and by a number of American manufacturers need only be those which conformed to authenticated legal decisions and which were fair alike to buyers and sellers. If material was sold on contract forms which clearly indicated the obligations of both buyers and sellers even though the provisions must necessarily be of considerable length, they would form a recognized standard, serviceable alike to both buyers and sellers. And they could in turn be made effective between the buyers and their clients, obviating the possibility of misunderstandings and the necessity for legal actions.

THE COATING OF STEEL PIPES.

The commission appointed to report on the water mains of West Australia, known as the Coolgardie main, make certain pertinent comments on the corrosion, which are of considerable interest to engineers.

The commissioners state that the two facts which have brought about external corrosion appear to be:—

(1) Deterioration of the protective coating, regarding which they state:

"It has been found that a coating which appears perfectly satisfactory to the naked eye, contains when examined with a magnifying glass, small holes due to minute bubbles which penetrate right through to the metal beneath. On removing one of the nodular incrustations which form as a result of corrosion, the coating at first sight appears to be sound. A more minute examination, however, reveals the fact that the metal has decayed below the coating, having been attacked by the penetration of the water through one of these minute holes to the metal surface. Were the pipe to be dipped a second time as recommended by the commission, care having been taken that the first coating remained uninjured, the odds against two air bubbles one above the other, giving direct access of the water to the metal, would be enormous.

"It is unfortunate that this recommendation, though no doubt a somewhat difficult one to comply with, does not appear to have been carried out."

(2) The fact that the pipe was buried in trenches when it should have been carried on trestles, so as not to be in contact with the surrounding soil, the soluble salts contained in which give rise to corrosion when moisture is present, regarding which they state:—

"Had the pipes been laid above ground, as recommended by the commission, the external corrosion, as influenced by the soluble salts contained in the soil, would have been entirely done away with."

It is understood that the sandy soil along this pipe line is so impregnated with salt that in many places it absolutely glistens, in which case it is hardly surprising that external corrosion set in.

The coating of steel pipes is a subject to which a great deal of attention has been devoted. If circumstances point to corrosive influences being present from within or without, it is best to order the pipes dipped in special solution, wrapped in hessian and recoated. On reference to the notes quoted from the Coolgardie commissioners' report it is observed that, in their view, had the pipes been dipped twice as this treatment provides, no corrosion would have taken place internally, while, externally, the thick and tough protection provided by the addition of hessian would also have prevented the abrasion of the coating in transit. As evidence of the efficiency of such coating reference may be given to the case of some thirty miles of 30-in. lock-bar pipes for high-pressure gas (similar to the water mains of Coolgardie) which were laid in Staffordshire ten years ago. These mains were laid through heaps of slag and ashes, well known to exercise a highly corrosive action on steel. Inspection of these a year ago shows them to be in as good a state of preservation as when laid, the pipes and coating being intact and bearing every indication that they will remain so for an indefinite period. This main is of particular interest, in that it has remained tight and efficient in spite of the subsidence amounting to feet, due to underground workings.

HYDRO-ELECTRIC STATION AT GATUN SPILLWAY.

Specifications and requisition for auxiliary electrical equipment for the Gatun hydroelectric station have recently been forwarded to the Washington Office for purchase in the United States. This equipment is in addition to the plant purchased some time ago, the first contracts embracing the hydraulic equipment, with the electric generators and exciters. The principal items of the present requisition are the switchboards, oil-switch group, station battery, light and power transformers, and an air compressor, all necessary for the equipping of three complete generating units. A brief description of the waterpower project of the Panama Canal follows:

From the storage in Gatun Lake, there will be available sufficient water to warrant the installation of 6,000 kilowatts in generating capacity, including reserve. The average head throughout the year will be approximately 75 feet, the elevation of the tail race being about eight feet above sea-level. During the rainy season, water will be plentiful and must be wasted over the adjacent Spillway. During the

