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LARGE HYDRO DEVELOPMENT ON THE ST. MAURICE RIVER

PRELIMINARY WORK ON THE 180,000-H.P. HYDRO-ELECTRIC DEVELOPMENT OF THE LAURENTIDE COMPANY AT GRAND MERE, QUE. — SOME DETAILS OF THE CONTRACTOR'S PLANT.

THE Laurentide Company has under construction at Grand Mere, on the St. Maurice River, a hydro-electric power plant, the ultimate capacity of which will place the company among the largest power producers in Canada. The new development is designed for an installation of 9 units, developing 20,000 h.p. each. Of this amount only 120,000 h.p. will be developed at the present time. It was expected that 3 units, developing 60,000 h.p., would be ready for operation early in November of the present year, but the temporary curtailment of operations, due to the European war, will prevent such substantial completion this year.

The St. Maurice River is one of the largest tributaries of the St. Lawrence. It takes its rise in the watershed dividing the St. Lawrence slope from that of Hudson Bay. It flows from west to east, about 350 miles, through a mountainous region, and is broken frequently by a series of cascades. The more important of these are the Shawinigan, La Tuque, Grand Mere and the Rapids des Hetres, nearly all of which are utilized by large industrial concerns. Grand Mere is situated about 90 miles north-east of Montreal, where the river drains an area of about 17,000 square miles. The point at which the development is being conducted is between two islands, one of them Grand Mere, which bears a rock with a remarkable resemblance of an aged woman, whereby the name was originally derived. The other is a triangular shaped, rocky island, about 600 ft. in width.

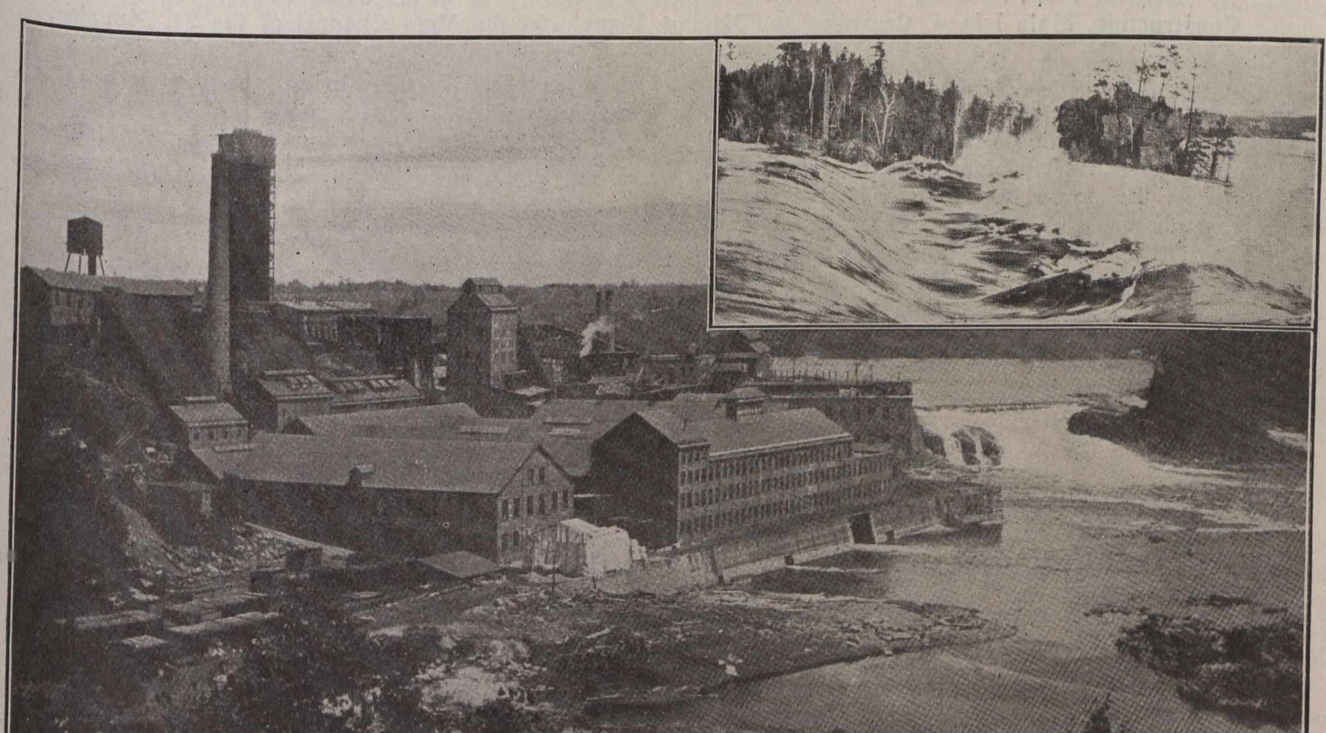


Fig. 1.—View of the Laurentide Co.'s Plant at Grand Mere. Inset Shows Channel and Grand Mere Rock.

The work was commenced in January, 1913. For years previous to this the Laurentide Company, manufacturers of pulp and paper, operated a dam and power house on the west shore of the river, the main channel remaining practically unharnessed. Fig. 1 is a view of the plant, while the inset shows at closer range the old channel where the first development took place. The river here is 1,100 ft. in width with a bay on the eastern side. Power was obtained by utilizing a head of 45 ft., acquired by the construction at different times of three dams of 250 ft., 75 ft., and 350 ft. length respectively.

In the present project for utilizing the entire flow of the river the erection is involved of a power house 457 ft. in length x 137 ft. in width, to extend diagonally across the west channel of the river at a point about 200 ft. farther downstream than the old site. A concrete spillway dam 1,700 ft. in length is to extend from the channel corner of the power house, through the island, across the east channel to the shore side of Bee Island, where it deflects at a sharp angle to the shore above. Its height varies from 65 ft. at the deepest point, near the power house, to 4 ft., at the shallowest, which is on the site of the large island. The construction of this dam for utilizing the entire flow of the river has necessitated cutting this island of Grand Mere down to water level in order to provide a sufficient length of spillway to control the water level above the falls during spring floods. A triangular area 400 ft. x 300 ft. with considerable depth, and constituting a mass of approximately 600 tons of solid rock, is being removed. The rugged pinnacle which gave the island its name is being carefully cut and conveyed to mainland, where it will be re-erected.

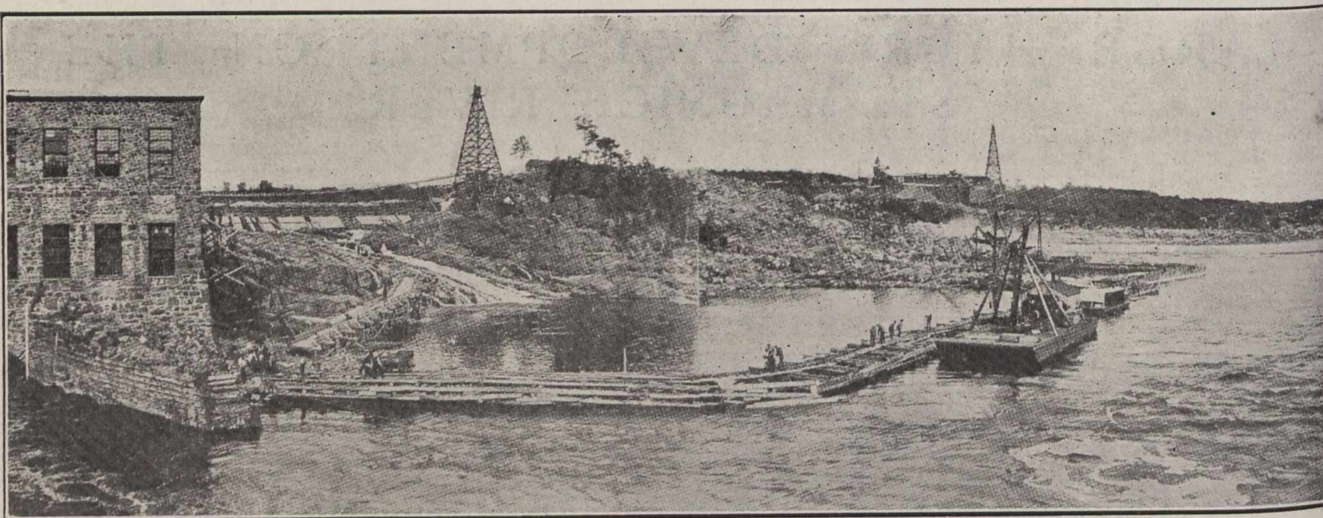


Fig. 2.—General View, Showing Present Power House and Dam, One of the Cable Towers, Cofferdam Under Construction, Main Island, Crushing and Mixing Plant, and the Main Channel of the St. Maurice.

In the new development the natural fall of 45 ft. will be raised to a total effective head of 77 ft. When the cofferdam, which is now diverting the river during the construction of the power house, is removed, the water will be backed up the river for a distance of about 15 miles.

In addition to the dam and power house construction, a tract of land, previously used by the company as storage yards for logs, had to be raised through a height of 10 to 15 ft. in preparation for the new water level.

The consulting engineers for the company are the Geo. F. Hardy Company, New York, and the contractors, the H. E. Talbott Construction Company. Operations were commenced immediately after signing the contract in January, 1913. Preliminary work by the contractors included the organization of force and equipment, together with preparatory operations in connection with the cofferdam below the falls. This could not be built until after the spring floods. The early part of the season saw the completion and pumping out of the cofferdams. The first was built on top of an old wooden crib dam previously constructed by the company, and dewatered the power house site from above. Considerable difficulty was experienced, however, in the construction of the lower cofferdam which extended across the tailrace at an average depth of about 20 ft. of water for a distance of about 600 ft. Wooden cribs, about 20 x 12 ft. in dimension, were filled with stone and sheeted with piling and canvas, thereby rendered watertight. These supported the dam. The placing of the cribs necessitated considerable dredging as the rock-bottom was covered with layers of debris, including bark, timbers, boulders, etc. In addition the rock surface was very irregular. Fig. 2 shows the cofferdam under construction. It also

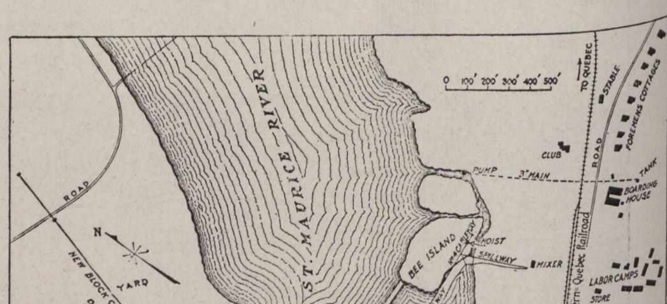


Fig. 3.—Contractor's Construction Camp, and Layout of Present and Proposed Development at Grand Mere.*

*By courtesy of *Engineering News.*

shows the present power house, the main island and channel.

