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Relation of the Curve to Town-Planning

Not a Single Straight Street Line in Some Plans — Some Others Show Curved Lot Boundaries — Discussion of Methods Employed in Laying Out Curves for Street or Lot Lines—New Handbook of Curve Tables Required

By H. L. SEYMOUR
Town Planning Assistant, Commission of Conservation

TO many minds, the term "town planning" apparently brings the vision of an area planned with curved street lines, the curve being regarded as a vital part of town planning, of which it is considered not only the distinguishing but also the chief characteristic. The curve, of course, is not an end or aim of town planning (a term so inexpressive of its wide and varied scope), but rather is incidentally a means of accomplishing several ends more or less related.

By far the most important of these ends, largely an economic one, is that of having streets conform to the topography or nature of the ground. To fulfil this condition, except on level ground, street lines can seldom be straight; they must be either a series of straight lines, which if sufficiently shortened become a curve, or else these straight lines, for the sake of appearance (another desirable end to be attained), should be joined by curves. In this latter connection, in his "City Planning," Robinson says:—

Build for the Traffic

"We shall come in time to realize that wherever there must be a bend, not less on main avenue than on minor street, that turn should be a curve and not an angle. We build our streets for the traffic that makes use of them; we see that car-tracks sweep around the angle in a curve and the tracks of wagons and motors describe lines of grace, but because it is a little easier to survey lots in straight lines and angles

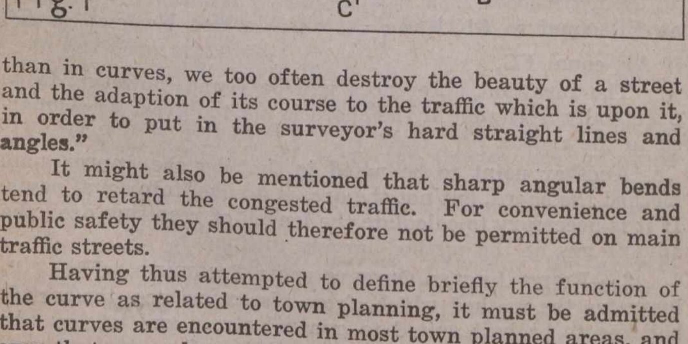

Fig. 1

than in curves, we too often destroy the beauty of a street and the adaption of its course to the traffic which is upon it, in order to put in the surveyor's hard straight lines and angles."

It might also be mentioned that sharp angular bends tend to retard the congested traffic. For convenience and public safety they should therefore not be permitted on main traffic streets.

Having thus attempted to define briefly the function of the curve as related to town planning, it must be admitted that curves are encountered in most town planned areas, and even that some plans as designed show not one single straight street line and exhibit also other curved lot boundaries. In this general connection the following extract from a letter received some time ago from Frederick L. Olmstead, a member of a prominent firm of landscape architects in the United States, is of value:—

"I am frequently impressed with the amount of labor involved in laying out and figuring a curvilinear street system according to railroad methods, especially where land values are low. Often there is a disproportionate and ill-balanced

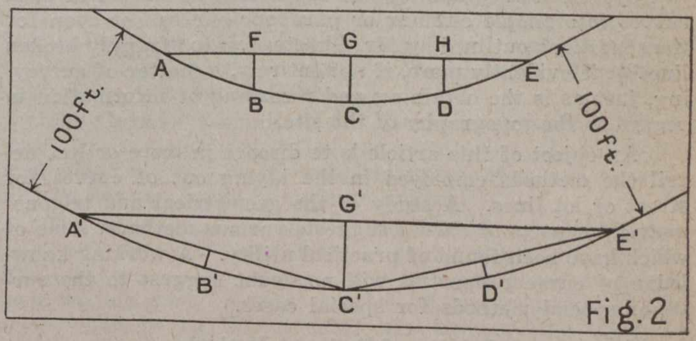

Fig. 2

expenditure in such work; straining at a gnat and swallowing a camel.

"For example, in laying out the side lines of streets, even where the plan must be curvilinear in general form for topographical reasons, there is no absolute practical necessity (such as exists in railroad work) for avoiding abrupt changes of direction, providing the total angle at any point is not too large.

"The justification for insisting on mathematically continuous curves and tangents in describing street alignments is essentially esthetic. There is a beautiful quality of gracefulness and an ideal expression of the continuity of vehicular movement in a road which changes its direction by perfectly gradual increments. But this calls not merely for the avoidance of angular bends, but for the avoidance of any abrupt change in *rate* of curvature.

Compound Curves Often Needed

"Unfortunately the desire to simplify calculations as much as possible, frequently leads a surveyor to put together his tangents and radial curves in such a manner as to produce an essentially and ungraceful ugly line. I constantly have to fight for the more liberal introduction of compound curves and easement curves in order to avoid the ugly effect of too sudden a change in rate of curvature in what purports to be a line of continuous movement.

"A frankly broken line, the successive pieces of which meet at angles of moderate deflection, if it is well fitted to the topography and good in its general form, is a better thing of its kind and may be far more agreeable in appearance than the usual mechanical combination of any radial curves and tangents that will take the road about where it has to go.

"By far the greater part of the land subdivision work of my firm has been done under conditions where a good appearance has a high market value, and where the side lines of streets are likely to be precisely and conspicuously marked by continuous hedges, fences, walls, etc. On curvilinear streets, therefore, we have generally stood firm for graceful flowing curves, even at the expense of a lot of extra calculation and surveying. But I am tending to the more and more frequent use of frankly broken lines. Used with skill and good taste they can often be made to produce thoroughly agreeable

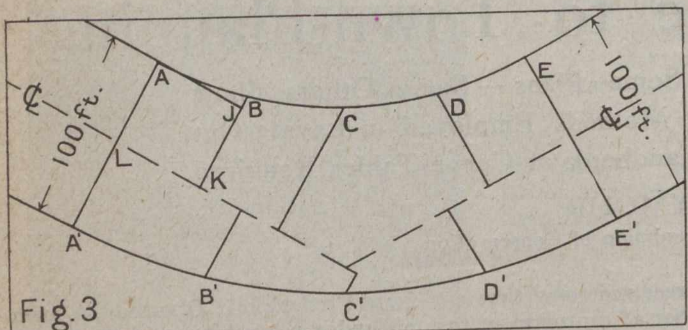

Fig. 3

results, and incidentally they save a serious amount of figuring and refiguring."

The designing of curved street lines as the practical solution of the various problems involved is, of course, an essential part of town planning, but the actual resolution of such curves into simple circular or parabolic curves (or even for the conditions outlined by Mr. Olmstead, into "frankly broken lines"), is evidently more, if not entirely, a matter of surveying, just as is the obtaining and recording of information in regard to the topography of the site.

An object of this article is to discuss in more or less detail the methods employed in the laying out of curves for street or lot lines. A study of the geometrical and trigonometrical aspects of curves suggests various methods, some of which have been found of practical utility. A working knowledge of curve properties will no doubt suggest to the surveyor special methods for special cases.

Adaption of Railroad Methods

1.—The Deflection Method.—An adaption of railroad methods to street or lot location. In railroad practice it is the custom to first locate a series of straight centre line "tangents" which are subsequently joined by curves of suitable radii.

These curves are generally laid out by the "deflection" method, a useful geometrical property of the simple circular curve being availed of, viz., that equal arcs of a circle subtend equal angles at any point on the circumference of that circle.

In practice, it is impossible to measure around the arc, so the chord is employed. With the 100 ft. chord as the basis, convenient tables have been prepared. (See any standard American handbook on railroad curves). For curves of large radii encountered in railroad work, results are obtained which, though not rigidly true, are considered as sufficiently exact.

In street locations where the radii are large, railroad curve tables may be conveniently used with a sufficient degree of accuracy. But for the smaller radii, and where for the registering of plans or other reasons a greater degree of accuracy is required, the difference between the arc and the chord must be allowed for and ordinary railroad curve tables cannot as a rule be conveniently applied. For a discussion of the deflection method as adapted to street or location, see "The Principles and Practice of Surveying," Vol. I, by Breed & Hosmer.

The deflection method is the standard method for street and lot location and is the one usually employed. But in a wooded area a great deal of cutting is necessary in addition to that for any preliminary lines that may already have been run. Valuable trees may be sacrificed, not only on street areas which would subsequently be cleared to a large extent, but also on lot areas.

In Fig. 1, illustrative of curved street lines, several points on the curves are shown as located by the deflection method, the curve on each side of the street being separately determined. Chords such as AB, BC, etc., must be cleared for chaining, and in addition, lines AC, AD, etc., opened up for sighting from instrument at point A. Assume 50 ft. arcs and a radius of curve of 200 ft., the same values for the purpose of subsequent comparison also being assumed in Figs. 2, 3, and 4. For the case shown in Fig. 1, there would be required in a wooded area (besides any preliminary lines such as the centre line tangents shown) 1,600 ft. of cutting, 960 ft. being in the street area and 640 ft. in lot area.

Requires More Involved Calculations

2.—Right Angled Offsets from Chords.—Formulæ can be developed for an exact mathematical determination of points on the curve by right-angled offsets such as FB, from a chord such as AE in Fig. 2. The necessary calculation is generally more involved than in the preceding method, though there is a reduction in the length of lines to be measured or cleared of obstruction. For the case shown in Fig. 2, there would be required 635 ft. of cutting, 380 ft. being in street area and 255 ft. in lot area.

A convenient modification that suggests itself is to join the ends of a chord such as A′E′ to the mid-point C′ of the arc A′E′ as established by offset from the mid-point of the chord.

Then the resulting chords, such as A′C′ can be bisected and ordinates (approximately ¼ of original ordinate G′C′) calculated to locate points B′ and D′, the resulting arcs being equal in length.

By proceeding in a like manner as many points (equally spaced around the arc) as desired may be located by this method of offsets from chords.

But it is by the use of approximate formulæ that offsets from a chord become really convenient. R. Russel Grant, in a paper published in *The Canadian Engineer* for July 26th, 1917, has shown how such a method is practically worked out. It should be noted that the approximate formulæ employed define points on a parabola and not on a simple circular curve.

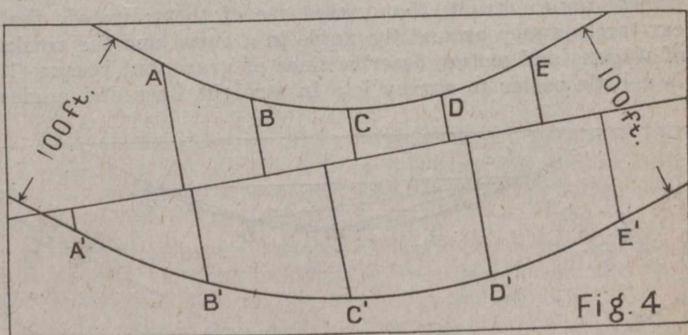

Fig. 4

For example, in Fig. 2, where GC is assumed equal to $(AE)^2$ divided by eight times the radius; and ordinates such as FB equal to GC less $\frac{GF^2}{GA^2} \times GC$, which becomes ¾ GC if AF equal FG.

The resultant differences will be found, however, to be practically negligible if the chord is not too great as compared to the radius.

Another point to be noted is that by the approximate method the chord, but not the arc, is divided into equal parts. If it is necessary to calculate the length of resulting arcs, the advantages of the method largely disappear.

3.—Right Angled Offsets from Tangents.—Fig. 3 illustrates the method which, from his experience, the writer believes to be best suited to general street and lot location work, especially in a wooded area. Offsets from tangent can, if desired, be rigidly determined. In an article dealing with this matter (see *The Canadian Engineer* for December 21st,

1916) it has been pointed out that a slide rule with special scales would greatly expedite curve calculations of this nature.

It seems apparent that a width of a lot fronting on a curve should be defined as a length of arc and not of one or a number of chords. In this method, then, the actual length of arc, or the angle subtended by that arc at the centre of the circle is taken as the basis from which all other information can be found. To illustrate, as in Fig. 3, for arc AB and radius R, the angle subtended at centre of circle is found to be $\frac{180}{\pi} \times \frac{AB}{R} = A$ (say); then $AJ = R$ sine A, and $BJ = R$ versine A. At K, a distance of LK equal to AJ along tangent, erect perpendicular BK equal to AL plus BJ, and the point B is located.

The lines to be cleared in a wooded area for case shown in Fig. 3, are (besides centre line tangents) only 280 ft. in length, and all such clearing would be in the street area. For streets less than the 100 ft. width assumed in the figure, the amount of clearing would be also further reduced. For a long curve, some portion of the tangents might be found outside the street area. For such a case, or where the offsets are considered too great, an auxiliary tangent might be employed. Easement curves which cannot be discussed in this brief article are also readily located by offsets from tangents.

Considering the chord as a line parallel to a tangent, the calculations for right angled offsets from tangent may be adopted also for the determination of right-angled offsets from chord.

4.—Offsets from Traverse Lines.—Where certain traverse lines have been run approximating to the location of centre lines (see Fig. 4), offsets may be determined by scaling from drawings to scale of say 20 ft. to the 1 inch. As a matter of fact, scaling on a plan of any size is always an important check in the work of curve calculations. In Fig. 4 the length of lines to be cleared are substantially the same as those in Fig. 3.

In conclusion, it may be stated that a variety of methods for curve location are evidently available; but also that there is evidently required a handbook of curve tables having particular reference to street and lot location.

The Ontario Provincial government has taken over the Cobourg and Port Hope toll road as part of the new provincial highway system. The price paid was about $10,000. The toll road company was organized in 1847. Negotiations are pending for the taking over also of the Cobourg-Grafton road.

In a report on housing conditions in "the Ward," the Toronto Bureau of Municipal Research suggest better pavements for Teraulay, Edward, Elm and Walton Sts. and Laplante Ave., not only for the improvement of the district, but also to assist in relieving traffic congestion on Yonge Street.

The Engineers' Club of Toronto will hold an informal dinner at 6.45 p.m. next Tuesday, at which an after-dinner talk will be given by Hon. Sir Wm. H. Hearst, Premier of Ontario. Sir William's subject will be "Reconstruction in Ontario." As it will also be Ladies' Night, a musical program has been arranged.

Although there has been an increase of over 10,000 in the number of children attending Toronto Schools in the past ten years, practically no schools have been built for several years past. Chief Inspector Cowley has informed the Board of Education that unless new buildings are provided the board will lose the provincial grants amounting to about $70,000 a year.

Work on the military hospital adjoining the general hospital at Calgary, Alta., has been stopped. John Weston, Calgary representative of Carter-Halls-Aldinger, who had the contract for the building, received a telegram from the Department of Militia and Defence ordering the work to be stopped and stating that all military hospitals in Calgary can now be dispensed with.

GERMANY'S PREPARATIONS

For Resumption of Technical Education—Do the Hun's Plans Include Any Ideas That Might be Advantageously Utilized in Canada?