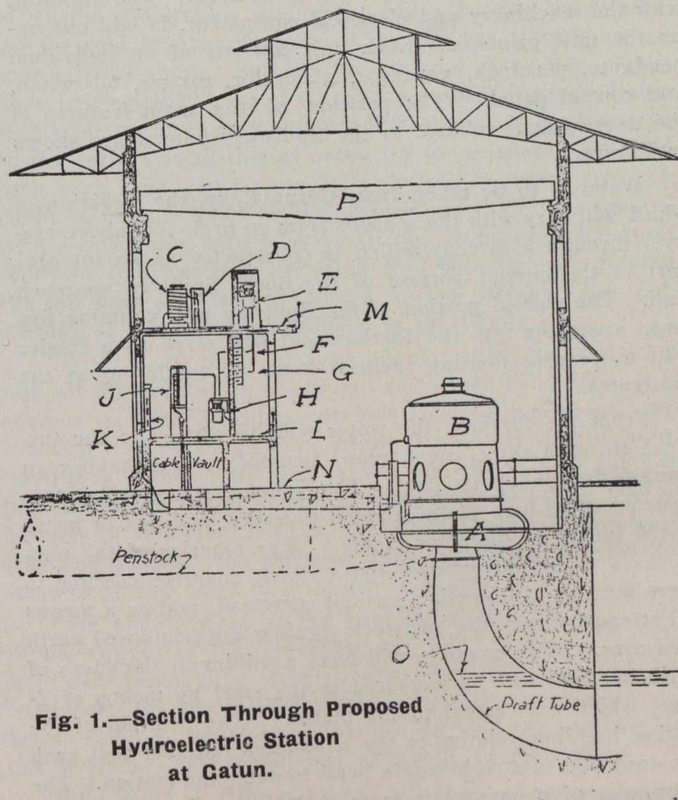


Fig. 1.—Section Through Proposed Hydroelectric Station at Gatun.

dry season, however, it will be necessary to draw upon the storage in Gatun Lake above elevation plus 79. The maximum quantity of water diverted for hydroelectric development is approximately seven per cent. of the minimum water supply and is the excess which is not required for lockages, evaporation, and leakages. Water will be extremely abundant for several years, until such a time as the traffic through the canal approaches full capacity.

The electrical load, which will be connected to the hydroelectric station, consists for the most part of power feeders, which will distribute energy to the machinery of the three locks, to the permanent machine shops, to the dry dock, to the coal handling plant, to the batteries, and to other smaller electric drive which is now giving service. In addition, there will be the lighting load of the locks and of the Zone towns. In all probability, considerable load will be obtained through a service for domestic purposes, electric cooking utensils replacing the stove, in order to create a saving in the cost of fuel, which is an expensive item upon the Isthmus.

There is a slight possibility of an electrification of the Panama railroad over the relocated lines, the electrification depending entirely upon the nature of the traffic conditions that result after completion of the canal. The circuits from the station to the load centres, in general, will be in duplicate, insuring as far as possible an absolutely continuous service. The station will be connected by means of a high voltage transmission line to the present steam generating station at Miraflores, which station will be held in reserve to tide over either shut-down or low-water periods of the Gatun station.

The hydroelectric station is to be situated adjacent to the north wall of Gatun Spillway. The building will be constructed of concrete and steel, and will be of a design suitable for a permanent power house in a tropical country. The dimensions of the building are such as to permit the present installation of the three 2,000-kilowatt units, and provision is made for a future extension of three additional similar units. The building will be rectangular in shape, and will contain one main operating floor, with a turbine pit and two galleries for electrical equipment. The station equipment will include a 30-ton crane to be used during erection and whenever repairs are to be made. The building, with the machinery and electrical equipment, is laid out upon the unit principle. Each unit consists of an individual headgate, penstock, governor, generator, exciter, oil-switch, and control panel. The position of the main features of the development relative to the Spillway channel are shown in Figure 1.

Water is to be taken from Gatun Lake, the elevation of which will vary with the seasons from 79 to 87 feet above sea-level through a forebay which is constructed as an integral part of the curved portion of the north Spillway approach wall. The curved portion of the Spillway wall contains five large apertures into the forebay and will serve as a fender wall to prevent floating debris from accumulating at the headgates.