Cofferdamming in the west channel was completed in August, 1913, and was immediately followed by excavation work for the tailrace and power house in addition to the erection of more extensive construction camps.

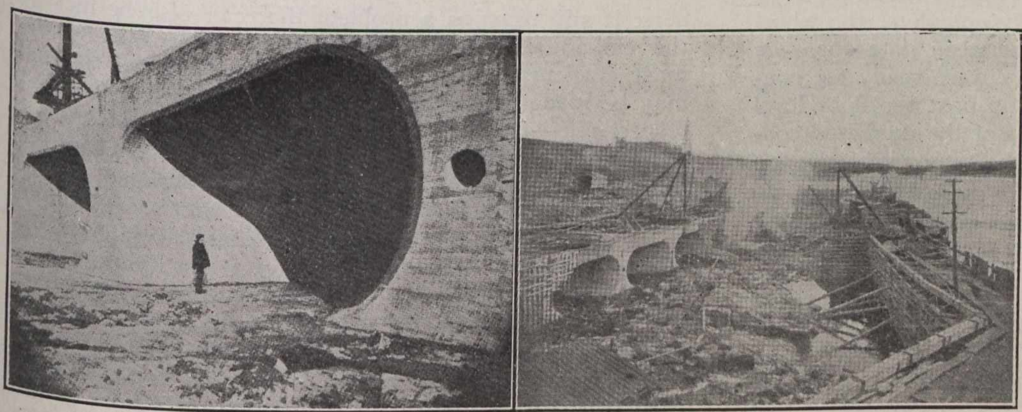


Fig. 4.—(Right) Power House Excavation With Draft Tubes, nearing Completion. (Left) Closer View of Completed Draft Tube.

These camps and their equipment have many distinctive features. They are located on the east side of the river, opposite the present mill site, as shown in Fig. 3, and are fully equipped with crushers, carpenter and blacksmith's shops, material bins, etc., in addition to the housing quarters for laborers. The need for a judicious arrangement of camp for the rapid and economical conveying and placing of material and supplies may be gained from the following: Over 2,000 carloads of lumber, cement, etc., are required for the work. The excavation will approximate 150,000 cu. yds. of rock and 250,000 cu. yds. of earth. About 175,000 cu. yds. of concrete will be required, with 1,000 tons of reinforcing steel and nearly 2,000 tons of structural steel.

The rock removed from Grand Mere Island is transported in large, flat buckets by Lidgerwood cableways 1,125 ft. in length, with a 2¾-in. cable suspended from towers 150 ft. in height, across the river and island. Cars, running on transverse tracks over the cut, convey the rock to the cableway, where it is hoisted, carried to the eastern bank and dumped into serving bins for the crushers. It is to be noted that all the crushed stone used in the concreting work is provided in this way.

The rock is crushed in a large gyratory crusher, assisted by a small reciprocating crusher into which feeds the extra large pieces from the main crusher. The broken stone is conveyed by belt (as are likewise the bags of cement from the cement storehouse) to the mixer. Another crusher operates in the sand and gravel pit to crush the larger stones rejected by the screens through which the gravel is passed.

Another cableway of 7 tons capacity and 1,650 ft. span conveys the concrete from the main mixing plant across to the power house and over a portion of the dam, while another of 600 ft. span conveys concrete from an auxiliary mixing plant on the west side of the river close to the power house site. On the 1,650-ft. span cableway a bottom-dumping bucket is used for carrying the concrete. The dumping is effected by releasing the tension on the ropes by which the bucket is traversed on the cableway, this tension ordinarily holding together the two overlapping hinged leaves which form the bottom of the bucket. Slacking the ropes allows the leaves to swing apart, thereby dumping the material. The bucket holds 2.4 cu. yds. of concrete and empties itself clean when dumped. During operations last summer it gave very rapid service and conveyed 450 cu. yds. of concrete over a distance of 1,100 ft. in the usual 10-hour shift. Hoisting towers with gates and chutes are used extensively in a distribution of concrete in the construction of the power house. Electric hopper cars convey the concrete from the cableway to the hoisting towers. In places not readily accessible to the cableways portable mixers are used.

The completion of the spillway over the eastern channel will be attended to by a fourth cableway of construction similar to those mentioned above.

While work was in full swing during the earlier part of the present season about 400 cu. yds. of concrete were mixed and placed daily, the excavation and crushing capacities being sufficient to provide rock aggregate at this rate. A certain amount of concrete work was effected last fall but the greater majority of it has been put in this season. It was delayed early in the summer owing to spring floods, which had not subsided from the power house site until early in June. Last Fall's operations on the power house structure consisted of the placing of the draft-tube forms and the pouring of concrete for the lower section. A portion of the adjoining dam was also constructed and the whole was brought above the normal

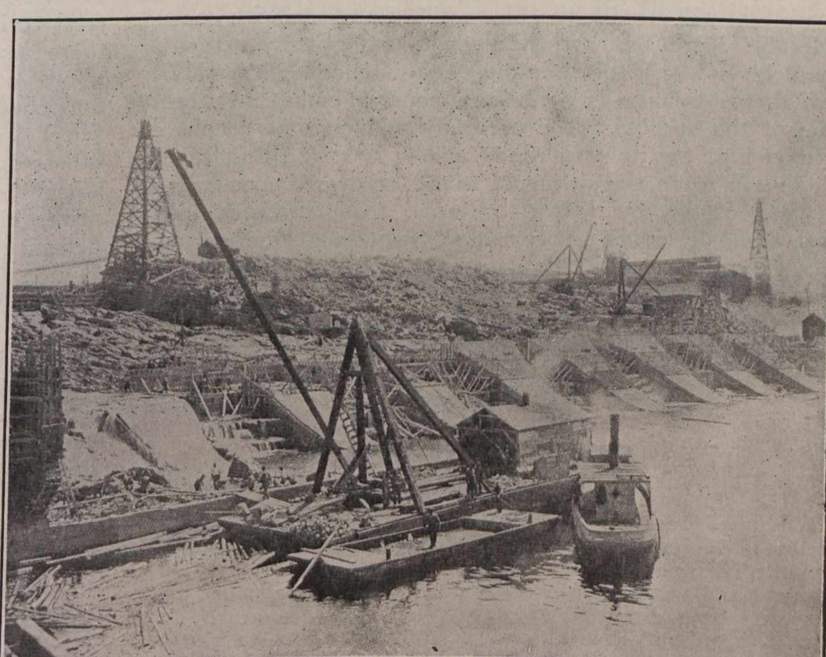


Fig. 5.—Recent View of Power House Construction.

water level in the tailrace, to approximately the elevation of the scroll chambers. The lower cofferdam was then removed, it being no longer necessary. The draft-tubes were completed in February, 1914.

Since June of this year the power house and dam structures have been pushed with great rapidity, concrete being poured day and night. By August the steel work for the power house was practically complete, the wheel pits were finished, the partitions between gate openings were concreted, the turbine casings were ready for concrete, and the walls were carried up past the floor level of the generator room. About half of the dam was constructed in the east channel and the removal of the top of the island was nearing completion. The penstocks and practically all of the concreting of the scroll chambers and control devices were in place by the end of August. Late operations have included the construction of a cofferdam on the bed of the river at the wide channel on the east side. Here there is about 15 ft. depth of water and the current is exceedingly strong. A channel is being excavated through the centre of the island to provide a water course for the river and a passage for logs of the lumbering interests on the St. Maurice.

Electrical energy for the construction motors and for lighting is supplied from the Shawinigan Falls plant, four miles farther down on the St. Maurice. Current is transmitted at 50,000 volts and is stepped down by three 1,000-kw. transformers to 2,240 volts. A part of the current is further stepped down to 370 volts, by a bank of 100-kw. transformers, and then converted to 600 volts d.c. for operating the d.c. motors. Another portion of the 2,240-volt current is stepped down to 450 volts, by three 75-kw. transformers. Current for lighting purposes is delivered to the circuits at 230-115 volts.

The 9 turbine-generators, when installed and in operation, will provide the Laurentide Company with considerable surplus power, which will undoubtedly extend the fields of the industry in the St. Lawrence Valley. No arrangements have as yet been announced concerning the sale of the surplus. The company will perhaps require 25,000 h.p. for its own needs and it is stated that this alone will mean the saving of a bill for over 65,000 tons of coal, costing over $4 a ton, apart from a general increase of deficiency of operation throughout the mills. The estimated cost of the development is $4,200,000 exclusive of transmission lines or the cost of changes in the paper and pulp plant owing to the electrification of the entire manufacturing system.

WATER-PROOFING CONCRETE.

The following mixture has long been used by the United States Army engineers in water-proofing cement: One part cement, two parts sand three-quarts of one pound of dry powder alum to each cubic foot of sand. Mix dry and add water in which three-quarters of one pound of soap has been dissolved to each gallon. This is nearly as strong as ordinary cement, and is quite impervious to water, besides preventing efflorescence. For a wash, a mixture of one pound of lye and two pounds of alum in two gallons of water is often used.

American cast-iron pipe makers are turning their attention with greater interest to the Latin American market in view of the recent developments. This change, when it comes, will greatly strengthen the opportunity to obtain a large part of the business of the various Central and South American countries, which at present goes chiefly to England, Germany and other European nations.

HOW ENGINEERS MAY BEST USE TECHNICAL JOURNALS.

WHILE much publicity has been given to the usefulness of the technical journal to the busy engineer, and to the proper methods for taking fullest advantage of the services which it renders, it still remains a problem that can best be met by the individual. Many men have many ideas as to the most efficient manner in which the engineering journal may be made of lasting service. All agree that it is indispensable—the differences of opinion centre around its application to each engineer's peculiar needs. There are engineers of all ages of manhood, and engaged, as we are told, in upwards of 110 accurately segregated branches of engineering. Requirements naturally afford leeway for wide variation. It is very gratifying, therefore, to have the instructive lesson which is contained in a paper read by John W. Alvord, consulting engineer, of Chicago, before the Convention of the Federation of Trade Press Associations, held in that city in September. Mr. Alvord views the problem from the standpoint of the young, the middle-aged, and the veteran engineer. His hints to each on how to read, and how to preserve, engineering data are of extreme value. We extract the following from his paper:

That we cannot keep abreast of the times without reading the engineering journals is obvious. That if we carefully read all the engineering journals in our chosen specialty we would have no time left to earn a living is easily capable of demonstration. What, then, is the proper attitude to adopt toward this ever-increasing flood of information that pours in upon us so relentlessly?