THAT Germany intends to lose no time in resuming technical education is proven by the following excerpts from a pamphlet entitled "Transition Measures and University Reforms," issued by the Society of German Metallurgists, a copy of which has been kindly sent to *The Canadian Engineer* by the eminent English scientist and manufacturer, Sir Robert Hadfield, who translated it:—

The transition period will make heavy demands on our German Technical Arts and Industries. The question is to put trade on the new peace economy and to put the experiences of the war to scientific account. For this, scientific and thoroughly trained engineers, above all, are required in large numbers; the academic technical younger generation appears, however, to stand in great jeopardy, as a large number of students, for economic or other reasons, will not be able to complete their studies.

Facilitating Resumption of Studies

In order to counteract the disadvantages arising therefrom we must facilitate, in every possible way, the resumption of their studies of all who have taken part in the war, or, otherwise the great reputation of our German Technics will suffer.

This demand is advocated by the German Committee for Technical Education, on which the leading representatives of German Technics and Industry, as also university teachers, have combined in an address to the German Education Authorities, worded as follows:—

The German Committee for Technical Education, after exhaustive consultation with representatives of technical professions as well as of technical universities and mining schools, has the honor to state as follows:—

The long duration of the war almost completely interrupted the education of those young men from among whom German technical arts and economy have to select their leading men. A large number of professors are in the army. Nearly all the students are serving the Fatherland in the army or at home. Many have sacrificed their lives, their health, and their working faculties. The extraordinarily great diminution in the numbers of the younger generation of engineers, chemists, mining engineers, metallurgists, and architects will render the resurrection of our economic life ominously difficult and will retard it. This danger must be averted timely and as energetically as possible.

The danger ahead of us lies in the fact that the transfer from university to actual practice will take place before the scientific education is complete. Those students who have lost the most valuable years for their education by fulfilling duties of the most extremely patriotic nature must rightly be concerned to cut down studies as far as possible. Many will also be compelled from economic reasons to become wage earners at an early date.

Education Below Usual Standards

To this must be added that the preliminary education of the students has sunk far below the usual standard on account of the leniency shown at the examinations held at the preliminary schools. We have, therefore, also to deal seriously with the danger of a very marked decline in the scientific attainments of the graduates of our universities and mining schools. This danger must be reduced to a minimum consideration for the students, no less than that for the most urgent requirements of technical arts and industries, compels us to seek methods by which we can expedite the training as much as possible, and still make it sufficiently thoroughly scientific.

This aim cannot be attained without modifying the curriculum hitherto usual. The technical universities and mining schools will, therefore, be compelled to set up another syllabus during a certain period of transition. In doing so the fact must be considered that it will be ever so much more difficult for the practising engineer to fill up any gaps in his general scientific education than to develop his knowledge of his own particular profession.

For this reason more stress must be laid upon diminishing the scientific education as little as possible; upon transmitting the principles of technical knowledge rather than upon a comprehensive teaching of technical details. Above all we must convince ourselves that the difficult tasks of the next few years can only be fulfilled by a far-reaching individualization of instruction. In order that such instruction will be suitable to the possibly very various stages of knowledge at which the young men returning will have arrived, each individual one will have to be assisted in filling up the gaps in his knowledge. In view of the want of uniformity, already referred to, in the preliminary education of the students, instruction by means of lectures alone will not suffice. The method of instruction used in normal schools must absolutely be adopted. Sufficient appliances for teaching must be maintained to even a greater degree than hitherto for laboratory and demonstration work. The necessary suitability of the instruction, together with the assurance of a thorough foundation, can only be attained by the provision of sufficient teaching staff. The chief professors must be provided with a sufficient number of qualified and experienced assistants and teachers. In the interest of a necessary rapid economic resurrection we must not shy at the expenditure necessary for this purpose.

Freedom for Teaching Staffs

Owing to the varied nature of the problems to be solved after the return of the young men, general guiding lines cannot be laid down. The teaching bodies of the technical universities and of the mining schools must therefore be allowed considerable freedom of movement during the transition period, in order to be able to decide in each instance how best to combine general interests with those of the students and of the technical schools.

The roads which lead to this goal may, of course, vary according to the quality of the available teaching staff, and of the students. Conditions laid down by the authorities for normal times will not be able to be strictly complied with during the transition period. It is, therefore, urgently pleaded that during a transition period of, say, two years, the technical universities and mining schools be permitted, on application being made by them, to suitably amend the conditions previously ruling. Advantage will have to be taken of such permission with reference to the services rendered to the army by the students when deciding the question of foregoing the twelve months' practical course, in some sections, and again when deciding questions concerning the period, the division and extent of the examinations, the periods over which the studies are to be spread, etc. By carrying out the measures here suggested very valuable experience will undoubtedly be gained which might be of the greatest service as a foundation for suggestions for more considerable university reforms later on.

Experts to Decide Careers

Further, the interests of the students could be considerably advanced by detailed, carefully thought out discussion by experts as to their professional careers. Even in normal times this would be so valuable that no section of the universities should be without it, but during the transition period, what with selecting a profession and discussing as to the most suitable form of studies, it is absolutely indispensable.

Sad to say it, but the fact must be faced, that the very great movements of fortune and losses during the war will render the continuation and completion of their studies very difficult or even impossible to many students. Assistance hitherto given by remitting tuition fees and in the shape of bursaries will be far from sufficing to ameliorate the very embarrassed state of many young men who are valuable for the further development of technics and industry. It may be assumed that the various governments will also be prepared to assist as much as possible in this direction. In this connection regulation and greater centralization of the bursary system would be appropriate in order to divert the moneys already at disposal to those who, in the judgment of the teaching staff, are deemed most likely to make such assistance useful to the public weal.

Every suggestion leading towards rendering study less expensive must be fully and systematically discussed. In this connection the first question is one affecting the housing and subsistence of the students. These questions would be best tackled by a committee of the students themselves. This is all the more to be recommended as such a committee could also usefully co-operate in other questions affecting the collegiate life and concerns of the students. Noteworthy instances are to be found already in some schools and universities. It is to be hoped that the various governments and the secondary schools will energetically aid these efforts.

Help for Gifted Youths

We believe we are voicing general expectation when we say that technical people of standing will be disposed to assist particularly gifted youths in their studies by providing the means in those cases where these young men are not in a position to provide for themselves whilst carrying on their studies. We reserve to ourselves the right to approach the leading representatives of German economic life with suggestions of this nature in order to make sure of a sufficient and capable younger generation for the technical professions.

As briefly indicated here, it will, of course, be of considerable importance if the army authorities, as soon as the difficulties of the war permit, release first of all the teaching staffs of the technical universities and of the mining schools, in order that they may resume their professional activity, and also make it possible for the students to resume their studies at the earliest possible moment. With this object in view we beg on behalf of the educational authorities to petition the war departments concerned.

We beg to summarize the result of our discussions as follows:—

Petition to War Department

Your Excellencies are requested—

(1)—To give permission for universities and mining schools, upon request, during a transition period of four sessions after the war, to be allowed a freer hand regarding the regulations hitherto governing the execution and completion of study, the examinations to be recognized to the same extent as hitherto.

(2)—To make a grant of money for instructional purposes and to make provision for the requisite teaching staffs for this absolutely necessary instruction.

(3)—To energetically assist all efforts which will render it possible for a sufficient number of particularly gifted students who have little or no means to carry out their studies.

(4)—To make provision for the early return of students and teachers with a view to the resumption of complete educational activity.

In a bulletin issued by the Jefferson-Wright Co., of Toledo, Ohio, is given the result of a canvass of about 363 architects' offices in New England, the middle West and the middle Atlantic states, showing that industrial and office buildings are planned aggregating $170,000,000. This is exclusive of Detroit and Eastern Michigan, where there are 2,064 projects aggregating approximately $50,000,000.

Asking the government either to build a road from Trout Creek to Lowering, a distance of 40 miles, or else to repair the present road, a deputation of fifty residents of the Parry Sound district waited last Tuesday upon Hon. G. H. Ferguson, Minister of Lands, Forests and Mines, Province of Ontario. The minister promised that the Highways Department would make a survey and present an estimate of the cost, and stated that the road would at least be repaired. One of the speakers declared that the government has in the past spent upwards of $100,000 in repairing the road, and that the money had been wasted.

Steam Shovel Practice

Methods Now Used Are the Development of a Quarter Century — Economy of Operation Is Dependent Upon Various Practical Elements—Mechanical Ability, Good Judgment and Experience Are Essential to the Efficient Operator

By CAPT. LLEWELLYN N. EDWARDS
Supervising Engineer of Bridges, City of Toronto

MODERN methods of earth excavation are sometimes said to have originated in war,—in the building of the Roman military highways and fortifications for the defence of all parts of that ancient, world-conquering empire.

While these works were doubtless among the most important activities of the Roman military engineers, it will be admitted by anyone who gives this matter careful consideration, that the claim mentioned above is at least far-fetched. Insofar as Canadian and American practice is concerned, it must be recognized that our most modern methods represent a consistent development of less than half a century, and nothing could be more certain than that it has been very closely allied with the enormous strides made in the methods of transportation,—from the horse-drawn vehicle to the high-speed, steam locomotive and the electric and other motors.

Capacity Doubled in Two Decades

No doubt one of the most important factors in modern methods of construction has been the development of the power-driven excavator commonly known as the steam shovel, although this term is more or less a misnomer, since many of these machines are operated by electric power. This development has been measured by the requirements of their use, and has kept step with the constantly increasing demands of economy and efficiency. In this connection it is especially interesting to note that within the last two decades the operating capacity of the largest shovels has more than doubled. This increase, although rapid, has been gradual and at all times amply justified by previous practice.

Experience has fully proved that whatever is feasible or desirable from a commercial or economic standpoint can be built from a mechanical standpoint. It follows, therefore, that the limits of the size of a shovel are dependent upon the magnitude of the work it must perform to ensure its profitable employment, and upon the facilities available for the disposal of the excavated material.

The various types of shovels are dependent for their characteristic features upon the classes of work for which they are designed. Steam shovels are now mainly employed upon excavations incidental to the construction of railways, highways, canals, sewers and ditches; in quarries and mines; and in the making of excavations for bridges, buildings, etc. However, there is an ever-growing field of usefulness, and from time to time work requiring special features of design and adaptability are coming into view.

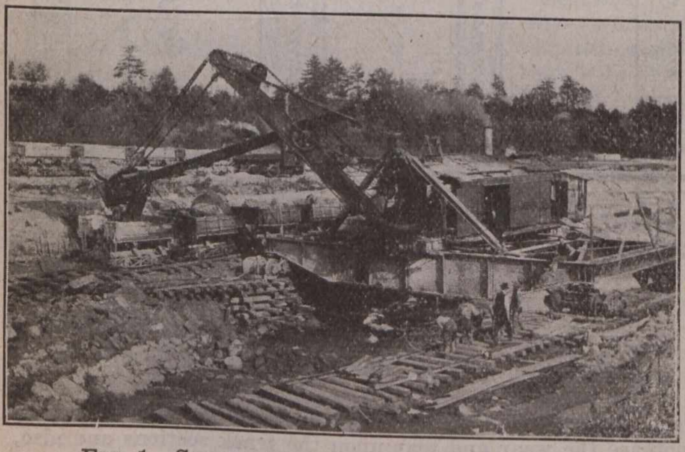

FIG. 1—SHOVEL USED AT HEALEY FALLS, ONT.

Fig. 1 shows an ordinary steam shovel mounted upon a specially constructed structural steel girder framework, used for the excavation of a power plant tail-race at Healey Falls, Ont. The special features here involved were the excavating of a solid rock cut approximately 18 ft. in depth, with water 11 ft, deep occupying the lower portion of the cut. A dipper arm 34 ft. long was used for this work.

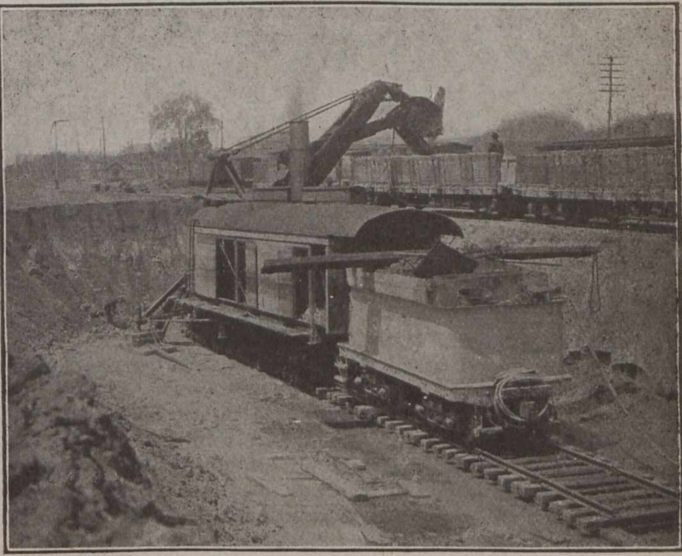

FIG. 2—TYPICAL RAILWAY STEAM SHOVEL

Two classes of shovels are in general use:—

Fixed or Rotating Bodies

1.—Those having a fixed main body upon one end of which is installed a boom and dipper so arranged as to be capable of being swung horizontally through an angle varying from one-half to two-thirds of a complete circle, the angle of swing being mainly dependent upon the construction of the jack-frame of the shovel. The remaining portion of the fixed body is equipped with the operating machinery, power plant, etc.

2.—Those having the entire shovel body mounted upon a turntable which renders it possible to rotate the body, including the boom and dipper, horizontally through a complete circle, the boom having no horizontal movement independent of that secured by revolving the main body of the shovel.

Shovels used for railway construction work are almost invariably built to standard gauge and are equipped with air brakes and other standard appliances necessary for coupling them into freight and work trains. Fig. 2 shows a typical railway steam shovel.

Wide Tread Wheels Preferred

Shovels used for highway, canal, sewer and other ordinary work may be constructed with trucks which adapt them to movements upon standard steel rails, or they may be provided with wide tread, traction wheels. In general the latter are preferred, since the wide tread wheels are best adapted to varying soil conditions.

Economy and efficiency of shovel operation are mainly dependent upon a properly proportioned combination of the latent power of the machine with the brains and experience of the operator. Broadly speaking, shovel operation may be divided into two phases:—

1.—The movement of the entire machine longitudinally, transversely or otherwise, as the physical requirements of the work may demand.

2.—The manipulation of the dipper and boom incidental to the actual excavation of the material.

Assuming that transportation facilities by cars, wagons or other means are ample for the removal of excavated material to the full working capacity of the shovel, and that this service is as nearly continuous as possible, the output

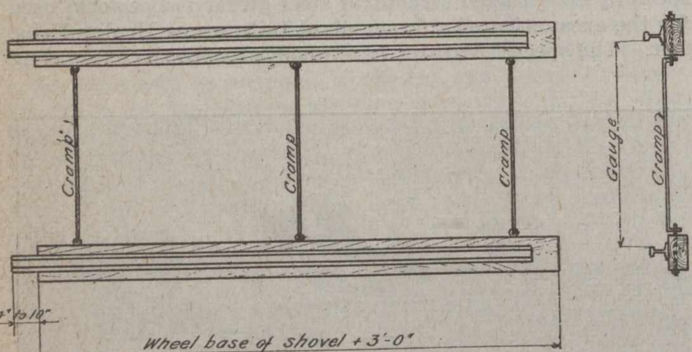

Fig. 3—Track Section for Long Distance Movements

of the shovel is mainly dependent upon (*a*) the efficient operation of the dipper and boom and (*b*) the movements of the entire machine incidental to the enlargement of the excavated area.