From the forebay, the water will be carried to the turbines through three steel plate penstocks, each having an average length of 350 feet. The penstocks are to be constructed of ⅜-inch plates riveted together, and are to be 10 feet 6 inches in diameter inside. The exterior of the penstock is to be surrounded by a thick concrete coating to serve both as a protection against corrosion, and as a means of strengthening the penstock against superimposed earth pressures. The concrete will have a minimum thickness of 12 inches and will be anchored to the steel by means of Z-bars, which are riveted to the plates. The position of the station building relative to the headgates requires that each penstock makes a right angle bend to enter the station. The alignment of penstocks is such that the steel and masonry will be entirely covered by the fill of Gatun Dam. Near the lower end of the penstocks, at the building wall, there will be installed a testing link, the purpose of which is to measure, by the velocity method, the quantity of water flowing in the tube.

The entrances to the penstocks will be closed by cast iron headgates, and bar iron trash racks, the latter being provided for the purpose of preventing sunken débris from entering the penstocks and either clogging or breaking the turbine runner. The headgates will be raised and lowered by individual motors, which will be geared to rising stems attached to the gate casting. Control of each motor from the station switchboard will be effected by means of reversing contactors with interlocks, a limit switch, and a float switch, all operating automatically. The driving machinery and the motors will be housed in a small concrete gate house, erected upon the forebay wall directly over the gate recesses and trash racks. The gate house will be constructed for the present requirements of three headgates, and provision is made for a future addition of three more units.

The turbogenerator units are to be of the vertical type; the entire weight of the rotating element being suspended from an overhung thrust bearing, which is supported from the top shield of the generator. The water turbine proper will be of the spiral casting, one runner, Francis type, and is to be set in heavy masonry foundation. The water will enter the turbine through a tapering joint from the penstock and discharge into an increasing, elbow draft tube, made of ¼-inch steel plates and will be imbedded in the concrete foundation. A section of the station, showing the arrangement of penstock, turbine, and draft tube, is illustrated in Figure 2. The turbine is rated at 2,250 kilowatts at a speed of 250 r.p.m. and will consume approximately 500 second feet of water at full load.

Superimposed upon the turbine casting is to be the generator, a distance ring, six feet in height, separating the two. The generator is to be rated at 2,000 kilowatts, and will deliver 3-phase 25 cycle current at 2,200 volts potential. The turbine, generator, and auxiliary equipment are to be of the best mechanical and electrical construction obtainable. The governor is to be mounted upon one side of the distance ring and is to be geared solidly to the main shaft.

The path of the electrical energy from the generator to the outgoing feeders is shown diagramatically by the heavy line in Figure 2. The leads emerge from the lower part of the generator and pass through a manhole at the base of the turbine into a duct line, which carries the cables to manholes in the cable vault; thence the leads are taken up the building wall in tile ducts to the generator reactances. The reactances are to give protection to the generators in event of severe and protracted short-circuit outside the machines and consist of air insulated coils mounted upon concrete cores; a reactance coil is inserted in each of the three phases of each generator.

Adjacent to the reactances is a concrete cabinet which contains small series and shunt transformers for energizing the instruments and protective devices on the main control switchboard. The generator leads next enter a concrete compartment which houses a pair of oil switches. The two switches permit a selection of connections to either of the duplicate buses, which are situated on the first gallery floor, directly underneath the generator oil switches. The buses are to distribute the energy among the several circuits, each of which is equipped with oil switches. The distributing circuit passes from the circuit switch to an instrument transformer compartment, which is quite similar to the generator instrument transformer compartment. From the instrument transformers, the circuit cables drop into the vertical duct shelves in the cable vault below; thence make an exit from the station through manholes at either end of the building into duct lines at the crest and toe of Gatun Dam. As far as practicable, the entire electrical equipment is in duplicate, and is designed with continuity of service, operating accessibility, and protection of human life as the prime considerations.