If we look about us to see how our fellow engineers solve this matter we shall find a great variety of attitude toward the problem. Some engineers simply do not take engineering journals; reading one occasionally here and there as opportunity offers. Others take all they can afford to take and let them pile up around the office, often unopened and unused. Others still limit themselves to a select few, which they carefully bind and shelve. Still others read journals when they can, and throw them away when they move on. As a rule, however, the engineer prizes his technical paper, and endeavors in some ill-defined and formless sort of fashion to preserve its information for future use. Generally he fails to find any practicable scheme which makes his rapidly accumulating material of much value to him after it has once passed under his eye, and for a large number of engineers, technical journals are only professional newspapers with which to idle away an hour or so and satisfy their curiosity. That their value is something much more than this, or should be more than this, is so apparent as to need no denial.

The problem of the engineer with his technical paper is much affected by his age, station and aim in life. To the man who is engineering only to get money and more money, the engineering journal is a newspaper, in which he may notice mainly where there are better jobs than his own that may be sought after and perhaps obtained. To the man who is anxious to fit himself every year of his life for something better it is an opportunity, quite unequalled many years ago, for a great variety of study. To the young engineer the engineering journal, properly read and noted, is a part of a post-graduate course in engineering. To the middle-aged man it is a mine of data, bearing in all sorts of ways on his work; and to the mature specialist only does it begin to become burdensome by its repetition of experience, and its volume of matter on subject which has already, to him at least, been well digested. Let us see if we can outline how each of these classes can get more profit out of the matter contained in the engineering journals than do the careless or the indifferent, who, after their journal is once looked over, let it go to waste or idleness.

The young engineer and the college graduate need, most of all, practical experience. It is safe to say that engineering literature will never have any proper perspective for him until he has been connected in some capacity with engineering work himself, be it in ever so modest a capacity. With the actual doing of engineering work, however, should come contemporaneously the reading of technical journals, particularly along the lines in which he is working. Nothing can be more instructive, broadening, and enlightening to a man doing a particular kind of work than reading about similar work at the same time. It follows, therefore, that the young engineer should as early as possible, take at least one first-class engineering journal and own it himself; bind it if he can afford to, but lay it away in an orderly manner, in any event. If he can afford two journals so much the better, especially if they are selected so as to widen his outlook.

It is to be doubted if laborious reading of all kinds of engineering articles all the time is advisable for anyone. Mere quantity of reading is mentally detrimental. If one might advise, it would be to suggest enforced systematic reading of all articles particularly bearing on the line of work the reader is immediately engaged upon, and the optional reading only of such other articles as interest him. This ought not to be much of a task. In course of time as his experience broadens, engineering reading will become less burdensome and more interesting because its relation to practical matters will be more and more appreciated, and the discriminating use of engineering literature better understood. Of course, all this applies to engineering societies as well; but that is another story.

It is probably not wise for the young engineer to indulge extensively in card indexes, filing systems, and the like, for topically arranging his available engineering journal articles. Few men know very early in life where fate and interest will land their future attention, and filing systems and special indexes are expensive and time consuming, and when indulged in without definite aim nearly always quickly become too voluminous and thereby useless. If any suggestions are made along this line, it would be to start a loose leaf, letter-size (8½ x 11-in. page) notebook and note in it (separate pages for separate subjects) only what appears to be extremely useful, either in exceedingly brief abstracts from engineering articles, or diagrams, costs, etc.

The young engineer is tempted to read much about large enterprises—the Panama Canal, big bridges, astonishing tunnels, great dams. This does no harm, and probably holds his interest for the time being. Gradually he learns that, for him at least, the chief value of the technical journal does not lie in its dramatic side, necessary as that may be for our general information, interest and pleasure, but its chief value lies in a fund of small things, which make up routine work of the ordinary every-day job. These are to be watched for, and noted, as practically useful to the average man.

We next come to the man in early middle life, actively engaged in his profession, and note at once that his problem with the technical journal is the absence of "time." Absorbed in a multitude of responsibilities, harassed with unexpected difficulties, worn out at night with the long day of strain, how shall he derive any useful good from the multitude of journals which his more ample income can readily afford, but which pile high on his table after every brief absence from the office? Whether or not such an engineer shall make any effort to systematically assimilate, file, and study current technical journals depends in part upon the nature of his routine. If he is largely engaged in administrative work, or is a salaried officer in a large enterprise with a comparatively limited range of problem or a limited call for miscellaneous data, he may generally be content with a cursory examination of the engineering journal such as will keep him qualified on his undertaking, and the preservation of such journals in bound form, with the standard published indexes. If, however, he is entering upon novel work, or work presenting a great variety of problems, overlapping into a great variety of fields, ambition will compel him to do more than this, and some form of special indexing will appeal to him more or less strongly as he feels the need more often for research in up-to-date material.

The average editor can judge of a technical article with only a brief inspection—a sentence here and there, a headline, and a moment's reading of the summary and conclusion. Long familiarity with matter of a similar character gives him the assurance that he can detect in this rapid review anything novel, new, or original, and can fairly pass judgment upon it in a general way. The working engineer who has had some experience with technical literature can form the same habit, and save much time. It is really wonderful how much repetition there is in engineering writing and in the production of engineering papers. It thus happens that we are under the necessity of seeing much the same facts and principles repeatedly published in varying form, for some one is always attracted to really read them, with consequent benefit to himself, under the belief that they are new and novel.

The mature engineer notes that a large amount of engineering literature is of the purely descriptive order, merely giving outline of work that has been accomplished, without going into reasons or principles. All this kind of writing is valuable and useful, and has its proper place, but all of this class of literature has its limitations. One of the most severe of its limitations is that it rarely describes mistakes, errors of judgment, or failures, and in these lie the most valuable lessons to the seeker after truth. One is obliged to read between the lines or read with reservation, much as one does in reading accounts of battles in the daily press. It is always wise to look back and note the origin of the despatches in such cases.

A tremendous lot of engineering literature is written which is of little permanent value. Often it represents the writer's struggles to understand a subject. Often it is compiled largely from a desire for publicity. Fortunately the editors of the technical papers can limit this kind of reading by care in selection.

But amid all these drawbacks a discriminating mind will always find a great deal of wheat amid the chaff, and the wheat that will be gleaned will be of differing kind and amount, depending upon the type of mind of the reader, his present problem, and his desire to systematize his information. What, therefore, shall he do with his special selection when once he thinks he has separated it from the flood of raw material?

Several courses are open to him:

First, he may rely on his memory and the published index to his bound volumes. It is safe to say, however, that few engineers really make much practical use of this method. The intervening index and the bother of a search prove to be discouraging to that degree that a proposed reference search is abandoned in about one-half the suggested attempts. The ideal filing system is one in which, with the least amount of effort, one can put his hand immediately and accurately on the thing itself, be it a book, a pamphlet, or a data sheet.

Second, he may keep a special card index of important data and reference to valuable articles. This at once involves labor and attention which few busy men can give and which, if done by assistants or librarians, largely loses its personal value to the one who needs it. The same objection as to the discouraging effect of intervening indexes holds good here, too, and it is further safe to say that of all the contrivances for indexing the most difficult to handle readily and examine rapidly is the card index system.

Third, he may abstract important data in a limited way on loose leaf transparent paper, standard letter-size, and he may remove or detach articles of special value from out his journals, to be filed in regular office file system, like correspondence.

The writer has tried all of the above methods at considerable cost in time and patience, and has, for many years, settled upon the third method. With all its admitted limitations it seems to be the best for an office which is expected to find out information on a great variety of subjects in a limited time, and with the least amount of effort.

Some description of its practical workings may be of interest:

All the technical papers of the office pass on to the desk of the head of the office and are at least looked over (not read) by him. Articles important to his particular specialty are checked with pencil, and articles of especial interest are looked over with care and double checked. Once in a long while data important enough to go to the data file are noted. This is either especially abstracted by the stenographer, or, if a diagram or cost data, perhaps traced in the drafting room, all on transparent paper for copying purposes. Special data of this kind, on 8½ x 11-in. sheets, are filed in the office data file (a separate but common standard correspondence file). From the data file loose-leaf working note-books are made up from blueprints for office or travel purposes. They are altered, refilled, amended and sorted back from time to time as needed to keep them of usable volume and usefully up-to-date.

The technical journals, with checked articles, go to the office clerk or the stenographer at odd hours, or the librarian if one can be afforded, and the useful articles are removed by tearing them out with a ruler. They are folded, usually once, to standard size, with one edge lap left for binding, and are then filed in a subject index file, like current correspondence. The Dewey Decimal system, especially arranged for the office, is used, but only as a general subject plan. When the file is full, portions of its contents, especially that which is most useful, are simply bound in plain pasteboard covers and placed in the library shelves, with titles. Such a book (or many books) would contain all the recent articles thought to be of special value on a given single subject. The remaining portions of the technical paper are thrown away, but in a large office, warranting the expense, duplicate bound copies can be kept as well, with the general published index as their key.

The objections to this system are as follows:

First, it is too expensive for any but the most important offices doing specialized work. Second, data accumulate almost too fast unless rigidly kept down to a minimum. Third, it requires some personal attention of the head of the office, a competent assistant, or the employment of a regular librarian.

The advantages are:

First, it compels the office head to know all the time what is being published in current engineering literature, if only by inspection. Second, it removes all intervening indexes between the searcher and the final repository in bound volume. Third, it keeps one's library usefully up-to-date on all lines in which one should be especially interested. Fourth, it is economical of final shelf room and cost.

Obviously, one should not start so elaborate a system as this unless he is fairly sure of the special line of engineering to which his life will be devoted. Otherwise, waste effort and discouragement will be certain. It is not to be recommended to the young man, but only to the mature man of early middle life when his work clearly indicates the necessity for it. It is, however, the prime requisite of the engineering specialist. To him some such a system is invaluable. Not a few consulting engineers use this standardized system interchangeably, particularly the data file, thereby greatly increasing its usefulness to one another as a joint effort.

We come finally to the mature and experienced engineer of advancing years. How can he make engineering and technical literature of use? It is safe to say that when an engineer has much passed fifty or sixty years of age and has led an active life, his need for engineering literature lessens. Out of the mass of detail which seemed to him so overwhelming and endless in his youth and early manhood, fundamental principles emerge like peaks out of the clouds, and upon these as foundation all detail classifies itself simply and naturally, and therefore, he feels less need for accumulated data or particular description. Probably no one enjoys engineering reading as does the mature engineer, for he can read between the lines and find much to instruct as well as interest, and yet while he is probably the most interested and intelligent reader of engineering literature that the journals have, his ambition as a collector is gone and filing systems no longer appeal to him.

If his acquaintance is wide, he reads with interest the accomplishments of his friends, and the addresses of society presidents and articles on the ethics of the profession. Of failures he is the keen student. The personal column appeals to him, and if he is of right-mindedness he is conscious of more pleasure than formerly in the accomplishments of those who have succeeded and succeeded well in dire and burdensome responsibility. More often than the young man he will turn back for his satisfaction to papers that served him well in times past, and perhaps smile at the lack of improvement that later attempts to deal with their subject often show.