Moving the Shovel.—Horizontal movements of the shovel are accomplished in several ways. The importance of making the "move up" in the least possible time is far too frequently underestimated. However, the thoroughly efficient shovel operator fully realizes its relation to the total excavated yardage handled in a given length of time.

Movements on Rails.—Whenever the shovel is to be transported comparatively long distances under its own power, the simplest form of track outfit consists of short sections of rails spiked or bolted upon wooden sills or stringers. The rails are maintained at proper gauge by means of eye-bolts and cramps. Details of this form of track section are shown in Fig. 3. Increased distribution of the wheel loads is generally provided, when necessary, by the use of transverse "mud sills" placed at intervals under the rail sills. The safe movement of a shovel down a grade requires that the track sections be secured against longitudinal movement by the use of rail splice plates or other appliances.

Economy effected by the use of track of this type, as compared with track of ordinary construction, is readily apparent.

To facilitate the "move up" of the shovel in the operating pit, somewhat shorter sections of track than those shown in Fig. 3 must be used. The length of rail is somewhat dependent upon the size of the shovel, but in general it should be equal to the length of the average "move up" distance.

Very Useful Track Section

The track section shown in Fig. 4 is well adapted to a wide range of service conditions. The joint ties perform a two-fold function,—the elimination of splice plates and bolts and the distribution of the wheel loads over a considerable area. The rails are held in place by the rail clips and coupling pins. The holes in the rail clips should be slightly slotted to facilitate the engaging of the holes in the rails.

Movement of joint ties is facilitated by the use of hooks or other specially devised carrying devices for which purpose eye-bolts are provided in the ends of the ties.

Movements on Wooden Skids.—Movements of the shovel on a wooden track are adapted to the use of shovels equipped with traction wheels. Usually the track consists of a double course of planks or lagging, the upper course of which is laid longitudinally or workwise with the direction of movement of the shovel. These are commonly called "running planks." The lower course of planks is laid transversely to the upper and serves to distribute the wheel loads on soft or uneven ground.

The upper and lower course planks may be used as detached pieces or they may be assembled into built-up track sections, as shown in Fig. 5, for use in conjunction with the shovel of the turntable class.

Whenever built-up sections are used, they are moved to and from their location in the track by being lifted upon the dipper arm, a sling chain being provided for this purpose. Doubtless the most important factor upon which the successful lifting, swinging and dropping of the track sections into correct position depends, is the expertness of the shovel operator. However, this is a detail in which a careful operator should be able to attain efficiency by a comparatively small amount of practice.

Tough, Hard Timber Required

The timber used must be tough and comparatively hard. The former property prevents splitting, while the latter facilitates "skidding" of the wheels when turning the shovel or changing the direction of the cut.

Movements without Track.—Shovels of light weight having traction wheels are occasionally operated without the use of track. In general the two conditions under which such operation may be undertaken are:—

1.—Upon a pit bottom consisting of a naturally cemented gravel or sand, shalelike clay or other exceptionally firm material.

2.—Upon a comparatively firm pit bottom and with a shallow cut rendering a "move up" necessary at short intervals.

Competent pit men contribute very greatly to the effective and satisfactory moving and operating of the shovel. One of their most important duties is the proper levelling and compacting of the pit bottom preparatory to the laying of track sections for the "move up." If this work be improperly

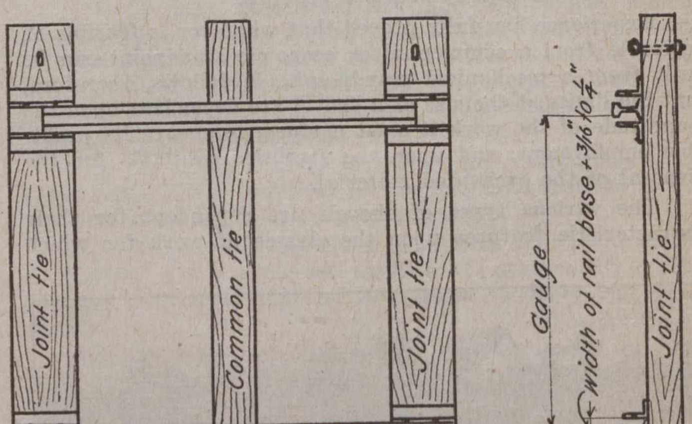

Fig. 4—Track Section for Move-Up in Pit

done, the track will take an irregular bedding, which tends to increase the wear and tear upon the track sections and also, by reason of track deformations, produces irregularities in the working functions of the shovel. A hardpan or a broken stone pit bottom involves a quite different class of preparation from that composed of soft, yielding earth upon which an allowance must be made for settlement and possibly for localized soft spots.

Turning the Shovel.—Turning movements are commonly effected by a series of forward and backward movements by which the alignment of the shovel is gradually changed to conform to the desired alignment. Railway and other shovels moving upon steel rails are deflected from a previous alignment by the use of curved track. Shovels equipped with traction wheels change direction by the use of a steering appliance which swings the forward wheels in the direction desired for any given movement.

Revolving shovels mounted upon traction wheels are equipped with the steering appliance mentioned above, but shovel operators quite frequently prefer to alter the alignment of the shovel by a series of sliding movements, commonly known as "skidding the shovel," in which the entire machine is swung about by a slight longitudinal movement. Possibility of breakdowns or unlooked for accidents is not appreciably increased provided the movement is executed with reasonably good judgment and care.

Skidding and Its Advantages

Fig. 6 shows a shovel placed in proper position for "skidding" in a counter-clockwise direction. It will be noted that the nearest rear wheel is trigged to prevent a forward movement and that other wheels are free to move both forward and sidewise. The dipper is thrust vertically downward and takes a firm, even bearing upon the pit bottom, the dipper arm being subjected to a slight pressure, which has the effect of tending to raise the boom.

Immediately upon the completion of the above preparation, the shovel is subjected to a combined swinging and traction effort. In the case here described, the shovel body is swung slightly in a clockwise direction. This movement, combined with the forward tractive effort, subjects the vehicle portion of the shovel to a thrusting force which produces a lateral slipping of the nearest front wheel and a combined lateral and forward movement of the wheels on the opposite side of the shovel. The nearest rear wheel executes a slight pivotal movement but, being trigged, remains otherwise stationary.

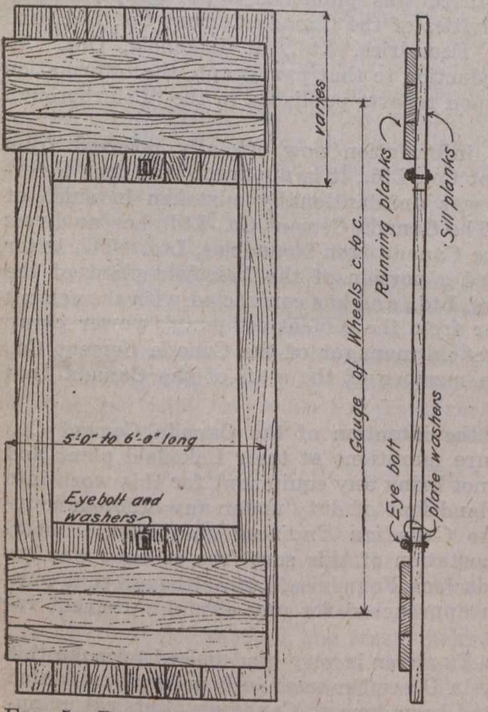

FIG. 5—BUILT-UP WOODEN TRACK—ALL PLANKS BOLTED OR SPIKED IN PLACE

Turning the shovel by this method possesses three advantages especially worthy of mention:—

1.—The area required for the execution of the movement is small in comparison with that required for a movement involving the use of the steering appliance.

2.—The time and labor elements are reduced to a minimum.

3.—The excavation of material is continued throughout the execution of the movement at a rate only slightly reduced below normal.

Dipper and Boom Operation

The composition, physical properties, etc., of the material to be excavated constitute important factors entering into effective dipper and boom operation. A brief consideration of natural soils, including rock formations, is therefore essential to a discussion of the functions affecting the efficient operation of these members.

Broadly considered, natural soil materials are divided into five general classes: Rock, gravels, sands, clays, and ordinary soft soils and earths.

Rock varies in its physical properties from the granites, syenites and other hard crystalline rocks, to the sandstones, conglomerates, shales and other comparatively soft rocks of sedimentary origin. Rock formations must generally be broken into comparatively small fragments by blasting before

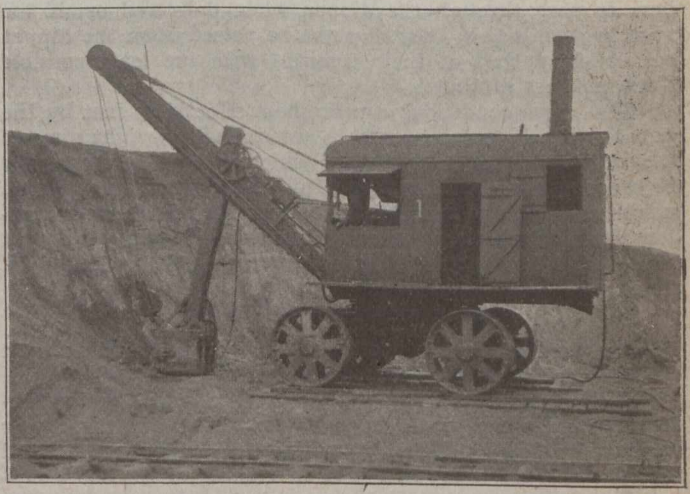

FIG. 6—SHOVEL IN POSITION FOR SKIDDING

they can be excavated with a steam shovel. However, very soft sandstones, conglomerates, shales and other rocklike material commonly known as "rotten rock," can frequently be excavated without blasting.

Gravels vary widely in composition and texture. A coarse gravel firmly cemented with a natural earthy cement containing iron, lime or other cementing material, may require to be blasted before being excavated; while on the contrary, a loose, disintegrated gravel may be freely excavated without previous preparation.

Sand-like gravel varies widely in composition and texture. It may exist as hard, practically cemented material or, when saturated with water, as a soft, unyielding, semi-fluid material.

Clay varies in its physical composition from that containing a considerable amount of fine, sandy material to that which is commonly known as "gumbo," in which there is no sand. It may exist as a firm, solid material of great cohesion and density, closely resembling shale rock, or as a pasty, semi-fluid material which will squeeze and ooze under pressure.

Soft soils and earths commonly contain vegetable matter. Swamp deposits of peatlike soils are almost entirely of vegetable origin.

From the above consideration of the diversified character of natural earths, it is clearly apparent that the operation of the dipper and boom is especially exacting, demanding the closest attention and skill on the part of the operator. The operation of the dipper involves two primary movements:—

(1)—A thrusting, commonly termed "crowding," movement by which the dipper is forced into the material; and

(2)—A vertical or lifting movement by which it is drawn through the material.

To these may be added a horizontal swinging movement, which is secondary in its nature, since it is produced by a swinging movement of the boom rather than by the dipper-operating machinery. The thrusting and lifting movements are almost invariably applied simultaneously.

A fully loaded dipper accomplished by the least possible effort and in the least possible length of time is the primary object sought by the operator. To this end he directs all dipper movements. However, the magnitude and the speed of the thrusting and lifting movements are influenced to a marked degree by the physical character of the material. A dense, hard and uniformly firm material (for example, a shalelike clay) can be successfully excavated only by a comparatively slow thrusting and lifting movement, giving sufficient time for the fracturing of the material. In comparison, a very tough but comparatively soft clay "cuts like butter" when the dipper is operated to "peel it off" in thin slices.

Rock, when well broken by blasting, involves no special consideration apart from that adapted to ordinary materials. Rock excavation from which large irregular fragments must be removed, demands a rather different treatment. These fragments must be adjusted in a manner which will permit them to pass through the dipper when delivered or, if too large to permit this, they must be so poised upon the dipper teeth as to permit of their removal with the least possible effort and loss of time.

The above conditions can be most effectively met by the operator who by using a certain amount of foresight aims to load each dipperful in a manner which will prepare the way for securing a succeeding dipperful. By the exercise of good judgment, the large fragments are thus shifted about to positions from which they are caught within or upon the dipper with least difficulty and effort and with practically no loss of time.

Adjustments of the Boom

The position of the boom (i.e., the angle it makes with the horizontal), has an important bearing upon the service operation of the shovel. When the boom supports are adjusted to their full length, the boom "swings low" and the dipper is correspondingly affected by an increase in its "reach" and a decrease in its "clear lift." A shortening of the boom supports produces correspondingly opposite results.

Apart from the "reach" and "clear lift" conditions of the dipper mentioned above, the adjustment of the boom may be made use of for the purpose of balancing or poising the dead load of the shovel combined with the dipper live load when the latter is engaged in filling and swinging operations. In this connection, it must be borne in mind that the boom and operating machinery stresses are increased by a lengthening of the boom supports.

The delivery of the dipper is effected by a swing of the boom or by a rotation of the shovel body, according to the class of shovel used. To be most effective, the complete operation must be executed as a practically continuous movement. This is commonly accomplished by permitting the dipper to coast free of swinging engine action over a short distance at the end of the delivery swing, thus permitting the engine cylinders to become free of steam and in complete readiness for the reverse movement which returns the dipper to the desired position for reloading. Coasting the dipper, as herein described, relieves the boom, swinging engine and other appliances from the shock and impact stresses which would result if the swinging engine remained in operation up to the instant the dipper delivery movement were completed.

Cars, wagons or other appliances used for the transportation of excavated material may be subjected to injury as a result of carelessly executed dipper delivery. This condition applies especially to rock excavation work.

In all dipper and boom operation, the operator should aim to eliminate excess movements involving losses of energy and time. In this connection a practical application of the theory of "motion study" will accomplish surprising results. The most common sources of loss are (*a*) failure to land the dipper in a position from which the thrust and raise movement can immediately be begun; (*b*) failure to stop the upward movement of the dipper immediately upon the completion of the filling operations; (*c*) failure to properly adjust the elevation and distance locations of the dipper during the operation of swinging, in readiness for the delivery to cars or other transporting vehicles; and (*d*) failure to release the dipper door immediately upon its arrival in position for the delivery of its load.

Care of Shovel Machinery

Successful shovel operation depends mainly upon the energy, skill and brains put into the work by the operator. The care which he bestows upon the engines and other operating parts is doubtless the most important factor.

Recognizing that a working shovel is the mainspring of the job, he will constantly be upon the lookout for loose nuts; broken bolts; and improperly adjusted gears, bearings, etc. He will "listen for knocks," well knowing that a loose bolt will produce a "knock," and that a "knock" unattended to is a sure forerunner of a "knock-out."