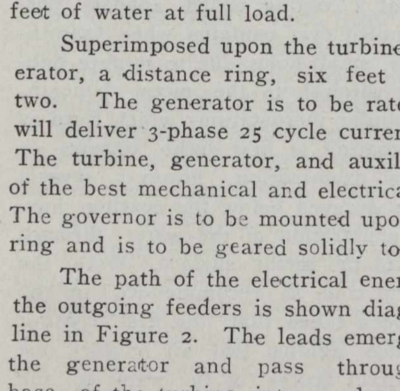


Fig. 2.—Location Plan.

A—Fender Wall. B—Forebay. C—Gate house D—Penstocks. E—Power House. F—Possible extension. G—Tail race.

One feature of a well designed, modern power house is the remote control of all auxiliary machinery and equipment, particularly of the dangerous switching operations on high voltages. The control and the protecting devices of the Gatun station have been worked out carefully and will permit of an extremely flexible and reliable operation of the generators upon any probable condition of loading. A main control switchboard of the unit panel type is to be erected upon the second gallery floor, where the operator possesses a good view of the entire station. Command of all operations is obtained through master control switches, and indication thereof is procured by means of small pilot (signal) lamps. The operator at the switchboard remotely controls all switching operations, both on the high tension and the exciter buses, and, in addition, controls the headgates, the governors, the rheostats, and the field circuit breakers.

Besides the control switches, the main switchboard contains all indicating, integrating, and recording instruments, which are essential for an intelligent and economical operation of the station. Time limit relays are mounted upon the rear panels to serve as a protection to circuits and generators in case of overload. Continuity of the operating circuit for the control of switches will be obtained by the installation of a storage battery upon the first gallery floor, the switches being mounted upon one panel of the main control switchboard. A voltage regulator, which will automatically maintain a uniform bus pressure, will be assembled upon a smaller station panel at one end of the main board.

The canal commission will try one slight variation from standard practice in an attempt to secure the greatest reliability in the excitation system without the necessity of installing additional water turbine exciter sets. In any alternating current station, it is absolutely necessary that the fields of the alternators be supplied continuously with direct current, usually at 100 to 125 volts potential. When the station is running smoothly, this direct current supply is obtained most economically through motor-driven exciter sets, which are operated directly from the 2,200 volt buses. Two such units, each of 100 kilowatts capacity, will be erected in the Gatun station. Difficulty is encountered, however, when the station is inoperative, as no source of 2,200-volt energy is available to drive the exciter sets. It is customary practice in hydroelectric stations to install independent exciters, which are driven by small water turbines. The small water turbines are more complicated than motor-driven sets, requiring adjustment of governor and of valves, and also additional penstocks and gates, with the resulting complication of operation. At Gatun, each main will be equipped with a 50-kilowatt exciter mounted upon the vertical shaft in the 6-foot space which separates the turbine and the generator. When starting, after complete shut-down, the direct-connected, 50-kilowatt exciters will furnish the necessary excitation until such a time as the motor-driven exciter may be connected to the system. This selection of exciter equipment results in a very simple and easily operated system which possesses ample capacity under all conditions of operation and exceptional reserve in event one exciter is accidentally damaged.

RAIL BREAKAGES.

The weather generally gets the blame for the great railway accidents which are so characteristic of this continent. It is a happy explanation because it is a verdict which doesn't hurt anybody. Extremes of cold and heat are held responsible for the breaking and warping of rails and it has been rather hastily assumed that such "accidents" were unavoidable. The Union Pacific has, however, according to the Wall Street Journal, discovered the secret of avoiding the "unavoidable." Our esteemed contemporary says: "While a joint committee of the railroads and rail manufacturers is wrestling with the problem of eliminating the dangerous breakage of rails, Julius Kruttschnitt and his consulting engineer, John D. Isaacs, have solved the rail problem to so complete a degree that the Harriman lines are far in advance of any other roads in the country in the matter of reduction of rail breakage.

In crucial form the rail problem has been a winter problem. During the winter of 1911-12 there was an epidemic of broken rails on a score of roads, attributed without exception to the severity of the cold weather. The Harriman lines have discovered a remedy for the cold weather rail breakage so effective that the number of the new rails broken during the winter months of 1909, 1910 and 1911 was no greater than the number broken in July or August. Moreover, the cold weather breakage of the new style of rails is far below the breakage of the old style rails in summer months, when they are under least stress.