Technical papers, along with the technical societies and their proceedings, form the repository of the professions; they are the interchange of experience, the common store upon which we all draw. Without them we would be strangely helpless. We are indebted to every one more or less who records his experience for the common use, and that debt we should endeavor to helpfully repay in kind, but wisely, concisely and thoughtfully.

The Fort William plant of the Steel Company of Canada, on which construction was started last year and not completed owing to the dull manufacturing season, has resumed operations and a large gang of men is at work on the completion of the building. The plant will be ready for operation between November 15th and December 1st.

ANALYTICAL TESTS AT WATER PURIFICATION PLANTS.*

THE elimination of unnecessary analytical work is a matter that needs consideration at this time quite as much as the making of the necessary tests. Laboratory practice at various purification plants has shown that many of the determinations which are ordinarily included in the standard water analysis schedule are here of little or no importance. For example, the determination of nitrogen in the usual forms of free and albuminoid ammonia, nitrites and nitrates serves no particular purpose in water purification except in special cases. They neither assist the superintendent in the operation of the filter, nor give any adequate idea of the safety of the filtered water. On the other hand, some of the simpler physical tests, such as numerical determinations of turbidity, color and odor, microscopical examinations and tests for alkalinity, iron and carbonic acid, have come to be regarded as most valuable; and in special cases various other tests, such as dissolved oxygen and manganese. Bacteriological tests are, of course, important.

One step in making an analysis of water has never received half the attention that it deserves, namely. sampling. Of what value is it to use analytical methods of great refinement if the samples themselves are not representative, if the mass of water from which the sample is taken is not homogeneous, or if the water changes in character from one day to another? Samples for chemical analyses are almost never larger than 4 liters (1 gallon); and samples for bacteriological analyses are seldom larger than 100 cubic centimeters (4 ounces), while the quantities actually used for the different tests are still smaller. In counting the number of bacteria, the quantity is less than a thimbleful.

On the other hand, we know that bodies of water are not homogeneous. In a lake or settling basin there are vertical and lateral variations; a river is constantly changing, not only in volume but in the character of the water; filter effluents vary, especially the effluents from mechanical filters where the runs are short and the rates are high. The causes of these variations which affect the results of water analyses through unfair sampling are so numerous that they cannot be studied by themselves, and the only course left is to apply to them the laws of probability, or, in other words, to arrange the data secured in some such way that the importance of the inevitable variations may be indicated and an index of the character of the water examined be obtained.

Thus we see that a question of fundamental importance is that of frequency of collecting samples. The question is, how often must samples be taken to obtain reliable results? As a general proposition it may be stated that the frequency of sampling should depend upon the frequency of change in the character of the water examined. For a water of constant quality, a few samples taken at infrequent intervals may serve to give a fair idea of the water, but if a water be subject to great fluctuations in character, a few samples taken at long intervals might or might not give a fair idea of the water. The reliability of the average result will be determined by the laws of probability. The average result does not tell the whole story, for it eliminates the individual results, and a water supply should be safe and wholesome all of the time.

*From the report of the Committee on Statistics of Water Purification Plants submitted at the annual convention of the New England Water Works Association, September, 1914.

The frequency of sampling has a limitation, which is controlled by practical and financial considerations. In a small plant the cost of daily analyses would usually be prohibitive, and even weekly analyses might be a burden. It would be recognized, however, that results based on infrequent samples are less valuable than those based on frequent samples; and that irregular sampling gives the most unreliable results. In order to emphasize this point it seems desirable to establish certain grades of control of operation, based upon the character of the records kept, as follows:

First Grade: Water purification plants under first-grade supervision are those where the analyses of the filtered water are made one or more times a day, and where engineering and such other data regarding the operation of the plans as are necessary are collected by one or more attendants constantly employed.

Second Grade: Water purification plants under second-grade supervision are those where analyses are made regularly, say once a week or once a month, by a trained analyst, and where an attendant constantly on duty makes simple daily tests.

Third Grade: Filter plants under third-grade supervision are those where analyses are made irregularly and infrequently, and where no daily tests are made by the attendant.

Sometimes it is difficult to grade the supervision given a plant. As an example, we have the Lawrence city filter, where daily tests are made during five winter and spring months of the year, and weekly tests during the remaining seven months. Here frequent analyses were made during those seasons which were most critical. This might be termed a mixed supervision of the first and second grades.

This grouping should not be considered as necessarily casting a stigma upon second- or third-grade supervision. Some water supplies may not demand first-grade records. In general it may be said that the safer the raw water, the lower may be the grade of analytical supervision. In other words, polluted waters require the purification plant to be operated with a higher factor of safety, and to this end a more careful analytical control is needed. Stored waters are safer than unstored waters, and with them a lower degree of analytical supervision may suffice. A corollary to this would be that small plants which cannot afford high-grade supervision of filters should endeavor to protect the quality of the supply by storage or by incorporating a large factor of safety in the design of the plant.

NOTE—The Committee on Statistics of Water Purification Plants, acting for the American Water Works Association, consists of Geo. C. Whipple, chairman; Robt. S. Weston, Frank D. West, Frank W. Green and E. E. Lockbridge. Blanks have been prepared illustrating the recommendations of the committee regarding the form of report, tests to be made and methods of recording results. These are arranged to show the analytical data by months and years, and are as follows:

Table 1.—Chemical and Microscopical Character of Raw Water.

Table 2.—Turbidity and Color of Raw Water.

Table 3.—Bacteria in Raw Water.

Table 4.—Chemical Character of Water Delivered to Mains.

Table 5.—Turbidity and Color of Water Delivered to Mains.

Table 6.—Numbers of Bacteria in Water Delivered to Mains.

Table 7.—Numbers of B. Coli in Water Delivered to Mains.

WIDTH OF ROADS FROM THE POINT OF VIEW OF ECONOMY.

An article appeared in the September issue of "Conservation" showing that in some instances wide streets may be actually cheaper than narrow ones. The author is Mr. R. Thomas Adams, senior town-planning adviser to the Local Government Board of Great Britain and recently appointed to act in the same capacity for the Commission of Conservation, Canada.

Some points in Mr. Adams' article are given below:

The advantage of wide roads is sometimes questioned. Where they are made in advance of requirements they may impose an extra burden on the existing ratepayers, for the benefit of posterity. This burden may be too great, even having regard to the ultimate benefit which may be derived, but of course this entirely depends on the degree of width and the extent of cost incurred. No definite standard of width can be satisfactory for adoption under all circumstances.

The ultimate economic gain to the community is one factor, but it is only one factor, in giving the matter consideration. The local circumstances may make it necessary for each road to be considered on its merits. The cost of expropriating land, the existence of buildings, the physical character of the site, the immediate gain as distinct from the prospective gain to the community must all be considered. There are, however, some general principles which afford us guidance in regard to these matters; for instance, where it is definitely known that a road will be required for use as a surface railway or tramway the width of the road should of course be greater than where such use is not contemplated.

There is no necessity for a road to be actually constructed in advance of traffic requirements. On that point there need be no difference of opinion. The sole question is whether the land should be acquired or earmarked for the road in advance of the full width being required. The investment made by the community to-day for the benefit of the future citizens may therefore be limited to the acquirement of the extra land. The construction can be spread over as long a period as may be desirable, but if the land is not purchased at the outset it may be assigned to private uses, such as the erection of expensive buildings, which would make it prohibitive to carry out the widening when actually needed. These possible losses and hindrances to the future development of a town must of course be considered, as well as the question of immediate gain, but the immediate gain, or rather absence of loss, probably makes the wider appeal to the ratepayers.

It is therefore of interest to have an example such as that afforded by the construction of a wide road at Liverpool, England. The city engineer of Liverpool has made extensive experiments in the making of wide roads round the suburbs of the city. Recently he demonstrated to his council that it was cheaper to make a road 120 feet wide than 80 feet wide.

The cost of the two roads, 80 feet and 120 feet wide respectively, is given by the city engineer as follows:

Comparative cost of widening a 40-foot road to 80 feet (tramways paved) with widening to 120 feet (tramways in grass).

Widening to 80 Feet.

Cost of land, 13⅓ yds. @ 5s.	£3: 6: 8
Street works per yard lineal	£7: 2: 6
Tramways (including paving) 1 yard @ £6: 15: 0	£6: 15: 0
	£17: 4: 2
	= £30, 286 per mile

The above estimate provides for the reconstruction of the old road to suit new levels.

Widening to 120 Feet.

Land for new road, 13⅓ yds. @ 5s.	£3: 6: 8
Street works per yard lineal	£4: 13: 7
Tramways (in grass) including land, 1 yd. @ £6: 16: 8	£6: 16: 8
	£14: 16: 11
	= £26, 128 per mile

This estimate does not provide for any alteration to the old 40-foot road.

It will be observed that in order to make the 80-foot road it is necessary to reconstruct the old road to suit the new levels, but that no such reconstruction is necessary in the case of the wider road. It is also important to note that the estimate for the 120-foot road includes the cost of the extra 40 feet of land for tramway purposes.

These circumstances are of course special to a certain extent. Instances might occur where the reconstruction of the old road would be necessary in either case. But even then the only extra cost per yard in making the wider road would be one-eighth the difference between £6: 15 and £6: 16: 8, the cost per yard of the tramway.

In this case the important point is that it is much cheaper for the Liverpool corporation to make a road 120 feet wide than 80 feet wide. All the ultimate advantages to the city are therefore additions to the immediate gain. The latter, however, is not limited to the saving of cost. In Liverpool they are finding out that these wide tree-planted roads are having the effect of keeping the homes of the well-to-do citizens within the city boundaries. Those who will not erect large houses in narrow uninteresting tramway routes are building them on the spacious highways which Mr. Brodie is constructing. Liverpool has for a long time suffered from the migration of its large ratepayers into outside districts. This not only increases the rates all round in consequence of lowered rateable value, but removes from the city those who, while in residence, subscribe to its charities and take an interest in its social life. That the policy of making wide avenues with grass margins is helping to retain these well-to-do inhabitants within the city limits is one of the indirect advantages which Liverpool claims.

A brisk demand for the product of the paper and pulp mills in the interior of Newfoundland has resulted from conditions growing out of the war in Europe. Steamers are rapidly arriving to take on board cargoes for England. It is expected that the mills will be obliged to supplement their present equipment, and it is anticipated that new pulp and paper concessions will shortly be in operation.

Milwaukee has a refuse incinerator with a total capacity of 300 tons a day. A 6,000 kw.-hr. turbo-generator is driven by the steam raised in a 200-h.p. boiler. The current from the generator is to be transmitted to a flushing-tunnel pumping station, some two miles distant, which will pump lake water into the north end of the Milwaukee River for flushing and cleaning purposes.