If perchance the "knock-out" materializes through ordinary and unavoidable wear and tear or otherwise, he will endeavor, by the exercise of trained intelligence, to accomplish such temporary repairs as will permit of continuing the operation of the shovel until such time as permanent repairs can be made without a complete tie-up of the work.

Reckless operation frequently takes the form of a sudden application of full steam to an engine, the too abrupt application of a retarding or stopping force, or a too generous thrust of the dipper with the inevitable result that the operating parts of the shovel are subjected to excessive stresses and uncalled-for abuse. Naturally enough, the operating costs will be augmented as the result of breakdowns and repairs.

The writer desires to express his thanks for helpful suggestions received from W. L. Davis, whose long, practical experience in shovel operation has been of material assistance in the preparation of this article.

NO IMPORTATION FREE FROM ENGLAND

"Peterborough Review" Made Error in Reporting Arrangements Between Canada Cement Co., Ltd., and Canada Iron Foundries, Ltd.

On page 50 of *The Canadian Engineer* for December 12th, 1918, there was published a paragraph dealing with proposed activities of the Canada Cement Co., Ltd., and the Canada Iron Foundries, Ltd., at Lakefield, Ont. As stated in the introduction to that paragraph, the information given was based upon reports published in the "Peterborough Review."

According to information now officially received from the Canada Cement Co., Ltd., it is apparent that the "Peterborough Review" was unintentionally mistaken in much of its information. The Canada Cement Co., Ltd., has no direct connection with the Canada Iron Foundries, Ltd. The latter company has leased a portion of the Lakefield plant of the Canada Cement Co., Ltd., and has contracted with the cement company for power from the cement company's power plant. E. W. Bailey, Lakefield manager of the Canada Cement Co., Ltd., will not be a member of the staff of the Canada Iron Foundries, Ltd.

It never was the intention of the Canada Cement Co., Ltd., to manufacture munitions at their Lakefield plant and that company did not bring any equipment for this work into Canada from England free of duty under any order-in council. Moreover, *The Canadian Engineer* understands unofficially that no importation of this sort free of duty was secured by the Canada Iron Foundries, Ltd., although that company has not been approached for any official statement regarding this point.

The Canadian Engineer is very glad indeed to make this correction, as early in December some daily newspapers hinted that an injustice had been done to Canadian electrical manufacturers by the War Trade Board of Canada in connection with importations on behalf of the Canada Cement Co., Ltd., or the Canada Iron Foundries, Ltd., and the information given in the "Peterborough Review" apparently supported that intimation, unintentionally, whereas it now appears that no basis existed for such an intimation in regard to the Canada Cement Co., Ltd., at least.

Geo. H. Greenfield will address the Montreal branch of the Engineering Institute of Canada this evening on "Inspection as a Means of Fire Prevention."

ECONOMICAL OPERATION OF HYDRAULIC TURBINES

Cleanliness, Care and Upkeep are the Important Factors in Obtaining Maximum Efficiency

By Eugene U. Gibbs
of S. Morgan Smith Co., York, Pa.

OVER-ALL efficiency of a hydraulic turbine installation is made up of two parts: (*a*) The efficiency of the turbine proper, consisting of the runners, regulating gates, bearings and draft tubes; and (*b*) the efficiency of the setting, consisting of the head-races, supply pipes, wheel casings, flumes, wheel-pits and tail race.

The product of the above two efficiencies will be the over-all efficiency of the turbine installation. Consequently, if the over-all efficiency of the installation is to be kept at a maximum, neither of the above efficiencies should be allowed to decrease. In treating this subject, it will be assumed that the turbine is of good efficiency, and likewise the setting. The losses that can occur from operation will be discussed under four headings: (1) Hydraulic losses in the setting; (2) hydraulic losses in the turbine; (3) mechanical losses; and (4) operating losses.

Hydraulic Losses in Setting

The head race of the turbine should be free of obstructions of all kinds and should not be used as a dump. It should be cleaned out at specified periods, depending on the character of the soil through which it passes and on the character of the water which may carry considerable amount of silt and foreign matter that is deposited and fills up the head-race.

The head-race should be kept as smooth as possible, so that the water can flow with the minimum amount of eddies and cross-currents. The banks should be kept clean and all cutting and washing carefully looked after. All vegetable growth under the water should be eliminated. All constricted sections should be removed, so that the water can flow with a uniform velocity the entire length of the head-race. If possible, the banks above the water level should be covered with grass, forming a sod, to prevent washing and slipping.

If the water is conveyed to the turbine by steel or wood flumes, they should be cleaned at stated intervals, depending on the characteristics of the water.

The trash racks should be kept absolutely clean and on streams carrying floating debris, this requires considerable work. In all plants it should be the duty of someone in particular to inspect the trash racks four or five times a day and clean them if necessary. The trash rack area of most plants is none too large, and when the trash racks become clogged with debris, the head often becomes seriously reduced.

Keep Trash Racks Clean

In low head plants it is very important to keep the trash racks absolutely clean; for instance, in a plant operating under a head of ten feet, a loss of two and a half inches of head through the trash racks would mean a loss of over two per cent. in the operating efficiency of the plant. The velocity of the water through the trash racks should not exceed one and one-half feet per second for low heads under twenty feet, and not more than two and one-half feet per second for heads above twenty feet, if maximum efficiency is to be obtained. There are cases where the head loss at the trash rack was fifteen per cent. of the available head, due to the high velocity of the water through the rack, caused by the rack becoming clogged with debris. With a systematic cleaning of the trash racks, the loss of head will be reduced to a minimum. When trash racks are long, mechanical cleaners should be installed.

The wheel-pit should be of sufficient depth and should be kept free of all obstructions. The tail-race should be kept clean, and as smooth as possible, by cleaning out as often as local conditions require. The same attention should be given to the tail-race as is given to the head-race, for the reason that deposits of silt and debris affect the head directly in the tail-race. High velocities should be eliminated from the tail-race as well as from the head-race.

In all turbine installations, a gauge should be placed as near the turbine as possible, so that the elevation of the head-water can be easily noted, and a gauge placed in the tail-race as near the discharge of the turbine as possible, so that the elevation of the tail-water can be easily noted. These gauges should be calibrated so that the head can be readily determined. These gauges should also be read at stated intervals and the record of the head kept for reference.

In small streams, a weir of sufficient length should be installed and readings taken and recorded, showing the amount of water flowing. The turbine could then be operated at the proper gate opening to correspond to the available water, so as to obtain the maximum efficiency. The knowledge of the amount of water flowing in a stream at all times is one of the most valuable assets to water power users on such streams. With such knowledge of the water available, and with power and efficiency curves of the turbine, high operating efficiency can be obtained.

Hydraulic Losses in Turbine

Hydraulic losses in the turbine are due mostly to lack of inspection and up-keep, excessive leakage of water being the result. When the chamber of the turbine directly above the runner is drained to the draft tube and the clearance between the top rim of the runner and the guide casing, called the "top running joint," becomes worn through lack of adjustment and repair of the steady bearing, a large amount of water is allowed to pass around the turbine and not through the runner.

If the bottom running joint between the runner and the guide casing becomes worn excessively, due to eccentric motion of the shaft or the shaft moving endwise, excessive leakage of water will occur and, consequently, loss of efficiency.

The runner and gates should be kept clean and smooth as possible.

Three Inspections Each Year

The hydraulic losses in the turbine can be kept at a minimum by frequent inspection, and the defects, when observed, rectified at once. Systematic inspections of the turbine should be carried out. Each turbine should be inspected at a specified time, at least three times a year. There are cases where turbines have run three or four years without any internal inspection, and there are, no doubt, cases where this time has been much longer, during which time the turbines were operating at a decreasing efficiency, due to wastage of water.

In the installation of hydraulic turbines, generally not enough consideration is given to the methods and appliances for taking the water out of the wheel cases and flumes.

Head-gate operating devices are considered as only to be used in cases of emergency, "when something happens." They are generally inferior in design and too small in capacity for the duty they should perform. Head-gates and apparatus for operating same should be designed and built so they can be operated easily and quickly, and operated every day if necessary. In some cases, when it becomes necessary to take the water out of the wheel case or flume, several men must be secured to operate the hoists, and with wagon-loads of ashes, saw-dust, etc., on hand to close up the leaks in and around the gate. If head-gates are designed and built so as to stand repeated operation and remain tight, and the hoisting apparatus designed and built to operate the head-gates easily, power house attendants would give more attention to the internal inspection of the turbines.

Mechanical Losses

Mechanical losses are due to non-alignment of the shaft, especially units in which *lignum vitae* bearings are used, caused by the bearing wearing and allowing the shaft to go out of its proper position. This causes undue wear on the running joints. The bearings should be frequently inspected and kept in correct adjustment so as to hold the shaft in its proper position.

Thrust bearings should be looked after carefully and kept up so that the shaft will not move endwise out of its normal position.

Operating Losses

Operating losses occur mostly in plants in which several units are installed when the load is such that all the units are not in operation. The maximum efficiency of all turbines occurs somewhere between eight-tenths and full power output, and by consulting the power and efficiency curves of the turbine, as furnished by the builder, the total load can be sub-divided among the several units, so as to obtain the maximum efficiency in operating the plant.

As shown, cleanliness, care and up-keep are the important factors in obtaining maximum efficiency in operating a hydro-electric plant, and it may be added that cleanliness can be applied to the general appearance of the interior of the power house as well as to the machinery. When a power plant has dirt, oil and water all over the floor, it indicates that such a plant is not efficiently operated and that the operators in charge are lazy and the superintendent or manager not "on the job."

With frequent inspections, careful up-keep, cleanliness and intelligent manipulation of the load, economical operation of the hydraulic turbine will be achieved.

TRANSPORTATION AND POWER*

Energy Must be Shipped in Bulk Unless Special Transportation Facilities are Provided for the Concentrated Product—Common Carriers Needed for Power

By C. G. Gilbert and J. E. Pogue
Division of Mineral Technology, U.S. National Museum

ENERGY is practically the only natural resource product susceptible of concentration which is shipped broadcast in the crude condition. The dictates of demand, it is true, still call for a large proportion of the supply in the crude state, and to this extent concentration in advance is obviously impracticable. But the order of requirement is changing rapidly, and even now over one-fourth of the call is for the concentrated product—electricity.

Yet there has been no progressive change in practice to correspond. It is as if our gold supply was shipped in the crude state of its native occurrence for concentration at the market centres instead of at the mine; for whereas the degree of material concentration effected on behalf of gold is considerably over 99 per cent., the attainment possible on the side of energy is a full 100 per cent.

Bulk Haulage Sometimes Cheaper

There is just one important difference between the two instances. Refined gold is adapted to haulage by the conventional means of transportation at hand, fully as much so, indeed, as the ore from which it is derived. But refined energy is not. It can not be loaded in freight cars or done up in express packages. The alternatives lie in providing special facilities of transportation or else hauling the crude material in all its excess bulk for concentration at the points of use, and the choice in practice has uniformly fallen in favor of the second procedure.

The reason for this uniformity is obvious. It is cheaper for the user of energy to rely upon the transportation facilities already at hand, employing them in the movement of the crude bulky material, than to provide himself with special facilities for the transmission of the refined electric derivative. But it does not follow, to be sure, that because the procedure so uniformly followed is individually cheaper, this course is economically preferable. In the absence of railway facilities, for example, it would be decidedly cheaper for the individual consumer to haul his coal from the nearest mine by truck than to build a railway line for the purpose. Yet no one would think of arguing in this case that reliance upon truck haulage is preferable to the opportunities that would be afforded by railway transportation. The issue between electric transmission and railway haulage is precisely similar.

Half Billion Tons Haulage

The provision of special facilities of transportation finds its justification in the magnitude of the service to be rendered. Were the item of haulage under view small in size or restricted in locality, the whole matter need not come up as a broad problem. But the haulage of power in material form amounts to nearly a half billion tons and covers the country. There is no default, then, on the side of magnitude. Special facilities, too, have been provided for oil, the power material next in importance to coal. To serve the end of this large resource a network of pipe lines, thousands of miles in aggregate length, are spread over half the country. In this case, however, crude oil is not in the nature of a general utility, but serves a specialized industrial demand centred in refineries. In consequence, pipe-line transportation found its creation and nourishment at the hands of the large private interests at stake.

Opposition by the Railroads

For electric power, on the contrary, there was no such activating interest. Though bulking large, it enjoyed a diverging distributive use quite the opposite of the convergent refinery consumption of crude oil. Moreover, the railroads were already established in coal fields when electricity came on the scene; their presence, therefore, offered scant encouragement to the growth of a more modern type of common carrier. On the contrary, it may be surmised that the whole matter may have been arbitrarily held back by the pecuniary disadvantage that would accrue to the established undertaking in event of change. Indeed, it may well be that this consideration has not been without weight in retarding the electrification of the railway lines themselves. A given railroad, under conditions of active competition, could scarcely be expected to take the lead in giving up such a lucrative item as the transportation of coal. It thus appears that such interests as already occupied the field were inclined to oppose the provision of special facilities for the transportation of energy, while in respect to oil the interests concerned in advancing its transportation were sufficiently strong and organized to overcome the factors inhibiting the establishment of the modern pipe line. Hence the energy needs of the country are now served by two carrier systems instead of three.

Competition Out of Place

A special type of transportation equipment in the way of electrical transmission lines is urgently needed to serve the energy requirements of this country, but these special facilities may be advantageously established only on the basis of a common carrier. In close analogy to the railroads, though in contradistinction to oil pipe lines, the service to be rendered is strictly distributive and of a public-service order; hence competition here is out of place to precisely the extent that it is inexpedient in the case of the railways.

Impetus to Railway Electrification

The railroads of this country wrought havoc with industrial life until the element of special-interest preference was eliminated and the whole system was placed on a common-carrier, public-utility basis. We may profit in this matter by that experience, and arrange to skip the period of adjustment that proved so costly and disastrous in connection with railway development. The railroads, therefore, provide a warning example from which may be determined the status that should be accorded the new development. Hauling coal is a problem of transportation; hauling energy in the form of electricity involves the same range of principles but requires merely a different set of physical means. In point of fact, the whole advancement contemplated is but a further refine-

*Excerpt from the report to the Smithsonian Institution on "Power: Its Significance and Needs."

ment in transportation equipment, just as the modern steel gondola is a refinement of the old-fashioned coal car.

The railroads themselves have a prime interest in this matter of establishing more facile means for the transportation of energy. Not only are they the chief haulers of energy in bulky form, but they likewise constitute the chief single consumer of this material energy which burdens their lines. The railroads burn approximately a fourth of all the coal produced in this country, this item alone representing at least a tenth of their total operating expense. Thus an improvement in energy transportation would not only relieve the railways from a needless burden of bulk haulage, but would at the same time benefit otherwise their operations by giving an impetus to railway electrification, with attendant gain in freight movements by nature of the greater freight capacity accruing to electrified systems.* Thus, on every count, the matter resolves itself into an inseparable part of the transportation problem, and from this coalescence there is no escape.†

Correlation of Power

The causes which have retarded the development of hydro-electricity and prevented the establishment of carbo-electric power stations at coal mines are broadly similar. In the case of water power, the failure is traceable to (*a*) initial cost and (*b*) a dead-locked issue between public and private interests; while, with coal, the element of initial cost has been almost equally effective, with a lack of interest, instead of discordant interests, acting as the contributory factor. The provision of suitable transportation will clear up the two retarding influences in both cases.