The secret of the elimination of the broken rail from the Union and Southern Pacific is fundamentally a matter of "section," that is, the shape of rail. The Harriman officials solved the problem by giving the rail a heavier base During the cold weather the base of the rail has a tendency to become bowl shape. In forcing the rail back into shape there is great likelihood of starting a surface fracture. Rails, highly tempered as they are, act like glass. A good scratch on the surface is all that is necessary to cut glass. It is the same with rails. In laying rails the rail is never cut. A slight incision is made on the surface and the rail is broken. With a rail whose base is heavy enough to prevent change of shape in cold weather, obviating the necessity of forcing the rail back into shape, causing surface breaks, the percentage of breakage was reduced to practically nil.

"With 20,000 miles of road offering different styles of rail, all different sorts of climate and traffic conditions, it is obvious that the possible combinations of conditions surrounding rail breakage were infinite," said Mr. Kruttschnitt, "and it is probably for that reason that the task of solution has struck the average railroad official as hopeless. When a series of rail breaks occur, the division officials get panicky and attribute the event to some mysterious factor instead of sitting down to work out the cause.

"We simply went at the situation systematically. Mr. Isaacs suggested that we chart our rail breakages and see if it were possible to discover some law of breakage. We went over our record of breakages to discover whether any blame could be attached to the various kinds of rail, localities or traffic. The result was as simple as astounding.

"We found that the 90-pound rail of the shape in general use gave an average of 6 breakages to the 100 miles during the summer months when the mean temperature was about 75 degrees, and 23 breakages per 100 miles in winter with the temperature around 40 degrees. We found that the rail with heavier base gave only two breakages to the 100 miles in the winter months, the same average as during the summer months, so that so far as the Harriman lines are concerned the rail problem is solved. We are proud of our rail record. We feel that we have solved the problem for all the roads. Of course, we have been careful in giving our orders to the mills we had found most reliable and have insisted on a high grade rail, but it is the shape of rail that has solved the problem fundamentally."

The experience of the Union Pacific is important, because if there is any way of preventing at any cost the deplorable accidents that occur every year through broken rails, there will be a public demand for its adoption, which neither the railway companies nor the legislatures can afford to ignore.

THE CANADIAN NIAGARA POWER COMPANY.

The annual report of the Queen Victoria Niagara Falls Park Commission states that in the month of August, 1911, the Canadian Niagara Power Company, Niagara Falls, Ont., asked permission of the commissioners to proceed with certain alterations and improvements at the entrance to their forebay. The officers and engineers of the company represented to the commission that they had encountered serious difficulties in operating their plant when the ice conditions in the river rendered it practically impossible to keep their intake clear. These conditions were acknowledged to exist by the superintendent of the park, but before taking action the commissioners thought it desirable to submit the matter to an hydraulic expert of large experience, Mr. Henry Holgate, C.E., of Montreal. The nature of the relief asked for by the Canadian Niagara Power Company was:

First.—The building of an ice shield some sixty feet in front of the present ice racks or about one hundred and fifty feet distant from the centre line of the bridge spanning the intake, and parallel with it.

Second.—The construction of an open canal to extend from the water's edge of the Niagara River to the southerly extremity of the forebay for the purpose of increasing the current of water across the intake arches northward to the ice sluiceway, in order to force the ice entering the forebay to pass out into the river.

Third.—The alteration to the entrance of the ice sluiceway so as to provide for more easy access for the water currents carrying ice.

Fourth.—Placing a submerged weir from the northerly side of the intake into the rapids at an angle with the lines of current, so as to provide for the mean water being raised about three feet.

Mr. Holgate reported upon the plans submitted and practically agreed with the company that the works of improvement were necessary for the efficient operation of the plant. He also expressed the belief that they might be carried out under proper restrictions without doing violence to scenic effects.