SOME CANADIAN DRYDOCK SCHEMES.

A drydock is to be constructed at Owen Sound by the Canadian Shipbuilding and Dry Dock Company, Limited. This corporation has capital of $2,000,000 and an Ontario charter. The head office is at Owen Sound. The company has authority to manufacture and deal in iron, steel and other metals; to construct and operate drydocks, harbors, elevators, warehouses, terminals, wharves, etc., and to carry on the business of a wrecking company.

The municipality of Owen Sound has decided to grant a subsidy to the company, which amounts to a cash bonus of $10,000 a year for a period of 20 years. This bonus is contingent upon the fulfilment of an agreement whereby the operating company must employ at least 200 men daily for an average of 300 days in each year. The company will be exempt from taxes, except school taxes, for a period of ten years. A site for the dock and plant has been selected on the bay shore of the city. The dock is to be 775 feet long from caisson groove to head peak, 104 feet wide at the top and 21 feet over the sills.

Those interested in the enterprise are Mr. F. F. Wood and Mr. E. D. Pitt Niagara Falls, Ontario; Mr. F. J. Nelson and Mr. John Roche, Buffalo. Mr. Pitt states that plans are being filed with the Dominion government and that the company's plant will be the largest and most complete for ship repair and shipbuilding and have the largest drydock on the great lakes.

The Dominion government has passed an order-in-council for a subsidy to the Amalgamated Engineering Works, Limited, of British Columbia, amounting to a maximum of $5,500,000, at 4 per cent. interest for a period of 35 years.

The subsidy is for the purpose of erecting at Vancouver modern drydocks to cost over $6,500,000. The plant of the company is to be located at North Vancouver, and will contain a drydock 1,150 feet long, capable of being divided into two sections of 650 and 500 feet in length, with a width of 100 feet.

Another large shipbuilding and drydock plant is proposed by the Dominion Shipbuilding, Engineering and Dry Dock Company, Limited, of Vancouver, B.C. Plans and specifications have been completed for the major part of the work. The plant will be located on the Burrard Inlet at Vancouver, B.C., and ultimately will represent an expenditure of about $2,800,000 for machinery, building and construction. It will have a graving dock, constructed of reinforced concrete, 1,000 ft. long and 100 ft. wide. Adjacent to the graving dock will be two marine railways and alongside of dock, wharves will be constructed to serve the traffic of the plant. One of these railways will handle vessels up to 1,000 tons, and the other vessels up from 1,000 to 4,000 tons. Seven shipbuilding berths will be constructed. Lynn Creek, a fresh water stream, located on an eastern edge of the rib will be dredged and retaining walls built on either side. The stream will then serve as a cleaning out basin and also as a fitting out basin.

The buildings for fabrication and general construction purposes will be located directly in the rear of the shipbuilding yards. The principal structures and their estimated costs are as follows:—

Machine shop, 250 ft. x 68½ ft.	$30,000
Pattern shop, 225 ft. x 137 ft.	30,000
Boiler shop, 250 ft. x 68½ ft.	20,000
Blacksmith and general forging shop, 250 ft. x 68½ ft.	30,000
Angle and plate shed, 600 ft. x 100 ft.	60,000
Woodworking shop, 100 ft. x 200 ft.	35,000
Copper shop, brass foundry, etc., 75 ft. x 125 ft.	45,000
General stores building, 75 ft. x 100 ft.	20,000
General office building, 60 ft. x 90 ft.	10,000

These buildings, with the exception of the last two, will be of steel frame construction with corrugated iron covers and concrete floors with asphaltum top. The general stores building will be similar except that the floor will be concrete without the asphalt surface. The general office building will be of brick and wood.

The principal item of expenditure will be for the graving dock; this with its puming plant is estimated to cost $1,500,000. The improvement of Lynn Creek will cost about $225,500. The stream will be dredged to a depth of 25 ft. and a width of 200 ft., for 1,800 ft., and retaining walls constructed on each side. The creek will be straightened out into a straight canal by diverting its channel. Wharves will be built on the top of the western retaining wall.

There will be two main wharves, one 900 ft. long, estimated to cost $12,000, the other 1,200 ft. long to cost $22,000. On the end of the longer wharf a hammerhead crane of 100 tons capacity will be erected. This will cost about $100,000. There also will be two marine railways, one of 1,000 tons capacity and one of 4,000 tons capacity, the cost, with power plant, being $15,000 and $130,000 respectively.

The Lake Superior Dry Dock and Construction Company, Limited, with an authorized capital of approximately $1,000,000, and a bond issue of £157,000, was recently organized to build a drydock at Sault Ste. Marie, Ont. In November. 1913, the city of Sault Ste. Marie voted a subsidy to the company of $20,000 per annum for a period of 20 years, subject to the payment by the company of taxes on a fixed assessment, which would return to the city about $10,000 annually. The Dominion government has granted a subsidy of 3 per cent. per annum on $1,386,528 for a period of 20 years. The bonds are said to have been underwritten in London and Messrs. Hoare and Company, of London, are trustees for the bondholders. Not long ago, the permanent board of directors was elected, the following being the list:—Mr. C. G. Bryan, director of the Canada Steamship Lines, Limited, director of the Richelieu and Ontario Navigation Company, director of Palmer's Shipping and Iron Company, Limited, London, England; Mr. Frederick R. De Bertadano, director of the General Accident Fire and Life Assurance Corporation, London, England; Mr. Rowland Hodge, director of the Northumberland Shipbuilding Company, Limited, of London, England; Mr. Francis Somerscales, late general manager of the Earles Shipbuilding and Construction Company, Limited, Hull, England; and Mr. Percival T. Rowland, barrister, Sault Ste. Marie, Ontario. The company's consulting engineers are Sir Douglas Fox and partners, of London, England.

In June, a payment of $25,000, the price agreed upon for their site, was made to the city of Sault Ste. Marie. Prior to the outbreak of the war, arrangements had been completed by this company, by which their bankers were prepared to advance them a sufficient amount against their underwriting agreements to enable them to commence construction at once. The agent of the contractors, the British Construction Company, and his staff, sailed from England for Canada on July 24th, with the intention of making arrangements to start immediately work on the drydock. The necessary machinery was shipped and is now on the ground. Owing to the conditions brought about by the war, the enterprise will be held in abeyance in the meantime.

The construction of the floating drydock and ship repairing plant of the Grand Trunk Pacific Railway Company at Prince Rupert, B.C., is making good progress. The first pontoon was launched August 24th. The second pontoon or section will be launched during September and within the next 60 days a section of the drydock will be available for repairs to craft in that locality.

The Drydock Subsidies Act of 1910 gives encouragement to enterprises of this nature. This act differentiates between first and second-class docks as follows:—

"A first-class dock shall be capable of receiving and repairing ships of at least 25,000 tons; shall cost not more than $4,000,000; and bonds to this amount or less shall be guaranteed for a term of 35 years.

"A second-class dock shall be capable of receiving and repairing ships of 15,000 tons; the cost shall not exceed $2,500,000; and the bonds shall be guaranteed for the term of 15 years."

Dawson, Yukon Territory, is planning to establish a municipal electric lighting and telephone plant at an estimated cost of $165,000. The Dawson civic league, which is planning various improvements, recently petitioned the Yukon council against the annexation of the territory to British Columbia, and the surrender of its independence.

About 65 per cent. of the permanent way of the Swiss Federal Railways is equipped with steel sleepers. The weight of the sleepers is 25.16 kilos. per running metre, and when the holes for the rail attachments are complete they weigh 72.5 kilos. (159.8 lb.) each. The tensile stress specified is from 35 kilos. to 45 kilos. per square millimetre, and the entire trough piece must be capable of being bent back double without showing any crack. At the switches double-trough sleepers are used, which weigh 125 kilos. (275.5 lb.) each.

SPEED VARIATION BY A GRAPHICAL METHOD

PERCENTAGE SPEED VARIATION FOR DIFFERENT GOVERNOR TIMES AND VARYING AMOUNTS OF LOAD CHANGES IN A HYDRO-ELECTRIC POWER PLANT, INDICATED GRAPHICALLY.

By T. H. HOGG, C.E., (Toronto).

THE problem of finding the percentage speed variation for different times of governor, and varying amounts of load change, is one with which the hydro-electric engineer has often to deal. The number of variables is such that it is difficult to grasp the range and variations unless resort is had to graphical means. The writer has recently had occasion to use such a method, which may be of interest to engineers dealing with like problems.

The methods used in modern hydro-electric plants to preserve uniform speed under various conditions of service are too well-known to warrant full discussion, but it will be necessary to give a brief résumé of the factors influencing speed-regulation in order that the chart illustrated may be understood.

With high head plants, speed regulation becomes increasingly difficult, on account of the increase in the length of the feeder pipe lines, and the necessity for the economical use of the small amounts of water often conserved in costly storage reservoirs.

The amount of energy stored in the moving water of these pipe lines precludes rapid speed regulation, unless other means are used to furnish deficient energy when load is thrown on, while the water is speeding up in the conduit to the new required velocity; and conversely, when load is thrown off, to take up the excess of energy which must be dissipated gradually.

While this adjustment of velocity of flow is being made, the increase or decrease of energy is usually taken up by one or more of the following remedies, *viz.*, synchronous by-pass, deflecting nozzle, flywheel, relief valve, breakplates, governor-actuated pressure regulator or surge tank.

Where the first methods are used, in case of load thrown off, the water is by-passed by means of a valve operating by pressure directly connected to the water-wheel gates and arranged to open as they close; when load is thrown on, dependence is placed on the extra fly-wheel attached to the wheel to give the additional amount of energy required. Modifications of this may be used, such as a by-pass indirectly controlled by the movement of the governor so that any movement of the governor actuates a relief valve. With load thrown on, however, a limit quickly comes to the available speed regulation on account of the flywheel required. It is to this aspect of the problem that the chart and discussion applies. The method used for the analysis of the problem is that given by Mr. W. Uhl in his paper published in the February, 1911, Journal of the American Society of Mechanical Engineers. The graphical treatment is based on methods illustrated in Peddle's treatise on "Construction of Graphical Charts."

In an open-flume turbine setting, the speed regulation is dependent upon the flywheel effect of the connected rotating masses; the variation being in accordance with the following formula: $s_1 = \dfrac{800{,}000 \times H.P. \times T}{n^2 \times (w e^2)}$, where s_1 equals the speed variation or ratio between total speed change and normal speed; $H.P.$ represents horse-power load variation; T the regulating time; $(w e^2)$ the moment of inertia of rotating masses, and n the normal revolutions per minute.