Would Reduce Interest Charges

In the first place, the establishment of a common-carrier system of electric transmission lines on a public utility basis will nearly halve the interest rate now demanded of projects having to do with electrical developments. We have for this assurance the example of the railways themselves, which have long been accustomed to procure capital at rates of 5 to 6 per cent. The system under view could be given more stability than the railways have formerly enjoyed, to the gain, perhaps, of better interest rates than may be calculated from the unqualified analogy. Not only would this stability be inherent in the transmission line development itself, but would reflect a similar measure of soundness upon the projects concerned with the development of power sites and the establishment of power plants, so that the field of power operations in its entirety would benefit. The recognition of public backing would transfer the whole matter from the type of investment sponsored by the professional promoter to the realm of securities represented by bonds of a substantial and conservative standing. And since the cost of money is the major expense attached to the developments, the reduction of this factor would reflect in increased proportion in the lowered price of electric power.‡

In the second place, a special common-carrier system under public oversight would serve to give the proper temper to the apprehension of the public in respect to surrendering what is now conceived to be its natural rights, thus breaking the deadlocked issue that has so long contributed to the sluggishness of hydro-electric developments; while the apathy surrounding the matter of coal-field generation of electric power would be replaced by conditions making for the profitable establishment of this activity. The public, seeing its interests properly safeguarded, can be counted on for sympathetic support of the movement; while industrial interests in general, being in the business of manufacturing commodities rather than energy, will find it natural to favor any action that would facilitate the supply of energy—an accessory to their operations—just as they are keenly interested in any constructive measures that would be likely to ease off the labor problem.

Public Sympathy Certain

The experience of this country has shown that the conduct of the common-carrier systems must be subject to public oversight. At the same time, it has been amply demonstrated that, for the sake of safeguarding private initiative and business enterprise, this oversight should be called into play as slightly as conditions permit. Applying these concepts to the proposition in hand, we reach the conclusion that while it is necessary that a system of electric transmission lines should be of a common-carrier, public-utility order, for which the railways provide a pattern; the realm of power production offers great leeway for the upgrowth of co-ordinated, but separately constituted activities, thus stimulating initiative and encouraging business enterprise far beyond their present attainments in this field. In this connection, it is worthy of emphasis that such restrictions as may be inherently necessary in correlating the whole fringe of attendant activities with the central enterprise will be overwhelmingly offset by the tremendous opportunities created by the unfoldment.

On An Equal Footing

This type of development will place water power and coal on an equal footing. In regions where only one is present, that, of course, will alone produce. But in regions where both are on hand, the one rendering the cheaper service will come into play through a process of natural, unhampered selection. Thus the common-carrier will co-ordinate the two resources, so long estranged, and lead to their complementary and balanced development. Adequate transportation has always been necessary to the development of resources; it is a trite commonplace that no region, however rich, can become of consequence until served by proper car-

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*The increase in freight capacity that accrues from electrification, with its accessory automatic devices that permit an almost solid stream of freight cars, is startingly great in view of freight congestions under present arrangements. With proper terminal facilities and electrification, it is safe to say that the freight capacity of a system could be multiplied by a considerable figure. It has been recently estimated, for example that inland transportation in England attains a capacity efficiency of scarcely 10 per cent. It has frequently been noticed in the United States as to the anomaly of hauling coal halfway across the continent to lift a train across the Continental Divide, when the topography of the divide is ready to provide for this purpose hydro-electric energy, which itself is susceptible to partial recovery on the down slope by means of regenerative breaking. In this connection, the pioneer work of the Chicago, Milwaukee & St. Paul Railway is deserving of the highest commendation for its constructive significance.

†It is commonly recognized that one of the weakest features in the industrial development of the United States is the overaccentuated responsibility now falling upon the railways: any measure tending to lighten this weight obviously strikes at the roots of a very fundamental and important issue. While the consideration may be a gratuitous digression in this place, a plan for adequate inland transportation in this country is conceived to embrace (*a*) airplane service for special mail and for passengers restricted in time; (*b*) motor-truck service for short-haul freight and for the service of farming districts in co-ordination with parcel-post deliveries; (*c*) railway service for normal freight and passenger accommodations; (*d*) trunk-line, deep waterway haulage for slow-moving and bulky freight; and (*e*) transmission lines for the delivery of electrical energy from the coal fields and water power sites.

‡It should be mentioned that in many instances the development of water-power sites involves the provision of facilities for navigation and irrigation. These attendant activities would be in the nature of by-products, so to speak, over the gain to be derived on the score of power, and as such they should weigh in outlay calculations as joint sharers in the expense apportionment. The provision of a lower money cost for water-power development, therefore, would reflect advantages over a wider scope than is embraced even in the broad item of power usage.

riage. This is no less true with energy. Given suitable transportation and our energy supply is assured.§

The final status of a common-carrier system for the transmission of energy can not be determined at this moment. The entire problem of transportation is in course of flux, and the special issue of power must be cast into the cauldron in which the railway matter is boiling. As the railways emerge, so should power. But with no inclination toward voicing a decision in the matter, it may be anticipated that a special transportation service for power, to fulfil its proper function, will have to be either (1) an integrated activity, privately financed, but under public oversight on the basis of a common-carrier, and comparable to a railway company; or (2) if still closer federal oversight be desirable, a close corporation, in which the government holds the stock, bearing some analogy to the activities carried on in behalf of the country by the Food Administration and the Emergency Fleet Corporation.

Should Undertake Preliminary Planning

But whatever the outcome of the railway issue—or, more broadly, the transportation issue, from which the power problem is inseparate—this country need not wait upon the eventuality before taking action. Just as the railroads are not idle during the period pending their final disposition, so the matter of energy transmission should not be held in abeyance until the question of control is settled. On the contrary, the establishment of such a project would require a preliminary period of planning and investigation, including a survey of the coal and water-power resources of the country with reference to the demand for power, and there is no apparent reason why this initial activity could not be engaged in at once. In view of the importance of the issue, this is not a matter to be referred to one side as an incidental piece of work, but belongs properly as a feature in the activities of the day.

§Taking a broad view ahead, we are confronted with the fact that the whole forward sweep of electrical development is dependent upon a supply of copper, or some such metal of ready conductivity. The copper supply of the world came under close observation during the course of the war and there has resulted no special confidence in the bountifulness of supply for the future. As is well known, copper mining has already been reduced to the expedient of working a lean type of disseminated deposit by large-scale methods of operation, and a large part of the world's output is so derived. In view of the importance of the property of conductivity, the whole future of transportation would seem here to enmesh with mineral resource efficiency in respect to copper and with electrochemical advance in respect to developing supplies of other conductors.

ENGINEERS' CLUB OF PETERBOROUGH

PROF. PETER GILLESPIE, of the University of Toronto, addressed the Engineers' Club of Peterborough, Tuesday, December 17th, on "Modern Methods of Sewage Treatment," using a number of lantern slides to illustrate his lecture. Among those present were the mayor and aldermen of the city, and the reeves of the townships of North Monighan and Otonabee.

The club now has a membership of fifty. Following are the officers:—Honorary president, R. B. Rogers; president, C. E. Canfield; vice-president, G. R. Munro; secretary-treasurer, R. L. Dobbin. Directors, William Sangster, P. P. Westby, C. E. Sisson, R. H. Parsons, and A. L. Killally.

A bill was introduced this week in both branches of the New York State Legislature incorporating a hydro-electric commission patterned upon the Hydro-Electric Power Commission of Ontario. The commissioners will be three state officers who will not receive any additional compensation. It is proposed to obtain the initial amount of power from "surplus" barge canal waters.

UNITED KINGDOM RESUMES TRADE

Permits to Manufacture and Priority Certificates No Longer Needed—Shortage of Labor and Tonnage

CABLE despatches have been received by G. T. Milne and F. W. Field, the British trade commissioners at Montreal and Toronto respectively, from the Imperial Department of Overseas Trade in London, pointing out that since the armistice was signed many restrictions of commerce have been withdrawn, while in the case of those which remain, licenses are being granted much more freely than previously. Particulars regarding these relaxations will be published weekly in the "Board of Trade Journal," the official organ of the Imperial Government for notices regarding trade. Orders placed during the war period now have good prospects of being fulfilled. The following relaxations in particular should be noted:—

1.—Permits to manufacture, and priority by certificates in connection therewith, are no longer necessary.

2.—Firms are at liberty to accept civil or commercial orders for immediate execution, thus freeing the engineering industry, among others, for commercial work.

3.—All the principal kinds of raw materials may now be used for the commercial manufacture of goods for export, but these raw materials themselves may not be exported in certain cases without licenses. Among those to which this condition applies are aluminum, brass, iron, nickel, steel, antimony, copper, lead, spelter and tin.

In general, restrictions on the export of manufactured goods have been removed, while they have been retained in the case of raw materials.

Certain factors will continue to hamper the export trade, notably shortage of labor till the army is demobilized, shortage of tonnage, and the need for reorganization of plant in certain industries before resuming normal work; but it is considered by the Department of Overseas Trade that the effect of these factors will diminish greatly in a few months.

D. T. Black, city engineer of Welland, Ont., reports that the total building permits for the year 1918 were $440,524, as compared with $241,334 the preceding year. The permits for December, 1918, amounted to $13,220 as compared with $1,000 for December, 1917.

The winter convention of the Association of Municipal Electrical Engineers will be held January 30th and 31st in the Chemistry and Mining Building, University of Toronto. The programme includes papers by W. B. Johnston, of the Montreal Light, Heat and Power Co.; W. L. Goodwin; Prof. W. H. Price, of the University of Toronto; A. S. L. Barnes, Assistant Engineer, Hydro-Electric Power Commission of Ontario; and C. H. Hooper, of the Canadian Westinghouse Co. The association will hold a dinner on the evening of January 30th.

Dick, Kerr & Co., Ltd., of London, Eng., recently received an order for two 5,000 k.w. turbo-alternator sets and condensing plants for the Union Miniere du Haut Katanga, one of the largest copper producers in the world outside the U.S. A., having extensive mining properties in the Belgian Congo. The turbines will be of the Willans-Zoelly type, operating on steam at 145 lbs. per sq. in. pressure and exhausting into a vacuum of 28 in., and will carry an overload of 6,250 k.w. for two hours. The condensing plants are each designed to deal with 66,000 lbs. of exhaust steam per hour and have 10,000 sq. ft. of cooling surface. The turbines will be coupled to Siemens alternators designed for a normal output of 5,000 k.w. at 0.9 power factor when supplying three-phase current at 50 cycles and 6,600 volts, and will be capable of carrying overloads of 25 per cent. for two hours or 50 per cent. momentarily. The ventilating air for these machines will be filtered in dry air filters of the Premier Cooler Co.'s make. The machines will each be fitted with a direct-coupled 110-volt exciter of the overhung type and will operate in conjunction with an automatic voltage regulator.

WIDTH OF PROVINCIAL HIGHWAYS

By W. A. McLean
Deputy Minister of Public Highways, Ontario

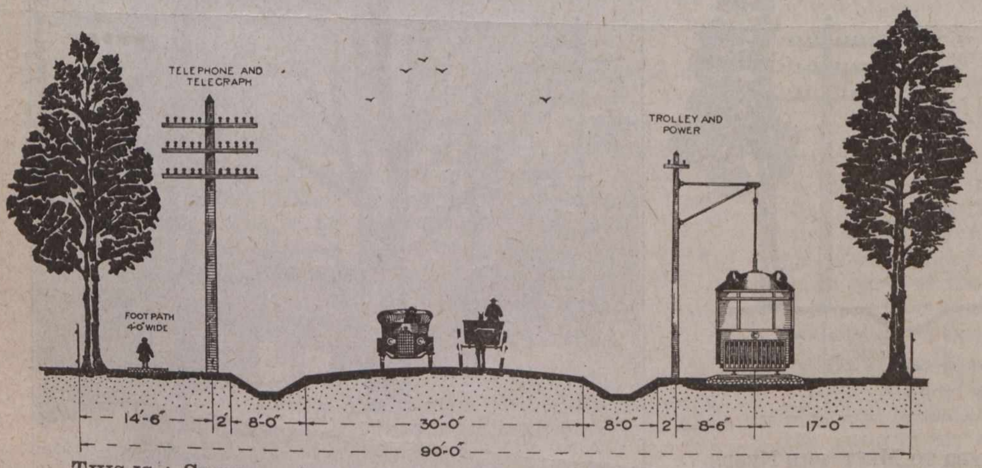
ONTARIO is to-day faced with the need for certain continuous main highways, particularly in the more densely settled portion of the province, for the purpose of linking up county road systems, and joining together, by adequate arteries, the more important cities and towns. In order that such continuity may be provided, and the local municipalities relieved from any unfair burden of caring for this through traffic, the Department of Public Highways has been authorized to assume, construct and maintain a system of "provincial highways."

Building for the Future

The immediate need is a reasonably good road surface, which in turn demands certain preliminary work of drainage and grading. But those interested and responsible would be seriously blamable if the needs of the future were overlooked. The planning of a system of main provincial highways gives an opportunity to provide adequately for the future at moderate cost and a minimum of inconvenience by arranging for an adequate width of roadway. The debt which Canadians of to-day owe the pioneers of one hundred years ago can only be repaid by we ourselves leaving the province a better place to live in than we found it. Our duty is therefore, to build not merely for to-day, but to plan and build for requirements of the future.

A Process of Development

In order that even a gravel or cheap stone surface may be maintained in some sections, a certain amount of substantial improvement will be necessary, particularly to provide adequate drainage—for without proper drainage, no class of surface can be kept on a road within reasonable cost. New culverts and bridges will be necessary, and these will be



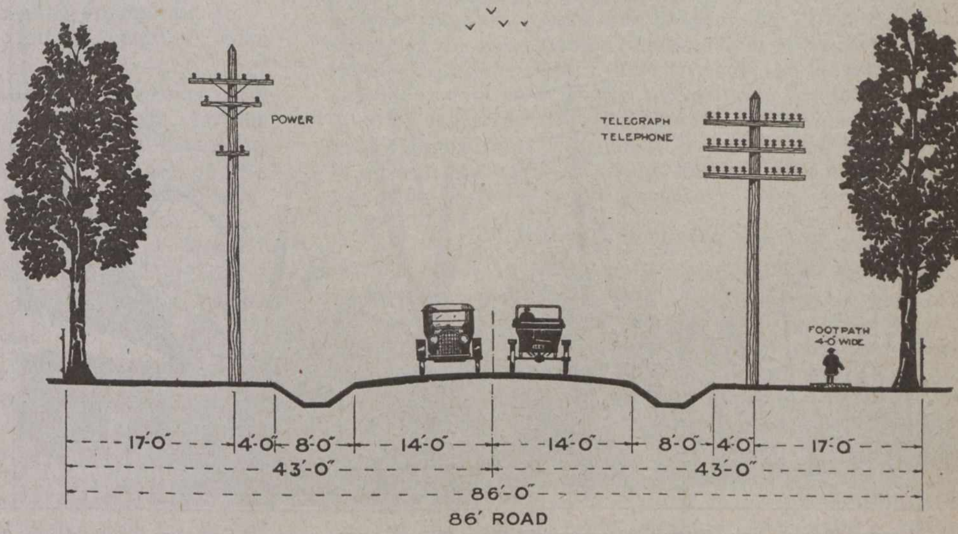
THIS IS A SUITABLE ARRANGEMENT WHERE AN ELECTRIC RAILWAY IS ON THE ROAD ALLOWANCE

built of permanent design. New bridges and culverts, drainage and widening for safety will all demand a considerable amount of grading and earthwork from point to point; so that, pending the time of more permanent surfacing, a process of development can be carried on at a moderate annual cost, which can be paid for from current revenue from year to year.