The commissioners, however, while fully realizing the importance of the company of ameliorating the ice difficulties, could not see their way to adopting the entire scheme of improvements without certain modifications. It was represented by the commissioners that an open canal, however important from an hydraulic point of view, was not a desirable feature for the park at this point, particularly when so much bridge work already existed, and they suggested that the company should construct underground conduits in place of an open canal. Apprehension was also felt that the construction of a submerged weir would tend to destroy the naturally turbulent condition of the surface of the rapids for some distance upstream, and create an artificial millpond appearance. Approval, therefore, of the construction of a submerged weir was withheld until definite expert information could be received on this phase of the matter. To that end the company obtained expert opinions on that special feature of the proposed works from Mr. William Kennedy, Jr., hydraulic engineer, Montreal, acting on behalf of the city of Niagara Falls; Mr. Louis Coste, engineer, member of the International Waterways Commission, and their own hydraulic engineer, Mr. C. C. Egbert, to the effect that, if the design of building a solid submerged weir was abandoned, and a structure formed by depositing concrete blocks or boulders upon the rock bottom with no portion of the structure within some feet of the surface of the water were substituted, the existing condition of the water surface might be maintained. This plan received the approval of the advisory hydraulic engineer for the board, and the whole matter is now being reduced to an agreement accompanied by plans and specifications. The commissioners, however, are safeguarded by a clause in the agreement distinctly stipulating that, in the event of the irregular blocks not accomplishing the object sought, after a reasonable test, the work shall not be proceeded with.

Simultaneously with the intake improvements the Canadian Niagara Power Company conveyed to the commissioners its intention of proceeding with the power house building to its entire completion, instead of finishing the work by sections as the development and sale of power necessitated. The company also presented a plan for altering the architectural outline of the riverward elevation of the power house, showing a new structure in the centre of the building to be used for office purposes. This slight addition, which was at once approved, completely changes the forebay facade of the building and breaks the lines of a building six hundred feet long without any relieving features. While the company is not adding to the capacity of the station beyond the sixth unit, the additional equipment from time to time required will be placed without serious disturbance to the park, so that the complete restoration of the park surface surrounding the power house may be now finished.

The company now has the following installation completed:—

Generators.	Normal Capacity.	Total.
5	10,000 h.p.	50,000
1	12,500 h.p.	12,500

FORTIER & KILPATRICK, LIMITED.

The prospectus has been issued of Fortier and Kilpatrick, Limited, incorporated under the Dominion Companies Act and licensed to do business in Ontario. The company's authorized capital is $250,000. This company has been formed for the purpose of taking over, for the province of Ontario—excepting Port Arthur and the territory lying north of the Canadian Pacific Railway between Port Arthur and Mattawa—the patent rights and also the sole right to manufacture sewer pipe with the Thomas glazed cement sewer pipe machine, also, the sole rights to manufacture and deal in Trojan partitions and ceilings, stonewood plastic flooring. sarco asphalt and waterproofing. The company have several side lines, such as washable water paint, asphalt, etc., and the right to engage in any other manufacturing and mercantile business which may be conveniently carried on therewith.

Patent rights for the Thomas glazed cement sewer pipe machine and the right to manufacture Trojan partitions and ceilings and stonewood and Trojan flooring and Sarco asphalt and waterproofing and Trojan washable water paint are being purchased and acquired by Thomas Mills for $90,000, payable as follows:—$20,000 in the capital stock of Fortier and Kilpatrick, Limited, consisting of 200 fully paid and non-assessable shares and $70,000 in cash.

Fortier and Kilpatrick, Limited, in addition to the purchase of the Thomas glazed cement sewer pipe machine, and all rights connected therewith for the territory named, have also purchased the rights, patents, formulas, secret processes, etc., of the Interior Construction Company of Winnipeg for the following utilities: "Trojan" partitions, ceilings, etc., "Trojan" plastic sanitary floors, and Thomas glazed cement sewerpipe.