The value of s_1 must be modified, due to several causes; the friction load of the generator and turbine remains and will tend to reduce the speed variation. Also, providing the turbine is correctly designed so as to give its maximum efficiency at normal or synchronous speed, the efficiency will be reduced with either increasing or decreasing speed. The amount reduced varies with the type of runner, being greatest for a high-speed, high-power runner, and least for a low-speed, low-power runner, since if correctly designed, the change in efficiency will be greater for a high-speed than for a low-speed runner for the same per cent. of variation in speed. The new value of s_1 to be used we will call s_2, and $s_2 = c\, s_1$ where c is a constant, as follows:

Type of runner (Specific speed)	13.55	20.3	29.4	40.7	49 7 / 62.8	70.97 / 83.78
C	.714	.703	.69	.671	.645	.606

Regarding the value of T in the above. The governor manufacturer will state the time required for a complete stroke of the governor, and experience shows that the time required for a governor to alter the power of a water-wheel after a great or small sudden load change will be approximately constant and equal to the time required for a full stroke or T.

As noted previously, a large amount of energy is stored in the moving column of water when long penstocks are used. Changes in velocity, therefore, involve changes in the kinetic energy, and produce pressure variations or oscillatory waves in the conveying conduits. It is this pressure variation or water hammer which develops when the flow in a pipe line is disturbed by the movement of a gate located either at the upper or lower end or in an intermediate position. These waves or oscillations once set up, continue until they are smothered by the friction on the walls of the pipe and between the molecules of water.

The velocity at which these waves travel is of considerable interest as on this depends the time element of the disturbances. This velocity depends upon the compressibility of the water and upon the nature of the material of which the penstock consists. It is found to vary from 1,000 feet a second for large diameter pipes to 4,500 feet per second for small diameter, and may be figured for any given set of conditions. Knowing this velocity, a, the minimum regulating time of the governor must always be greater than $\dfrac{2L}{a}$ where L = length of the penstock, otherwise dangerous interference to regulation, due to speed oscillations, will be developed and extreme pressure heads will exist on the valves and penstocks.

Now, knowing or having fixed the regulating time of the governor for any particular plant having a long pipe line, it is possible immediately to obtain the pressure variation due to any given change of load (velocity). Let us call this pressure variation $\frac{dH}{H}$ with the sign + for governor closing and — for governor opening.

Therefore the speed variation of the unit due to any change of load may be immediately obtained from the following formula:

$$s_3 = s_2 \left(1 + \frac{dH}{H}\right)3/2 \text{ for load thrown off.}$$

$$s_3 = \frac{s_2}{\left(1 - \frac{dH}{H}\right)3/2} \text{ for load thrown on.}$$

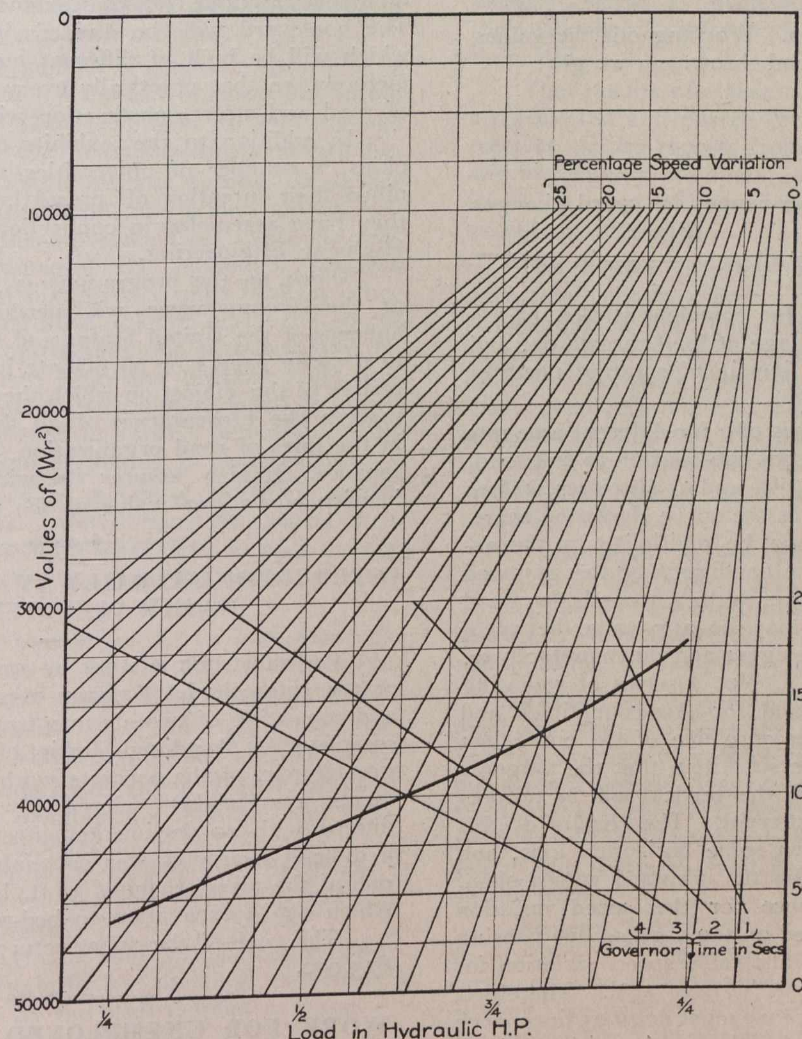
For a closing time of governor T greater than $\frac{2L}{a}$, the pressure increase or decrease $\frac{dH}{H}$ may be found from

$$\frac{dH}{H} = \frac{p}{2}\left(p \pm \sqrt{p^2 + 4}\right)$$

where $\frac{dH}{H}$ = pressure variation

$p = \frac{Lv}{gHT}$

L = length of penstock
v = velocity in penstock
g = acceleration of gravity.
H = gross head



Curve Showing Percentage Speed Variation for Different Governor Times and Varying Amounts of Load Change.

s_2 is the value previously obtained for open flume conditions and is here modified on account of the head variation.

It will be noted that the speed variation of a unit is inversely proportional to the (we^2) of the rotating parts, so that in order to secure any given percentage of speed variation we must install a certain value of (we^2) or flywheel.

T = time of governor
s_3 = speed variation in per cent.

We can now proceed to the construction of our chart.

Let us assume the following example: Two machines of 2,180 h.p. each on one penstock.

Length of penstock L = 1,655 ft.
Gross head H = 535 ft.

Velocity in penstock:

For ¼ load on one machine v_1 = 1.17 ft. per sec.
For ½ load on one machine v_2 = 1.91 ft. per sec.
For ¾ load on one machine v_3 = 2.49 ft. per sec.
For full load on one machine v_4 = 3.16 ft. per sec.

and n = 900 revolutions per minute. The type of wheel used is one with a specific speed of about 13, and therefore $s_2 = .714\, s_1$.

$$\text{Therefore } s_3 = \frac{s_2}{(1 - \frac{dH}{H})^{3/2}} = \frac{.714\, s_1}{(1 - \frac{dH}{H})^{3/2}}$$

$$= \frac{.714}{(1 - \frac{dH}{H})^{3/2}} \left\{ \frac{800{,}000 \times H.P. \times T}{n^2 \times w r^2} \right\}$$

$$\therefore s_3 = \frac{T \times C}{(w e^2)}$$ when c is a quantity varying with the percentage of load thrown on. Working out the values of c for ¼, ½, ¾ and full load thrown on we get:

$c_1 = 292$
$c_2 = 790$
$c_3 = 1{,}195$
$c_4 = 1{,}790$

Therefore, we have the whole range of speed changes represented by the formula $(w e^2) = \frac{T \times C}{s}$ in which T represents time of governor for complete stroke, c is a quantity varying with percentage of load thrown on, and $(w e^2)$ represents moment of inertia of rotating parts of the unit.

First, let us plot the values of c for different amounts of horse-power thrown on from one-quarter to full load, using as ordinates the values of c and as abscisses, values of horse-power. This gives us the curve shown on chart.

The values of c must now be multiplied by the assumed values of T. For the conditions of the assumed example T will vary from 1 second to 4 seconds for good commercial operation, and may be any value between, subject to the choice of the designer and the manufacturer. To multiply values of c by T, plot a series of radiating lines making these lines stand for governor times and converging to a point on the zero line of the curve just drawn. These lines must be so drawn that the tangents of the angles they make with the vertical will be proportional to the times they represent. The results of this multiplication will be read on some horizontal axis, and they must next be divided by the assumed values of s_3. Choose a point of convergence for the speed variation lines and this must be located on the vertical line passing through the T centre. The allowable speed variation for commercial operation will not be over 25%. Therefore, from the point of convergence we must draw 25 lines, such that the tangents of the angles they make with the horizontal will be proportional to 1, 2, 3, etc., up to 25.

To determine the limits within which the desired results of $(w r^2)$ must fall, by working out a few cases we find that 0 to 50,000 will cover all the practical field of operation. Choose a scale such that these can easily be read; say, 5,000 equals 2 spaces. Therefore, we locate the centre for the speed variation lines on the vertical line which passes through the centre of the T lines, and 20 spaces above it. From this centre draw the radiating speed variation lines, according to the tangents of the angles.

To read the chart, enter at the bottom at the assumed load thrown on, and run up to the curve; from there go horizontally to the desired governor time, then vertically to the speed variation line, and then horizontally to the vertical scale representing value of $(w r^2)$. Or if value of $(w r^2)$, amount of load thrown on, and time of governor are known, enter as before at the load thrown on, run vertically to curve, thence to governor time and the intersection of the vertical through this point with the horizontal drawn from the desired value of $(w r^2)$ will be on or near one of the speed variation lines, thus giving the speed variation for the assumed condition.

AMERICAN GOOD ROADS CONGRESS.

Among the educational features to be presented at the American Good Roads Congress, at the International Amphitheatre, Chicago, December 14th to 18th, inclusive, will be a model boulevard, twenty feet wide and more than four hundred feet long extending around the arena. The boulevard will be divided into sections, each of which will be built of different materials or by different methods, so that practically every modern standard type of road and street construction will be shown.

In addition to the exhibits of several States and cities, a number of universities and colleges have signified their intention of presenting the exhibits which they have assembled in connection with their courses in Highway Engineering.

Work on the programme is progressing as rapidly as the circumstances will permit. The leading road-builders of the United States and Canada have consented to prepare papers or participate in the discussion on the phases of the subject on which they are best posted. This insures the presentation of all the latest developments in the lines of road organization, construction and maintenance. It also assures the wider and more comprehensive educational value of the proceedings.

INTERCOLONIAL RAILWAY BRIDGE OVER THE NASHWAAK RIVER, N.B.