If conditions permit, this development may be such that all preliminary work can be completed and paid for before the permanent surface becomes necessary; and so that the final cost of the road may entail a minimum capital expenditure. In the meantime, traffic will have received the best possible service, and many preliminary arrangements can be made. These preliminary arrangements would especially include provision for a sufficiently widened and properly located road allowance.

Width of Road Allowance

Main highways of to-day serve purposes not contemplated when originally surveyed and made their present



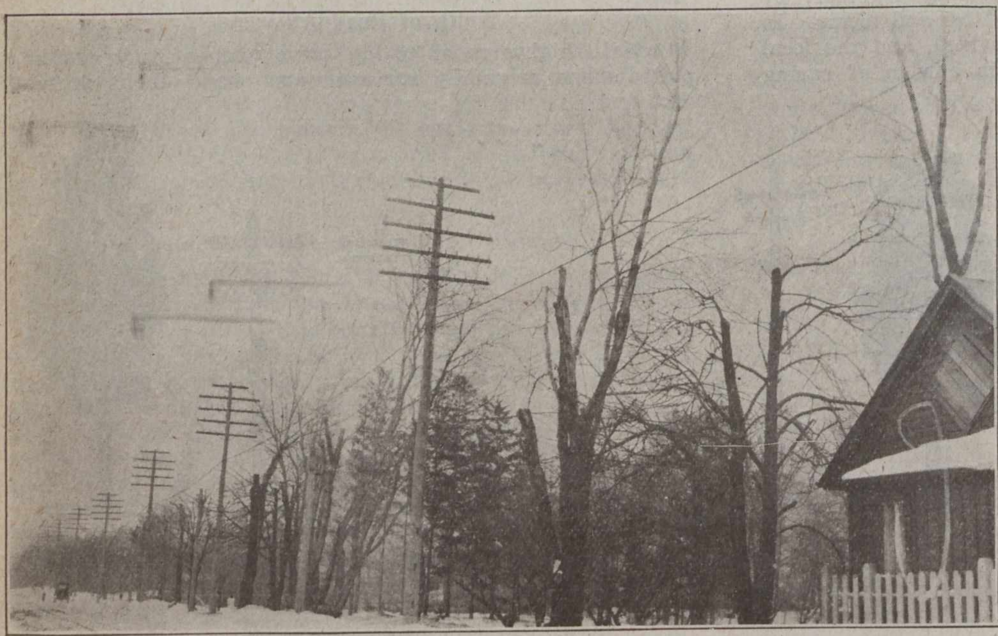
THE 86-FT. SECTION ALLOWS SUFFICIENT ROOM FOR FOOT-PATHS, DRAINAGE AND THE FREE DEVELOPMENT OF TREES, WHILE SNOW TROUBLES ARE LESSENED

widths. Half a century ago the use of roads was confined to one service—the comparatively slow horse-drawn traffic. Roads in the first surveys were made forty feet wide, but this was found too narrow. Soon a width of sixty-six feet was adopted, as in England, and was made the general standard of the province. This was ample to provide a roadway, drainage, foot-paths, and rows of trees, the natural complement of an attractive roadway.

To-day, in addition to horse-drawn traffic, the fast-moving motor, the heavy motor truck, require an added width of roadway for ordinary safety—safety not alone for the car, but rather for the horse-drawn vehicle. The telephone line (sometimes two or more competing companies), the telegraph line, electric light and power lines, sometimes the electric railway, demand a place on the main highway, if public requirements are to be adequately served. The foot-path, owing to the amount and dangers of motor traffic, becomes a necessity where not previously required.

As a result of the encroachments of these services, the magnificent rows of trees which formerly lined many of the roads have been cut and disfigured, in the end destroyed, in order that the needs of telephone and other wiring systems may be met. Property owners, knowing the ultimate fate of trees, are discouraged from planting them along the highway. It has become apparent that, if trees are to be permitted on main routes of travel, a width of sixty-six feet or less, where all services are carried, has ceased to give sufficient room, and greater width is needed.

The widening of the provincial highway system can only be attained through the loyal co-operation of interested property owners. The additional amount of land required is comparatively small. To widen a 66-foot roadway to 86 feet requires approximately two and one-half acres per mile. This acreage per mile means a very small area from each farm. Where electric railways are now in existence or anticipated, a width of at least 90 feet is desirable. Unquestionably a farm fronting on a wide, safe highway, carrying a full complement of telephone and power service, a convenient foot-

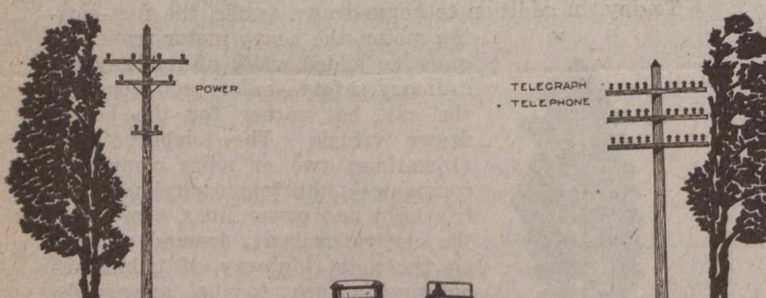


When Trees are Thus "Pruned," Rot Sets in From the Stub Ends and the Trees Die

path, and lined with trees, is benefited thereby much more than the value of the additional land necessary.

In an important sense, the land is not taken from the front of the property; for the travelled roadway is no nearer to the buildings; and the farm still has a front, but on a better and more imposing highway.

The co-operation of property owners should therefore arise from self-interest, as well as from a spirit of patriot-



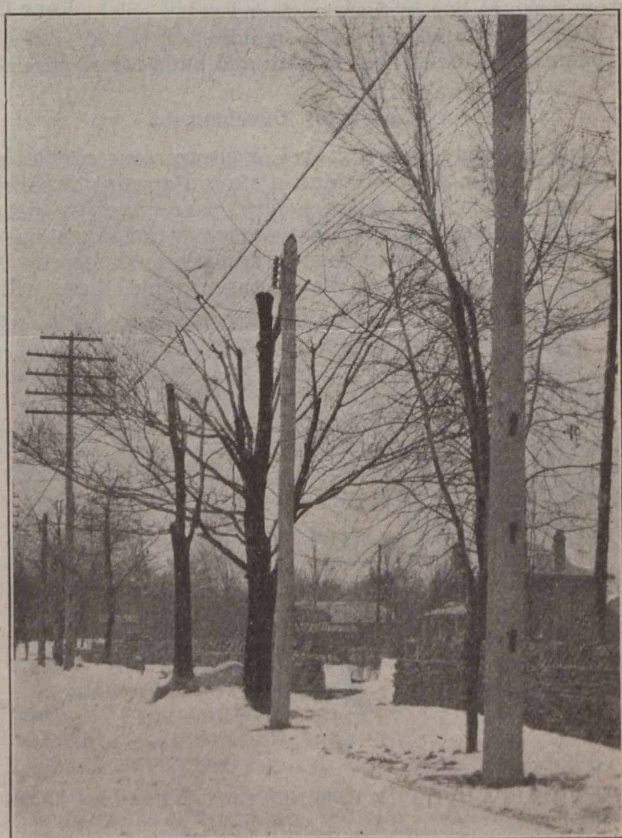
On a 66-ft. Highway, Trees are Destroyed to Meet the Needs of Telegraph, Telephone and Power Services

ism in attaining a work of such manifest public and private advantage—a work of which the province as a whole may well feel proud.

While co-operation is sought, the department feels it desirable, on behalf of provincial benefit, to pay property owners for the land an amount which will be equitable and relieve them from temporary inconvenience. But the department does not feel justified in entering upon a large expenditure for this purpose, in view of the benefit directly accruing therefrom to those from whom the necessary but small amount of land is bought. The amount paid for land is intended to be on a uniform basis for all, and for any district, as far as possible, a fixed ratio to the assessed value. The province would also make a fair allowance for any valuable improvements, permanent stone fences, fruit trees, etc., within the area taken; for the moving of any building, if immediately necessary; and, if necessary, would move existing fences. In many districts, property owners may feel that fences are unnecessary.

These terms have been generally accepted by property owners along the Ottawa-Prescott Highway, and the widening of that highway to a width of 86 feet is now assured.

This work, it should be emphasized, is being done with a view to the future, as well as to the present. It is not to be expected that the full width sought could be had for the entire length of the road at once, except by unreasonable expense, and unnecessary inconvenience to some property owners. Thus the moving of large and valuable buildings is not contemplated. It will be enough if, in special cases, arrangements can be made whereby, in process of time when rebuilding becomes necessary, the land can pass to the province as part of the road allow-



Trees Mutilated to Meet Needs of Wiring Systems on the Toronto-Hamilton Highway

ance. In the meantime, the best possible adjustment can be made. In some cases the widening can be all on one side, or more on one side than the other to avoid buildings or valuable improvements, to improve the location of the road, etc. The convenience and wishes of property owners will be met as far as possible by suitable adjustment of the plan of widening.

Shade and Ornamental Trees

The object of the department is to beautify the provincial highway—not to destroy beauty. Existing shade and ornamental trees will not be unnecessarily cut or injured. Trees will be conserved,—not wasted.

Where no trees are now growing, the standard cross-section can be closely followed in tree-planting. Valuable standing trees, on the other hand, will be preserved as far as possible, and the general design of the road modified to this end. A desirable variety will thereby be created on the highway.

The cutting and mutilating of trees by telephone, telegraph and power companies will be guarded against, and proper pruning insisted upon.

Trees are objectionable along a macadam or gravel road only when so planted as to exclude an amount of air and sunlight necessary to dry the roadway, or when the roots interfere with drainage. To this end trees planted by the department will be at the greatest possible distance from the roadway—at the margin of the road allowance. They will not be planted too close together, will be pruned upward to admit air and sunlight, and the denser varieties of shade trees will be avoided.

Distribution of Cost

The general distribution of the cost of provincial highways is very favorable to local municipalities. Additional land necessary for widening, the cost of gravel pits and stone quarries, the cost of machinery and its repair, all engineering and overhead charges, and departmental supervision are paid entirely by the province. When a road is assumed as a provincial highway, the province becomes responsible in case of accident. The municipality is given, in effect, an accident insurance policy with respect to the road.

The municipality is required to pay only thirty per cent. of the cost of labor and material actually placed in the road—an amount considerably less than the total necessary expenditure.

Safety, Convenience, Appearance

The co-operation of all adjacent property owners in all matters is urged in so developing the system of provincial highways as to provide a maximum of safety, efficiency, convenience and attractive appearance—all factors in which adequate width of road allowance is necessary. The interest of property owners in the development of each provincial highway is invited and sought, with a view to a maximum of improvement.

It is, however, to be emphasized that the highways department does not feel justified in entering upon, and will not enter upon, a large or uncertain expenditure for widening purposes, such as would be involved by general expropriation proceedings. The widening of any provincial highway or section of such highway, with attendant benefits to local property, will therefore be possible only through the loyal support of property owners, and their acceptance of the reasonable terms and proposals of the highway department.

Hon. Frank Carvell, Minister of Public Works, has assured the Toronto Harbor Commission that sufficient work will be done this year on the harbor to keep more than 800 men busy.

An Ottawa despatch to the daily newspapers states a report has been made to the Dominion government that an expenditure must be made of $35,000,000 on bridges and roadbed before the Canadian Northern Railroad will reach the standard desired by the government.

Prominent contractors of Toronto recently interviewed Premier Hearst and Hon. N. W. Rowell regarding the Dominion government's plans for housing, and it is thought likely that Ontario will take advantage of the Dominion government's offer to lend money for this purpose.

SCIENCE AND INDUSTRY*

What Britain, Japan and the United States Are Doing in Industrial Research—Manufacturers Find the Work Profitable—Several Great U.S. Laboratories

By Prof. J. C. Fields
University of Toronto

THAT the cultivation of science bears an important relation to the national welfare is being more and more widely realized in civilized communities. A more important place in education is being assigned to it. An ever increasing body of manufacturers are recognizing in science the true source of the monumental results achieved by certain corporations which have placed their trust in the laboratory. Great establishments, both public and private, for scientific and industrial research, are being founded. The constituted authorities of more than one country are repenting their neglect of science in the past and are giving tangible evidence of their intention to do better in the future.

Million Pounds for Research

Whatever other lessons the peoples have learned from the war, it has brought home to them the power of science. This power, too, it is realized, may be used for good or for evil. Before the war the British Government paid scant attention to the claims of science. In spite of the blindness of her rulers, however, Great Britain had the good fortune to possess a group of very able scientists who, on the declaration of war, hastened to offer their services to the Government.

In the country where, before the war, official eyes saw nothing, or next thing to nothing, in science which had a bearing on the national welfare, there now exists a "State Department of Scientific and Industrial Research." A fund of a million pounds has been placed at the disposal of the department for the furtherance of research. Among its other activities it has been getting manufacturers in the same industry together for the founding of laboratories on a co-operative basis, the department defraying part of the cost. The department also subsidizes individual investigators.

There is no dearth of problems for investigation, but the available supply of scientifically trained men has been considerably curtailed. Nevertheless, valuable results have been achieved in many directions. Studies are being made of the light alloys, of refractories, of concrete, of the corrosion of non-ferrous metals, of insulating oils, and many other matters of vital interest to industry.

What France is Doing

In France a great national "Physical and Mechanical Laboratory" for scientific and industrial research is being established under the auspices of the Academy of Science. It has ample funds at its disposition for its own needs and will be able to offer financial assistance to similar laboratories with which it will be affiliated in other parts of the country. Also a "Society for the Promotion of Industrial Chemistry" has been founded in Paris. This society will have branches in all parts of the country. It will initiate research and will keep the French manufacturers in touch with chemical developments all over the world.

In Japan a sum of two million dollars is being spent on the building and equipment of an "Institute for Physical and Chemical Research," this expenditure being shared equally by the government and the manufacturers. The site for the building was donated. A Japanese dyestuffs industry has been started with a capital of $4,000,000, on which the government guarantees 8% annually for ten years. The like guarantee has been given to a newly founded glycerine industry with a capital of $1,500,000. These and other moves on the part of the Japanese authorities indicate an intention on their part to place the country in an advantageous position for international trade. In its ventures, it may be remarked,

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*Excerpts from an address delivered last year at a meeting of the Toronto Board of Trade.

the Government of Japan has had the benefit of expert American advice in addition to that of the Japanese scientists.