An offering of $150,000 stock of the company is being made at par. The proceeds from the sale of this stock will be devoted to acquiring the above named rights and patents and for putting money into the company's treasury to manufacture the same. The following are the directors of the company:—Messrs. John H. Hudson, manufacturer, 93 Bernard Avenue, Toronto; George R. C. Merriam, president Traders Limited, 31 Adelaide Street West, Toronto; W. E. Whitehead, manufacturers' agent, 355 Palmerston Boulevard, Toronto; James Aitchison, barrister, Canada Life Building, Toronto; Thomas Mills, banker, 79 Clarence Street, Kingston.

PERSONAL.

MR. S. HETT. B.A.Sc., has been appointed engineer in charge of revision for the Hudson Bay Railway.

MR. McARTHUR is being mentioned for the position of engineer for the municipality of Regina.

MR. E. M. KINDLE, A.B.M.S., Ph.D., a member of the United States Geological Survey, has been appointed invertebrate palaeontologist on the Geological Survey of Canada.

MR. DUNCAN McDONALD has retired from the position of manager of the Montreal Tramways Company. His position is being taken by Mr. James E. Hutcheson, of Ottawa.

MR. W. H. FISK, who has been connected with the Mackenzie-Mann interests in Mexico for the past five years, will probably be appointed to succeed Mr. W. B. Boyd as Chief Engineer of the Toronto Power Company, the Electric Development Company and the Toronto Railway Company.

MR. JAMES MILNE has been appointed electrical and mechanical engineer for the city of Toronto. Mr. Milne is at present manager of the Ontario Salt Works, Windsor. He is of Scottish birth, is 45 years of age, and has resided in Canada for twenty years. Eighteen years ago he was a teacher of mechanical and electrical engineering in the Toronto Technical School, and he has had a wide experience since that time. Mr. Milne is a street railway expert in addition to his other qualifications.

MR. ALFRED STILL, who left England in the early part of last year to take up the position of electrical engineer to the Lake Superior Power Co., of Sault Ste. Marie, Ontario, Canada, has lately been appointed chief electrical engineer the the mining department of the Algoma Steel Corporation. His headquarters will be at Magpie Mine, Ontario, where he will have charge of the electric power equipments at the various mines controlled by the company, and will also be responsible for the completion and operation of the 4,000 h.p. hydro-electric generating station connected to the mines through an 18 mile three phase overhead transmission. Mr. Still is an Assoc. M. Inst. C. E. and a member of both the American and British Institutions of Electrical Engineers.

TOWN PLANNING CONGRESS.

Uuder the auspices of the Winnipeg Town Planning Commission and the Winnipeg Industrial Bureau, the first Canadian Housing and Town Planning Congress was opened in the auditorium of the bureau on July 15th last.

The president of the Winnipeg association occupied the chair, and introduced Mayor Waugh, of Winnipeg, who spoke of the object of the gathering, why it was convened, what had been done, and what it was hoped to do. The congress was called together to devise plans and means to make every city and town more beautiful, and a more attractive place in which to live—to get residents to take more pride in their houses and the surroundings.

At the afternoon session of the congress W. Sanford Evans presided, and the meeting was addressed by Dr. Charles A. Hodgetts, medical adviser to the commission of conservation, Ottawa, on "The Housing Problem"; Dr. M. M. Seymour, Regina, commissioner of public health for Saskatchewan, on "The Tenement House Question"; and a paper by Frederic Law Olmstead, chairman of the International Housing and Town Planning Congress Committee, Brookline, U.S.A., on "The Four Cardinal Points of Town Planning," was read by Dr. Perry. The general trend of the papers was in strong condemnation of the tenement residence and apartment house, which subsequently degenerated into a tenement against the evils of overcrowding; and an earnest appeal for legislation empowering the municipality to have stringent control over such houses and conditions within them, for the good of public health and the vitality of the people.

In connection with the congress an exhibition of town planning, garden cities and schemes for improvement was illustrated by plans, photographs, charts and other data. The exhibit was displayed on the four walls of the room in which the meetings were held.