The substructure work in connection with the bridge of the Intercolonial Railway over the Nashwaak River, and consisting of two abutments and four piers, has been completed by Baird and Howie, of Fredericton, N.B. The greater part of the concrete work on the piers and abutments was run last winter under severe weather conditions with no detrimental effect. Foundation work of a difficult character was encountered in some instances, one of the piers reaching 30 ft. below water level, below which again excavation to bed-rock was necessary.

The cost of the substructure will be approximately $45,000.

WORK FOR UNEMPLOYED AT BURNABY, B.C.

It is proposed in the municipality of Burnaby to set men to work under the supervision of Mr. Fred. L. Macpherson, municipal engineer, on the cutting of trees and the general cleaning up of road allowances throughout the municipality. A rock-crushing plant will also be installed. Crushed rock and cordwood are materials for which there has been a keen demand. The former has been subject to haulage from Pitt Lake.

The municipality is going ahead with all needed improvements and an extensive program has been arranged to provide employment throughout the winter.

STATISTICAL CONTROL OF RAILWAY OPERATION.*

By W. M. Baxter,
General Manager's Staff, Canadian Pacific Railway.

THE business of a railroad may be divided into two distinct departments, namely, acquiring traffic and moving traffic, which is similar in industrial enterprises to the selling end and the manufacturing end. A railroad manufactures and sells transportation.

The great difference between the producing of the railroad's commodity and that of a flour mill, or coal mine, from the viewpoint of management, is in the fact that the plant and equipment of the railroad is dissipated or spread over a large stretch of territory or country, while that of the flour mill or coal mine is concentrated, so that all supervision must be delegated, most of the work being done by transportation units, which are continually changing their location, so that they cannot be supervised except in a scattered manner.

An unusually large number of employees must work without supervision, and the margin of operating profit is exceedingly small, when compared to the average returns on the investments in manufacturing and farming.

As the general manager usually spends the larger portion of his time in inspection, and under normal conditions seldom directs the movements of trains, he sees but an infinitesimal volume of the company's business moved. As the scope of his vision is thus limited, other methods must be resorted to in order to check the operation. The means of accomplishing this is to separate the operation of the road into rigid and definite units and then to compare these units with similar ones on other roads, or with the same road at various periods, or with arbitrary standards chosen as guides, or bench-marks.

Controlling a railroad by means of statistics might be defined as the process of determining the unit in each operation and then maintaining these units as nearly rigid as possible, seeing that they are collected, reported accurately and promptly.

The basic operating unit in freight traffic is the ton-mile, which is the product of the ton and the distance. The basic unit in passenger traffic is the passenger mile.

There are 6 important statistical units deducible from these two fundamentals, which are defined as follows:—

1. The average train load, either freight or passengers, is obtained by dividing ton mileage and passenger mileage by train mileage.

2. The average car load, freight and passenger, obtained by dividing ton mileage and passenger mileage by the respective car mileage.

3. The average length of haul for passengers and freight, respectively, obtained by dividing passenger mileage and ton mileage by the total number of passengers carried and the total tons moved.

4. Ton miles per engine hour obtained by dividing the engine ton miles by the number of hours the engines are in service.

5. The average revenue per passenger mile and per ton mile, obtained by dividing the freight receipts by ton miles and passenger receipts by passenger miles.

6. The average density of traffic per mile of road, obtained by dividing ton miles and passenger miles by the length of road.

* From a paper read before the Canadian Railway Club, Montreal, Sept. 8th, 1914.

It is unfortunate that this data cannot be given to the executives earlier than 5 or 6 weeks after the operations have occurred, owing to the enormous concentration and calculations which must be resorted to in arriving at them on a large system economically. While they are of final value in determining the general efficiency of the system, it is necessary to have a more immediate check in the form of current records.

Perhaps the most tangible source of daily information is the train sheet, which is received by the train masters and superintendents, from the despatchers. This sheet records the movements of all trains on the division, showing their consist as to loads and empties and number of cars in the train, and sometimes shows the number of passengers carried on each of the passenger trains, as well as the general movements of traffic, the observance of schedule time, the cause of delays and weather conditions.

By this means of concentrating upon a number of primary officers as much first-hand detail information as they can absorb, the foundation of statistical control has been laid.

The results of these primary officers' observations are collected and passed on to their next superior, who receives similar reports from many such primary officers, and in this way the operations of the road and work performed is reported with diminishing detail, until the chief executive is reached.

The division superintendent is undoubtedly the most important primary officer. The operation of his territory is reported to him daily, and frequently on congested terminals he receives certain information hourly. In addition to this daily data, he has a number of statistical sheets prepared monthly, which show in condensed form, sometimes grapically, the comparative results of a large number of operations on a division, one month as against another, one day as against another, and one year as against another.

When these records are graphically presented the sheets are ruled with a number of vertical lines, representing the number of days in a month, or the months in a year, or, in other words, progress of time, while a horizontal ruling to scale represents volume or quantity.

In this way the directing officer can readily see, for example, what has been the average tons per train mile, and the average pounds of coal consumed per 1,000 ton miles for a certain district or territory for a number of months, compared with the same months of the previous year, or if the records have been kept for a number of years, fair indication will be had of the season's effect on the traffic.

The important daily returns which a superintendent receives are those showing the number of trains of loaded cars, empty cars, and total cars received and forwarded in each direction at all of the terminals, also this same information for train movements at important intermediate points. He must know the entire train movement and the tonnage movement, and the failure to perform a given service of these movements as expressed in delays and other causes, must be thoroughly investigated and remedies applied. He is informed about the conditions of each of the yards and terminals on his division, and also about outside important terminals, which may affect movements in his territory. He knows the demand for freight and passenger equipment and the class of each required at the various points, as well as the available supply, and the condition and amount of power to move it. All of this information is of a statistical nature.

The officer next superior in rank is the general superintendent. He has received through the superintendents statements showing by divisions the number of engines assigned, total number of through engines shown on the train sheets, the number of through freight engines out of a shop and available for service before a specified time, usually at midnight, the number of through freight engines in shop for repairs and reported as coming out within 24 hours, and those which will not be completed in 24 hours, and also the average mileage made by these engines in service, special engine assignments, such as way freights, passenger engines, switch engines, work trains pick-ups, etc., together with general remarks on the entire power situation.

He also receives reports on the cars handled at stations, showing the number of cars of merchandise on hand and when unloaded, together with information relating to special car movements. He is also notified concerning traffic exchange at all foreign line connections, and if there is a special traffic, originating in his territory, such as coal mining, or some big manufacturing industry, he is advised of the number of cars moved and supplied, and a statement of detentions and their causes, as well as a report on the weather. While these are the principal reports he receives there are numerous special and minor statements furnished or compiled in his office daily, weekly, and monthly, which are beyond the scope of this article.

It is evident that no general superintendent could exercise close watchfulness over the thousands of separate items which these reports cover, and in reality he does not. A man in this position not trained on the property could not make efficient use of them, as the information gained is not so much absolute as relative. As the great majority of the data he thus receives must be judged comparatively to be of use, the graphic method of recording statistics is perhaps most practical and is instantly read.

The general superintendent, being familiar with all the conditions of his territory and knowing how it ought to operate, can look for the deviations from the results he is expecting. It may be fairly said that his system of control is by deviations from known standards.

The general manager, however, receives a smaller number of reports dealing only with the principal topics. All of these general considerations, and many other local ones, the managing executives have clearly in their minds, but accurate statistical information must be the basis of their judgment in any specific case. They must receive constant advices relative to the current productive power of various localities on the system, the state of the wheat crop, the cotton crop, the lumber market, or seaport traffic, so as to be able to foresee the possible future requirements necessary to handle the business expeditiously. This is again a matter of statistical organization, but it can be made to yield large results in actual operating efficiency.

The traffic department and the operating department must work hand-in-hand in their investigation of anticipated business, although from different motives.

The traffic manager is interested primarily in car supply and train service. It is his duty to secure the largest possible number of routings of business actually in sight, and also devise means for creating business that is not in sight. His business is divided into two main classifications, local traffic and competitive traffic, and he requires daily statistics to show how his local traffic compares with his expectations or with other seasons, and it is of great importance to him to know how his local agents are handling the competitive situation.

Even the local traffic is probably competitive with the traffic of other roads serving other markets, and the traffic manager must gauge the prosperity of his local industries largely in terms of their output, and this can be done only by comparative statistical data.

The intricacies of the mechanical department are, perhaps, most susceptible to statistical control. It deals with plain units in great variety, as, for example, pounds of coal consumed per specified service as per train mile or ton mile, or engine miles between stoppings or axle miles per hot box. There are really myriads of details in the mechanical performance of cars and locomotives, which can be standardized by means of statistical records. And deviations from these selected or normal standards will show up in great contrast, thus plainly denoting where investigation and remedy is needed.

The superintendent of motive power and his primary officers are continually engaged in these investigations.

Statistics of earnings and expenses are the ultimate check on all of the road's records, and when taken in conjunction with the statement of work performed and shown graphically, present the final picture of the system.

Without knowledge of the work done, however, earnings and expenses are not an adequate means of control. Many roads west of the Mississippi River in the United States operate for 60 per cent. of gross earnings, or slightly less, while in the East the average is nearer 70 per cent. Thus the operating ratio is an uncertain test of efficiency. The high rates in the newly-settled parts of the country make relatively easy a showing which the best operation in the world could not accomplish in a territory of intense competition of long duration, where the struggle for business has reduced the margin of profit of the railroad to a minimum.

These comments apply primarily, of course, to the statistical use of the operating ratio by the banker or broker, or student of railway affairs who is trying to judge one property in terms of another. The manager of the road confronted habitually by the same set of conditions can form a great many accurate opinions from the reported earnings, and they are of the highest statistical importance to him. Where detail knowledge of the property is absent, however, there could scarcely be a more perilous standard of railway efficiency than the relation which operating expenses bear to earnings. A road in mountainous country must pay relatively high sums for every ton moved, because of the necessity of double heading or of breaking up trains into short sections. On the other hand, a road operating in a swampy, water-level territory, as some of the roads in the Mississippi Valley do, are likely to have an abnormal maintenance cost. A road hauling large proportions of merchandise will have a high ton mile rate, but also a high ton mile cost, because of the necessity of rapid service and small tonnage in car loading. A railroad operating in the cotton belt, or wheat belt, will fluctuate greatly from one season to another, while a road in Canada will report a marked increase in operating cost during winter months.

Similar difficulties confront the banker and broker in making comparisons of efficiency based on the ton-mile. When 1,000 tons are moved 100 miles, a service of 100,000 ton-miles has been performed, regardless of the nature of the commodity. Some of the railroads in Indiana and Illinois, built to haul coal, frequently produce 100,000 ton-miles by moving a 4,000-ton train 25 miles, with a single engine and train crew. On the other hand, a road loading light manufactured articles might be doing well to load three tons per car, and in this instance it would take a single train moving approximately 1,000 miles, or 40 trains moving each 25 miles, to produce 100,000 ton-miles.