In the United States a great scientific movement has been getting under way during the past quarter of a century. Associated with the movement in later years has been a development on the side of the application of science to industry.

A cheering feature of the situation in the United States is the attitude of the big industrial establishments to science. There, at least, the debt of industry to pure science is freely acknowledged. The ancient delusion about the scientist not being a "practical man" has pretty well disappeared in the larger industries. If one is to take as a standard the power to bring things to pass, the real scientist, that is to say the research worker, is the most practical man in the world. If, however, his practicality is to be measured by the effort he expends on accumulating a fortune for himself, he is, and will remain, unpractical.

"Pure" and "Applied" Science

There is a widespread misapprehension among laymen in regard to the nature of science. They have, as a general rule, an impression that there are two types of science. On the one hand they believe that pure science was invented for the diversion of university professors and theorists in general. It has, they assume, no point of contact with, or influence on, everyday life, either immediate or remote. On the other hand they conceive of applied science as a disconnected something which dispenses with the subtleties of pure science and takes a short cut to results. The director of a big commercial laboratory across the line told me that the short-cut men had cost the government of the United States millions of dollars. There is, as a matter of fact, no other science than pure science and "applied science" is simply that science applied.

In the great laboratory of the General Electric Co. at Schenectady, I was informed that the research workers are discouraged from thinking of financial results, as discoveries are more likely to be made by those who are working in the scientific spirit. This laboratory is maintained at an annual cost of over $500,000 and employs seventy-five investigators, including among them several who are eminent in the world of pure science. There are research workers in the General Electric Laboratory who are busied on purely scientific problems without having any definite commercial objective in view. One such problem, for example, is that of determining the atomic structure of the molecules of certain substances. Work of this character, conducted under commercial auspices, is justified on the ground that great and unforeseen developments in industry follow from fundamental discoveries in science.

The place assigned to the scientific spirit and to pure science in the conduct of the great laboratory of the General Electric Co. is naturally gratifying to the scientist. The results achieved are at the same time eminently satisfactory to the directors of that great commercial concern, whose very existence is rooted in research and whose activities cover a continent.

Besides the research establishment at Schenectady, the General Electric Co. maintains at an annual cost of $50,000 what is known as the Nela Laboratory, at Cleveland. This is a purely scientific foundation of a highly specialized character, which confines itself to the investigation of phenomena relating to light. In addition to the regular scientific staff employed in this laboratory, a number of outside scientists make use of its facilities gratis by permission of the company, a graceful acknowledgment on the part of this great commercial organization of its debt to science.

Other Private Research Laboratories

Another extensive research laboratory is located on the water-front in New York. This is included under, and is a part of, what is known as the Engineering Department of the Western Electric Co. and constitutes, as a matter of fact, the research end of the Bell Telephone System. The Engineering Department, which numbers some 3,600 employees, devotes its attention to development and scientific work in connection with transmission of intelligence and in particular with telephony.

The scientific workers in the research laboratory number 318, and are divided into four groups, of which the largest contains 125. The problems handled by the members of this group are purely scientific. They do not originate in service, but are initiated by the workers, and may have anything to do with the transmission of the human voice. Directly on the four groups a sum of $1,000,000 is expended annually. The Engineering Department, of which the research laboratory is a part, costs, all told, inclusive of the laboratory, $4,000,000 annually. According to the chief engineer, the reason that America leads the world in telephony and telegraphy is to be found in this laboratory. Its thought product, I was told, keeps about 25,000 workers busy in a factory located in Chicago.

A certain amount of co-operative research is done in laboratories maintained by associations of firms in the same industry as, for example, in the case of the association of cement manufacturers, but research under this form of organization is not being carried out on anything like the scale contemplated in Great Britain and is small compared with that done in the laboratories of individual firms.

A good deal of research work is of course done by consulting chemists, physicists and engineers for firms which may or may not possess laboratories of their own. Usually this work will consist in handling specific problems. In some cases, however, the consulting specialist devotes a definite portion of his time to the supervision of the regular research work carried on in the laboratory connected with an industrial plant.

The Bureau of Standards

Research on a large scale, for the benefit of science and industry, is conducted at that great institution maintained by the Federal Government at Washington, D.C., and known under the name of the "Bureau of Standards." This establishment employs about three hundred scientific workers and handles the greatest diversity of problems. It tests papers, textiles, structural and other steels, building and roofing materials, cements, paints, inks, chronometers, thermometers, barometers, electrical apparatus of all sorts, radio-active preparations, and in fact anything and everything to which a mechanical, physical or chemical test can be applied.

It tests the supplies purchased by the various departments of the United States Government. It has eliminated all fraud in this connection and has saved the country many millions of dollars.

It is studying the telephone service, street railways, gas, electric light and power, etc.

It furnishes manufacturers' chemists with standard samples of chemicals with which to compare their own product. It is investigating the magnetic properties of iron and steel. It is studying the properties of materials at low temperatures. It is engaged on the problem of standardizing radium, It is carrying on researches in connection with wireless telegraphy. It is conducting experiments on rubber in order to determine, if possible, the relation of its commercial properties to its chemical constitution.

It is laying the foundations of an American ceramic industry, by its study of native clays. It is standardizing colors for the benefit of the industries.

The Mellon Institute

The fractional enumeration here made of some of the present day activities of the Bureau of Standards gives but a faint suggestion of the scope and multiplicity of the functions of that admirable institution.

Another type of industrial research organization is represented by the Mellon Institute. This is an endowed institution associated with the University of Pittsburgh. The building and equipment, costing over $500,000, are the gift of Andrew William Mellon and Richard Beatty Mellon, of Pittsburgh, who also provide a yearly allowance for running expenses.

The general equipment and facilities of this laboratory are at the disposition of the manufacturer gratis. He pays, however, the salaries of one or more scientific workers, called fellows, who are selected for him by the Institute and who devote their time to the solution of his problems. The fellowships are of different amounts, but average about $3,500 a year. In the summer of 1917 the total number of fellowships was forty-two, the number of fellows employed on them being sixty-four. In some cases a bonus is attached to a fellowship, such bonus to be paid only in the event that a discovery of sufficient importance is made. Discoveries are patented, the patents becoming the property of the manufacturer who has donated the fellowship.

Numerous Investigations Being Made

Among the fellowships in successful operation at the time of the visit of the writer to the Mellon Institute may be mentioned the Bread Fellowship of an annual value of $6,500. With this fellowship is associated a bonus of $10,000, which has been paid three times over in the course of the past six years. As a result of investigations carried on in connection with the Gasoline Fellowship, several plants have already been erected. A million-dollar carbohydrogen concern operating in Pittsburgh was founded on the strength of discoveries made on a fellowship at the Institute in the years 1912-14. The Illuminating Gas Fellowship proved a godsend to its donor when, with the outbreak of war, the supply of potash was cut off.

There are fellowships which have for their respective objects recovery of the by-products of coffee roasting, utilization of the citrus waste of Florida, synthesis of drugs formerly imported from Germany. A number of fellows are studying processes for the reduction of iron, copper and aluminum ores. Others again are investigating methods for the production of acetylene and hydrogen. Several fellows on the same foundation are busied on problems connected with the petroleum industry. There are fellowships on phosphate, coke, fire brick, glass refractories, etc. To convey an adequate idea of the variety of the work of the Institute it would be necessary to reproduce a complete list of the fellowships.

It is not an easy matter to obtain reliable information with regard to manufacturers' profits, and where such information is furnished it is in general understood to be confidential. I have some interesting data relating to the financial returns from research, but for the reason just indicated, I am not at liberty to give much detail. In one case an industry founded with a capital of $25,000 had accumulated $200,000 of assets at the end of two years and was doing a business of $1,000,000 annually.

In another case an industry started in a like small way was making a monthly profit of $50,000 at the end of eighteen months, during the first six months of which the business was in the experimental stage.

Big Profits to Manufacturers

The third case which I will cite is one in which an initial investment of less than $100,000, gradually increased to between $300,000 and $400,000, resulted in an industry which was disposed of for $1,500,000 at the end of two years.

The fourth case is that of a plant which cost $25,000. At the end of four months it had paid for itself and was making a profit of $1,500 a day.

An instance which might be cited is that of an old-established firm which decided about three years before the war to see what there was for it in research, with a result that $1,000,000 has been added to its annual profits. This was achieved at an average annual cost approximating $12,000. The research work was done by three men who improved the processes and replaced important agents by cheaper and more effective substitutes. Another instance could be given of a firm which saved $180,000 through the resourcefulness of a single research man in the first year after he had begun work on its problems.

The examples of the financial results just given cover four different kinds of industry. The profits represent actual values created by research. Certain of the firms in question, it may be noted, have adopted the bonus system, whereby the wages of the workmen increase as the profits of the company augment through improvements in the processes.

The benefits of research are, of course, not always as conspicuous as in the cases here cited. That the results to be obtained are not, however, to be regarded as a matter of haphazard, is evidenced by the policy of those commercial concerns which, in the light of their experience, willingly spend hundreds of thousands of dollars annually for the maintenance of a research laboratory. The experience of the Mellon Institute, too, is that a very small proportion of the manufacturers endowing fellowships are out of pocket through their investment.

Canadian manufacturers should have within reach all the facilities for industrial research which are placed at the disposal of manufacturers in other countries. Within the not distant future there should be established at Ottawa an institution corresponding to the Bureau of Standards at Washington, D.C., and the National Physical Laboratory in England. The need of an establishment like the Mellon Institute to consider specific problems offered by individual manufacturers for solution is also pressing. The cost of building and general equipment might well be borne by the government, as also the cost of general maintenance. Ultimately the greater part of the expense would fall on the individual manufacturers for whom definite work was being done, for they would have to pay specific costs connected with that work, including the salaries of the scientific workers. The reward of the manufacturer would lie in the possession of patents taken out on the discoveries made. The government might stipulate that the results of investigation conducted in the laboratory should be published after the lapse of a certain number of years. It might also, by the collection of a small per cent. of the royalties on the patents, ultimately make the institution self-supporting.

Lack of Adequate Equipment

The scientific workers in the laboratories just referred to and in those laboratories which already exist or which in the natural course of events will develop within the plants of private corporations in Canada should, for the most part, be graduates of our Canadian universities. Much good industrial research work can be done under direction by men who have had an undergraduate course in a scientific department. The directive function should, however, belong to men who have had a more advanced training. This implies that in the leading universities of Canada the research ideal should be more in evidence, and that developments in graduate work should take place. Nowhere in Canada is there a university adequately equipped and manned for such work. This is a reproach which should not remain.

How can we tolerate the thought that in Germany provision is made for training men in advanced research which is not made in Canada; that positions exist for men so trained which do not exist in Canada! What excuse can we Canadians offer in extenuation of the fact that the leading universities of the United States have left our universities far behind in the matter of research? If the people of Canada realized the significance of the modern scientific movement, they would see to it that the necessary funds were forthcoming, and they would surely insist, as a matter of national pride, on our universities taking their place alongside the foremost in the world. This would mean on the one hand more time, and in some cases better equipment, at the disposal of the members of the staff in order that they might be scientifically more productive. On the other hand, it would mean adequate inducement held out to young men of requisite ability to prolong the period of their studies and prepare themselves more effectively for research work, either in pure science or in the application of science to industry.

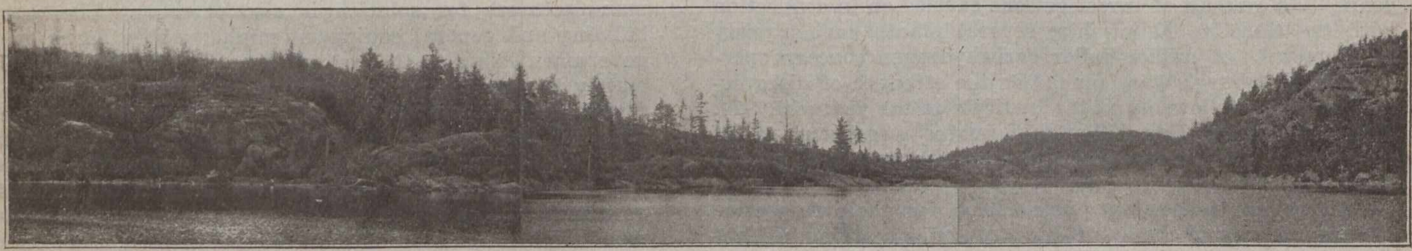
The only unfinished section of the Trent Canal is that between Lake Simcoe and Georgian Bay. Construction of this section will proceed at once. It is expected that the work will be completed this year.

The new directors of the Canadian National Railways will soon present a report to the government, which, it is stated, will call for the completion of terminals at Montreal, Toronto, St. John, Vancouver and other cities, and for the construction or completion of certain western branch lines.

BIG EDDY CONSERVATION DAM

Being Erected Near High Falls, on the Spanish River, by the International Nickel Co., at an Estimated Cost of $1,750,000—General Dimensions

THREE-QUARTERS of a mile above High Falls and their present power development on the Spanish River, in the Township of Hyman, Ont., the International Nickel Co. of Canada, Ltd., is constructing the Big Eddy Conservation Dam at an estimated cost of $1,750,000 (including acquired land, clearing of site, etc.). Fraser, Brace & Co., Ltd., of Montreal, have the general contract, and the work is being carried out in accordance with plans and specifications prepared by Henry Holgate, consulting engineer, Montreal.



Looking South Toward Dam Site

The dam will impound the waters of the upper Spanish watershed to such an extent that the level of the impounded water will be 99 ft. above the present normal river level. The water will be backed up the river for a distance of approximately twenty-five miles. The total draining area of the Spanish River above the dam is approximately 2,800 square miles.

While the scheme does not at present call for a new power plant, the dam being primarily intended for regulating purposes, the available head will be so increased and the flow will be so regulated that a much larger amount of power will be available, and the company will unquestionably build a more extensive power plant at this site some time after the completion of the dam. The company's present High Falls plant has a capacity of about 12,000 h.p.

The dam will be of gravity type, containing approximately 80,000 cubic yards of concrete. It will be 1,125 ft. long, consisting of a west wing and non-overflow section 102 ft. 6 ins. long, an overflow section 173 ft. long, a regulating sluice section of 60 ft., an overflow section (with log slide and trash run) of 240 ft. 6 ins., a headworks section of 164 ft., and an east wing and non-overflow section 385 ft. long.

There will be three regulating sluices for draining off from storage. These will be controlled by Larner-Johnson hydraulically-operated valves. The regulating valves will have cast iron bodies 5 ft. 10 ins. long and 9 ft. 11½ ins. at greatest diameter. They will be set in cast iron tubes about 11 ft. 0¾ ins. long. The cast iron supply pipes will be 18 ft. long and will taper from 7 ft. inside diameter to 6 ft. 6 ins. inside diameter.