The Social Museum of Harvard University contributed a series of pictures and plans. The series included views of housing conditions in several cities; of garden suburbs; of city planning; of model cottages and modern dwellings. A feature of this exhibit was the illustrations of slums and slum life in larger cities of the old and new worlds. Attention was drawn to the dark bedrooms of the slum-areas where crowded humanity lives and suffers, from which sunlight and fresh air are excluded by gigantic skyscrapers. The methods adopted to remove the eyesore by the erection of attractive dwellings and by the creation of open spaces is indicated. There was a large assortment of exhibits from cities in the United States, New York, Kansas, Minneapolis, Tampa, Florida, New Orleans, Louisville, Harrisburg, all contributing; but the feature was supplied by a few of the plans of the proposed improvements in Chicago; and which represent a scheme which had foresight been employed a few years ago would have saved the city no less a sum than $300,000,000. Kansas City views showed park situations before and after improvement. Pittsburg was represented by an eyesore, as the exhibit is a view of an open sewer in the middle of a street which exists to-day.

The model towns of England, Bournville and Port Sunlight were beautifully illustrative of the ideal the city-planner aims at. Liverpool had an exhibit showing the improvements effected in the slum district of the Bevington area, necessitated by the "Housing of the Working Classes" Act. The garden suburbs of Hampstead, with the grouping of co-operative housing which eliminates the servant problem, were effectively shown. Edinburgh, old and new, its magnificent streets and fine buildings were illustrated in a series of photographic views. Manchester and Birmingham each had their representative exhibits. Germany and conditions in Germany were adequately shown, but of especial mention were certain Mannheim views, where the usually hideous gas tank is made an architectural centre from which the streets of the town radiate, and the interior park arrangement for sunlight and fresh air, adapted in the "Alfredshop" colony, Essen.

France was illustrated in a garden suburb and model village views. Perhaps the most interesting exhibit of all was the newspaper cuttings of the plans for the new federal capital of Australia, Vass-Canberra, New South Wales, which took first and second places respectively in the competition; while also shown was a copy of one of the competitive designs for the city improvement of Montevideo, conducted by the Republic of Uruguay.

The following is a partial list of delegates:—

Mayor Waugh, C. D. Sheppard, J. W. Harris, Dr. Mattice, J. D. Atchison, C. F. Bennett, H. Falk, H. Edwards, W. W. Willis, Winnipeg; J. T. May, C. Chambers, Toronto; J. P. Gilroy, Isaac Cowie, N. T. McMillan, W. Fingland, R. S. Ward, R. Martinson, W. Pearson, C. F. Roland, W. Sanford Evans, Paul Clemens, G. F. Chapman, W. Furnival, Winnipeg; M. H. Ross, Regina; M. Wilson, F. Saunders, J. Antonison, T. J. Townshend, Moose Jaw; Dr. T. H. Hodgetts, Ottawa; A. W. Boilfus, Chicago; M. L. Kenzie, Brandon; J. East, Dr. Whitlaw, Edmonton; Victor Mager, St. Vital; J. P. Marshall, Battleford; W. Smith, Kirkella; H. Goodie, Port Arthur; Mayor Armstrong, Edmonton; J. Caldwell, Virden; A. M. Jeffries, Edmonton; H. D. Pickhard, Brandon; G. W. Hayler, London.

COMING MEETINGS.

THE WESTERN CANADA IRRIGATION ASSOCIATION.—Sixth Annual Convention Kelowna, Okanagan Valley, B.C., August 13, 14, 15 and 16, 1912. Secretary, Normon S. Rankin, P.O. Box 1317, Calgary, Alta.

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.

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

EIGHTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY.—Opening Meeting, Washington, D.C., September 4th, 1912. Other meetings, Business and Scientific, in New York, beginning Friday, September 6th, 1912 and ending September 13th, 1912. Secretary, Bernhard G. Hesse, Ph. D., 25 Broad Street, New York City.

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

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, Mr. Hugh B. Fergusson, 409 Carter Cotton Bldg., Vancouver, B.C. 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 ASSOCIATION OF ARCHITECTS.—President, A. F. Wickson; Toronto. Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

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, Hon. W. R. Ross, Minister of Lands, B.C. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

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