The curved draught tubes from the valves will be about 17 ft. long and will vary from 4 ft. 10 ins. inside diameter to 6 ft. inside diameter. Two 12 in. cast iron supply pipes, each about 63 ft. 8 ins. long, will supply pressure water to the regulating valves. They will have screened intakes 30 ins. in diameter. There will be sluice gates for closing the openings to the regulating valves.

The overflow sections will be divided by piers into 17 ft. bays and will be provided throughout with guides for stop logs.

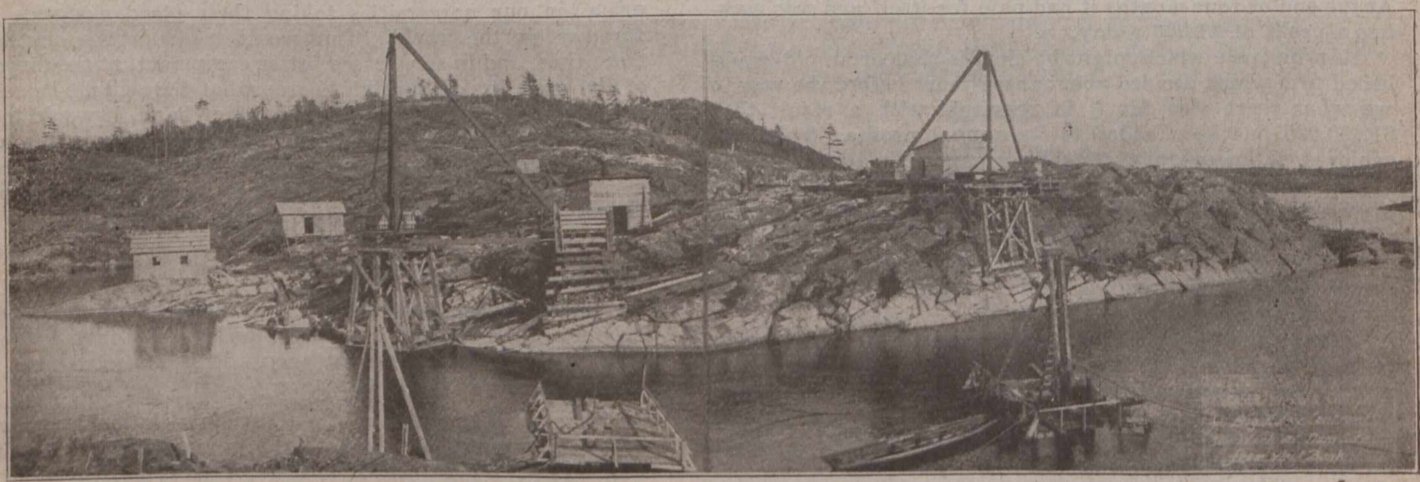
The log slide will be of reinforced concrete supported mostly by concrete arches. The length of the log slide will be 330 ft. and the width inside will be 8 ft. at the dam, tapering to 4 ft. at the lower end.

Provision has been made for a stairway from the top of the dam down through the structure to the regulating valve house.

The Canadian Engineer is indebted to J. L. Agnew, vice-president of the International Nickel Co. of Canada, Ltd. (the head office of which company is now at Toronto, Ont.), who is head of the Mining and Smelting Division at Copper Cliff, Ont., for most of the above information and for the following general dimensions:—

Greatest thickness of dam at regulating valve tubes	100	ft.
Width of top of dam at non-overflow sections	5	"
Width of top of dam over regulating valve section	30	"
Width of stop log platform over overflow sections	12	"
Width of trash run	12	"
Thickness of piers supporting platform over overflow sections	2½	"
Thickness of platform over overflow sections	2	"
Width of opening between piers supporting platforms over overthrow sections	17	"
Length of house over regulating valves	60	"

(Concluded on page 138)



Work at Dam Site—View from West Bank

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PRINCIPAL CONTENTS

PUBLIC WORKS NEEDED

EACH day that labor is unemployed, there is an economic loss to the community. As our contemporary, Engineering News-Record of New York, has pointed out, every man not employed is either a public charge or an idle producing unit. As it is certain that the return to normal conditions will take some time, public works should absorb labor as fast as possible, even under conditions which might seem uneconomical on account of the high wage scale and the high prices of materials. Even if the public pays greater prices for public improvements, it would be well to undertake them at this time upon a large scale, in order to prevent the economical loss due to idle man-power. If the army is demobilized slowly in order to prevent unemployment, the public pays for the maintenance of the soldiers. It would be better to demobilize as promptly as the military situation permits, increasing the amount of public work to any extent necessary to prevent unemployment. Such a course would mean permanent, substantial returns for the money spent, whereas the maintenance of men in camp without military necessity is a dead loss.

HERR DOKTOR!

SIR ROBERT HADFIELD has performed a public service in procuring and translating some recent publications of the Society of German Metallurgists and Mine-Owners. Canadian engineers who are now deeply concerned in discussing legislation for the protection of the title "engineer," will be interested in knowing that the managing committee of the above-mentioned German society have unanimously expressed their conviction that it is not expedient to reserve the title, "engineer," solely for those who have completed a university course, it being considered by the committee that the graduates are sufficiently protected by their diploma.

"The suggestion worthy of being fully considered," says the report of the committee, "was expressed in committee that the dignity of the engineer who has completed the university course would be better raised by the title of 'Doktor.' This solution would be of great service to the appreciation of a complete technical university education in academic circles."

See what we have missed! Had Germany been permitted to conquer the world, every Canadian engineer might have been a "Herr Doktor." Free, gratis, for nothing! We cannot understand why Herr Bernstorff overlooked this bribe in his efforts to keep Canadian engineers out of the war.

The committee agrees, however, that protection of the word "engineer" would be desirable despite wholesale granting of Doctor-of-Engineering degrees. "So far as the protection of the title of 'engineer' is further concerned," continues the committee, "we have joined in the unanimous decision come to at a committee meeting of the German Association to the effect that protection of the title 'engineer' is desirable; that those hitherto using the title 'engineer' should not be deprived of it; but that in doubtful cases a Council of Engineers, on which the authorities would be represented, should have the right to decide whether the title of 'engineer' was justified or not."

EAST WANTS BETTER SERVICE

COL THOS. CANTLEY, member of the Board of Directors of the Canadian National Railways, last week met a delegation of the members of the Commercial Club of Pictou, N.S., and of the Board of Trade of New Glasgow, N.S. Alex. McGregor, M.P., who was spokesman for the delegation, said that certain changes are inevitable along the Intercolonial Railway between New Glasgow and Mulgrave.

"It is no secret," said Mr. McGregor, "that the heavy grades and curves along that stretch of the railroad are impossible so far as the future is concerned. That section is operated at a loss of from $50,000 to $75,000 monthly."

J. D. McDonald, of Pictou, urged that the harbor be bridged, and the "Short Line" connected in order to relieve the pressure of freight upon the main line, to eliminate the costly haul over the Cobequids, and to provide a better service for Cape Breton. The harbor should be bridged at or near Pictou Landing.

Replying, Col. Cantley said that he had already impressed upon his colleagues very strongly the necessity of improving transportation between Moncton and Sydney. From Sydney to Mulgrave there is no trouble, but from Mulgrave to Stellarton only light trains can be handled and derailments are too frequent. Railway engineers have made frequent surveys in an attempt to overcome the difficulties, but an easy solution has not yet been found. The most feasible scheme proposed is to go around Cape Porcupine, following the shore to a very considerable extent, but even then the grade would be 1.68%, which is not good enough for Canadian National Railway Standards, said Col. Cantley. Besides, the cost would be almost as great as if a new line were built. Personally he favored a line from Mulgrave via Guysboro to Sunny Brae, thence to New Glasgow, etc. Such a line would be a few miles longer than the present road, but very good grades would be obtainable.

Mr. McGregor said that he had interviewed President Hanna of the C.N.R., and had urged the claims of Nova Scotia, but the president stated that the west wants a great many extensions, and that the claims of the west might be given preference to those of the east to some extent.

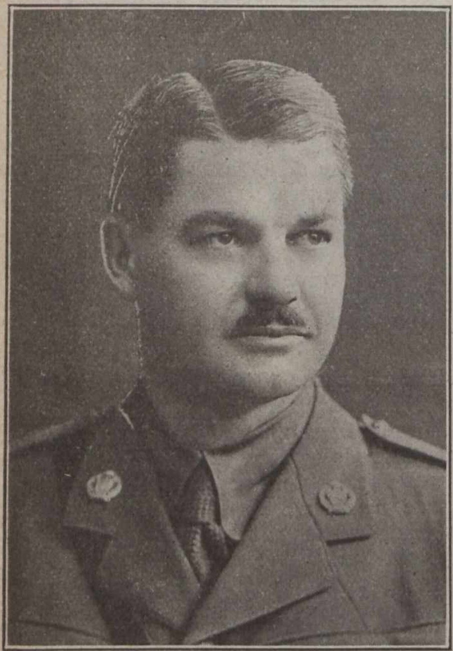
It was decided that a committee of six be appointed to gather data and to submit same to the Railway Board. Col. Cantley suggested that the committee should ask that survey parties be sent out as soon as possible, to report upon the project.

Col. Cantley roughly estimated the cost of the proposed line from Mulgrave to Sunny Brae at $8,000,000, while the bridging of the harbor at Pictou and the conversion of the "Short Line" to main line standard, would cost at least $2,000,000.

PERSONALS

DR. J. A. L. WADDELL, consulting engineer, Kansas City, Mo., has been elected a corresponding member of the Academy of Science, France. Since the Academy was founded in 1795, only eighteen corresponding members have been chosen from the United States, Dr. Waddell making the nineteenth. Of those eighteen, three are still living; viz., Drs. Pickering and Hale, astronomers, and Dr. Davis, geographer.

MAJOR F. L. C. BOND, who was recently appointed chief engineer of the Grand Trunk Railway System, was born in Montreal in 1877 and educated at the Montreal High School, the Collegiate Institute and McGill University. After graduating from McGill in 1898, he became resident engineer of the Eastern Division, G.T.R., and in 1901 was appointed engineer in charge of double track construction. The following year he was superintendent on the construction of the Park Avenue tunnel of the New York Subway, but returned to the Grand Trunk as resident engineer, Eastern Division, being promoted in 1913 to division engineer of Eastern Lines. In 1916 he went overseas with the 10th Battalion, Canadian Railway Troops, and he has just returned from France. Major Bond succeeds H. R. Safford, who resigned last summer to accept an appointment as engineering assistant to the Regional Director of the Central Western District, United States Railroad Administration.



G. I. DAVIDSON, who has been with the Canadian General Electric Company, Ltd., for the past eighteen years, has been appointed manager of the publicity department of that company.

GORDON F. PERRY, who has been general manager of the National Iron Corporation since the incorporation of that company, has succeeded the late Cawthra Mulock as president of the firm.

E. F. SEIXAS, who for the past nineteen years has been general manager of the Niagara, St. Catharines & Toronto Railway, has been appointed general manager of the Monterey Railway, Light, Heat & Power Co., at Monterey, Mexico.

V. I. SMART, formerly Professor of Railway Engineering and Transportation, McGill University, and J. A. BURNETT, formerly electrical engineer, Grand Trunk Railway System, are now associated as consulting engineers, with offices in the New Birks Building, Montreal.

OBITUARIES

JOSEPH BOURQUE, of Hull, P.Q., contractor, died recently at the age of 53. Mr. Bourque was born in L'Assomption, P.Q. He served a term as mayor of Hull. Among the buildings which he erected was the Central Post Office, Montreal.

WILLIAM J. GALBRAITH, formerly of the contracting firm of Galbraith and Cate, Montreal, died recently of pneumonia at his home in Montreal, at the age of 32. Mr. Galbraith graduated from McGill University in 1909 and the following year was assistant engineer for M. P. and J. T. Davis on caisson work for the Quebec Bridge. In 1912 he organized his own contracting firm but after the outbreak of war he joined the staff of the Foundation Co. as superintendent of construction in various shipyards in the United States. Latterly Mr. Galbraith was engaged in the valuation of a shipyard for the Dominion government.

EDMUND BURKE, senior partner of Burke, Horwood & White, architects, Toronto, died this week of pneumonia at the age of 68. Mr. Burke was for many years a councillor of the Association of Architects, and in 1910 vice-president of the Royal Institute of Canadian Architects. He was a past-president of the Engineers' Club of Toronto, and was architect for a great many of Toronto's most prominent churches and industrial buildings, including the Robert Simpson Store, Y.M.C.A., Meteorological Building, Methodist Book Room, McMaster University and the Metropolitan Church. Mr. Burke was born in Toronto in 1850 and was the son of a prominent contractor.

HARRY GODFRED SIDENIUS, assistant to the chief engineer of the C.P.R. Natural Resources Department, Calgary, Alta., died last November at the age of 37. He was educated at the Technical School at Copenhagen, Denmark, although he was born in New York City. Between 1904 and 1907 he was assistant to William Ingham, chief engineer of design and construction of the waterworks system at Port Elizabeth, South Africa. He came to Canada in 1907 and the following year was engaged with Smith, Kerry & Chace on the Winnipeg power projects. From 1909 to 1913 he was in the Natural Resources Department of the C.P.R., chiefly as resident engineer of construction at the Bassano Dam, on the Bow River, Alta., one of the most noted structures of its type. During 1914-5 he was engaged as assistant to the city engineer of Calgary, chiefly in connection with studies of the city's water supply. Throughout 1916 and part of 1917 he was attached to the 4th Field Troop, Canadian Engineers, with the rank of captain, as instructor at Sarcee Camp, Calgary. For eighteen months previous to his death he was again with the C.P.R. Natural Resources Department. Mr. Sidenius was a member of the American Society of Civil Engineers and of the Engineering Institute of Canada.

BIG EDDY CONSERVATION DAM

(Continued from page 136)

Width of house over regulating valves	20	ft.
Height of racks for sluice openings	25	"
Width of racks for sluice openings	8	"
Length of racks for penstock openings	32	"
Length of steel guides for sluice gates at openings to regulating valve openings	98½	"
Elevation of *lowest* part of stream bed before excavation	140.0	
Elevation of top of non-overflow sections	286.0	
Elevation of normal water level below dam	185.0	
Elevation of normal water level above dam	284.0	
Elevation of crest of overflow sections	276.0	
Elevation of crest of opening to log slide	268.0	
Elevation of crest of opening to trash run	262.0	
Elevation of invert of log slide at outlet end	192.5	
Elevation of top of operating platform in regulating valve house	194.5	
Elevation of inverts of three supply tubes to regulating valves on upstream face of dam	186.5	
Elevation of top of discharge draft tubes from regulating valves	184.05	

The Quebec Public Utilities Commission has appointed Messrs. Drinkwater, St. Marie and Gibeau as a special board of engineers to prepare a report which will supplement the plans submitted by the Provincial Board of Health for the intercepting sewer for the towns of Longueuil, Greenfield Park, Montreal South and St. Lambert. The report is to be submitted by March 1st. None of the municipalities oppose the scheme, but the difficulty is the apportionment of the cost.