The worst of it from a statistical point of view is that most railways are moving a thousand different kinds of traffic all at the same time, and cannot always manage even to haul their coal and light manufactured articles in separate trains. The ton-mile in consequence is an average figure composed of a multitude of dissimilar parts.

This, however, does not confuse the general manager or his assistant. They have been watching the operations of each of the districts for years, and if a new superintendent on a division increases the average loading from 690 to 720 tons, they regard it as a measure of increased efficiency, because they are comparing the results of a known territory at a particular season, under known circumstances with the same territory, and circumstances in another season.

Even this discriminating use of the ton-mile, when expressed in terms of average train load, often leads to its own peculiar form of error. When traffic is handled smoothly at efficient speeds, big train loads almost always mean economical operations, because they indicate that the business is being done with the fewest locomotives and train crews. But, if freight is held at terminal points longer than competitors are holding it, in order to collect maximum loading, or if the tonnage ratings are pushed to the limit, with resulting engine failures, blockaded traffic, overtime for crews and abnormal coal consumption, the big train load results in expensive economy.

This example of an over-done economy is likely charged to statistical government, but it illustrates a point. Statistics are only of use comparatively when measured against similar performances elsewhere, or against a standard arbitrarily chosen and designed in advance. But the analogy must be a real one. It is useless to compare results obtained with dissimilar commodities, or with the same commodities handled under different conditions of grade, curvature, and motive power.

UTILIZING ONTARIO'S WATER POWERS.

The mines and metallurgical plants of northern Ontario are now for the most part operated by electricity generated by water powers. At Cobalt, the falls and rapids on the Montreal and Matabitchewan Rivers are utilized; at Sudbury, mines and smelters are supplied with power by the Spanish, Wahnapitae and Vermilion Rivers; power is conducted to Porcupine from the Mattagami; at Michipicoten the Michipicoten and Magpie hoist the ore and operate the machinery at the Helen and Magpie mines; the Canadian Exploration Company's gold mine at Long Lake, also utilizes water power. A new water power installation is being put in at Gowganda Lake to operate the Miller Lake-O'Brien silver mine and a transmission line is under construction from the Blanche river at Charlton to work the gold properties in the new field at Kirkland Lake. Water powers are numerous in northern Ontario, and, as at Iroquois Falls on the Abitibi River, are employed also to operate pulp and paper mills. They have been of great service to the mining industry in providing cheap power.

The Argentine Minister of the Interior has under consideration a project to establish a motor omnibus service in the national territories of Argentina. It is proposed to initiate a service in the tobacco-growing districts of San Javier and Tacaruare in the territory of Misiones, where tobacco cultivators frequently suffer losses because of lack of transportation facilities.

ROAD WORK IN SASKATCHEWAN.

Good progress is being made on road construction in Saskatchewan, according to an announcement made by F. J. Robinson, chairman of the Highway Commission in Regina. He stated that more than 1,500 men and 1,000 teams were now at work on road construction. It is expected that the number of men employed on this class of work will be greatly increased within the course of another week.

Of a total sum of $1,200,000, voted by the Saskatchewan Government for highways improvements, $1,002,-685.84 was spent on the roads during the year ending April 30, 1914, according to the annual report of the Saskatchewan Highways Commission, tabled in the House a few days ago. Of this sum $507,517.02 was spent on road improvement direct and $417,065.69 was spent by municipalities under commission regulations. For steel bridges and concrete abutments there was a vote of $300,000, the total sum spent on this class of construction being $337,483.18.

At the recent session of the Saskatchewan Legislature it was announced by Premier Scott that the provincial government has decided to spend $750,000 instead of $500,000 as originally intended, on roads in the south-western part of the province. Here the farmers are dually handicapped by long hauls to market and over extremely poor roads.

THE EMPRESS-BASSANO BRANCH OF THE C.P.R.

A very important line now under construction by the Canadian Pacific Railway Co. lies between Empress and Bassano, Alta., and has just been opened to service. It forms a part of the double-tracking scheme, and is considered by the company an important link in the Transcontinental route, as it reduces the distance between Swift Current and Bassano by 25 miles, and avoids some very heavy grades which exist on the line through Medicine Hat. The new line has been provided with 85-lb. Algoma steel rails. At an early date all the transcontinental trains of the C.P.R. will be routed over it.

It is proposed to make a further reduction in the mileage from coast to coast by a new line between Cabri and Moose Jaw, as well as to avoid some heavy grades thereby.

ELECTRIFICATION OF THE LONDON AND PORT STANLEY RAILWAY.

The work of renovating this line, preparatory to its electrification by the London Railway Commission, is progressing rapidly, a good portion being completed. The whole line is being reballasted by the Pere Marquette Road, which is still operating it. The steel on the main line, with the exception of around the switches at the terminals, has been renewed with 80 lb. rails, Canadian Northern Section; and the ties are being replaced with new untreated cedar ties. The following contracts were made: Algoma Steel Co., 3,000 tons of rails and angle bars, 30,000 tie plates; J. J. Gartshore, 380,000 spikes; Canadian Ramapo Iron Works, 52 sets of switches and frogs; Steel Co. of Canada, 34,000 track bolts and 65,000 tie plates; and Canadian Concrete Products Co., 1,100 ft. of concrete piping of various sizes. The inspection of most of the material was made by R. W. Hunt and Co.

Specifications are nearing completion for the electrification of the line, including sub-stations, overhead construction, bonding, cars and locomotives. Terminal plans are also being considered. The engineering work is all being handled by the engineering staff of the Hydro-Electric Power Commission of Ontario, for which F. A. Gaby is chief engineer.

AT WHAT PRICE IS POWER CHEAP?

By H. E M. Kensit, M.I.E.E.

CHEAP power is one of the principal topics of conversation from coast to coast in Canada; cities that have it, or think they have it, spend thousands in advertising it, and those that have it not are eager to spend a million or two on any scheme that appears to offer it.

Yet, it is safe to say that the great majority of people who talk glibly on the subject have no clear idea as to what constitutes cheap power nor of whether power at a given price would be cheap for a given purpose; in fact, the general idea appears to be that if power at a certain price is "cheap" for any purpose it is therefore cheap for all purposes.

If the following questions were put to any but experts on the subject the replies would, in about nine cases out of ten, be as shown:

(1) Is power cheap at $25 per h.p. year? Yes.

(2) Is power cheap at 6 cents per kw.h.? No.

(3) Is power at $25 per h.p. year cheaper than at 6 cents per kw.h.? Yes.

But, as a matter of fact, the answer given is just as likely to be wrong as right, depending entirely on the circumstances of the individual case for which the power is to be used.

To demonstrate this it is only necessary to analyse the accounts of a few miscellaneous users of power. The following is condensed from the actual accounts by meter of consumers supplied under a sliding tariff ranging from 6 cents per kw.h. for consumers taking less than 100 kw. per month to 2 cents per kw.h. for users taking over 8,000 kw.h. per month, with a fixed charge of $1 per month per rated h.p. of motors installed. The equivalent cost per h.p. year is the total annual account divided by the rated h.p. of motors installed and connected (column 3). Column 5 is the rated h.p. at $25 per h.p. divided by the kw.h. actually used.

The fact that the actual cost exceeds 6 cents in some cases is due to the fixed charge of $1 per month per rated h.p. having a large influence where the consumption is small.

Going back, now, to the questions given above and taking them in the same order:

(1) Is power cheap at $25 per h.p. year? It will be seen from column 3 that in 8 out of the above 13 cases it would not be cheap and in some of them it would be very expensive. In case 7 it would be equivalent to 44 cents per kw.h.

(2) Is power cheap at 6 cents per kw.h.? It will be seen from columns 2 and 4 that in 5 cases it would have been decidedly cheap, equivalent to from $3.40 to $15.40 per h.p. year.

(3) Is power at $25 per h.p. year cheaper than at 6 cents per kw.h.? It will be seen from column 5 that in 9 cases it would have been cheaper and in 4 cases (45%) it would have been dearer.

Most people, including engineers, will declare unhesitatingly that 6 cents per kw.h. is too dear for power, but that $25 per h.p. year is cheap power. Yet, here are 45% of actual cases in a list of 13 miscellaneous industries in which 6 cents per kw.h. works out cheaper than $25 per h.p. year, and in one case works out to $3.40 per h.p. year. In fact, the table shows that for small industries with poor load factors 6 cents is quite a cheap rate.

On the other hand, even a two-cent rate on an 80% load factor, such as might be obtained in pulp mills, cement works, electro-chemical works, etc., works out at 88% motor efficiency to about $120 per h.p. year.

Referring again to the table, it will be seen that a sliding tariff of 2 to 6 cents, such as could be given by any ordinary steam power station, works out in practice to a very reasonable cost for power supply to a miscellaneous list of industries, the only exception in the list being an hotel and not a factory.

Comparative Cost of Power for Small Industries, Per K.W.H. Actual and Per H.P. Year Calculated.

		1	2	3	4	5
	Class of work.	Rated h.p. of motors.	Actual cost per kw.h.	Equivalent cost per h.p. year.	Rate per h.p. year equivalent to 6 cents.	$25 per h.p. year would have been equivalent to:
1.	Foundry	13½	5.79 cents	$14.70	$15.30	9.85 cents
2.	Brewery	33¼	3.63 "	19.60	32.40	4.62 "
3.	Printing	11½	7.63 "	41.20	32.40	4.63 "
4.	Printing	11	5.27 "	26.70	30.40	4.94 "
5.	Printing	5	7.15 "	12.00	10.00	14.80 "
6.	Brickyard ...	35	3.34 "	6.33	11.40	13.20 "
7.	Planing mill..	77½	5.44 "	3.08	3.40	44.20 "
8.	Planing mill..	5	5.72 "	30.90	32.40	4.63 "
9.	Cold storage..	43	2.91 "	14.70	30.30	4.95 "
10.	Laundry	30	3.01 "	27.50	54.80	2.74 "
11.	Flour mill....	75	2.25 "	21.80	58.00	2.58 "
12.	Hotel	5	4.73 "	106.40	135.00	1.11 "
13.	Elevator	15	9.10 "	8.00	5.27	2.84 "

NEW FRASER RIVER CHANNEL.

Fraser River shipping will receive an enormous impetus upon the opening of the new channel, which has been in the process of construction during the past summer. This channel provides from 18 ft. to 20 ft. of water at low tide. It lies about half a mile north of the main waterway, which has been a menace to the shipping interests of the Fraser River towns owing to the continual formation of sandbars in the channel. The new waterway will be ready for use as soon as the necessary aids to navigation have been placed.

Editorial

A SLACK TIME FOR ENGINEERS.

An example more illustrative than that which has brought about present conditions, of the setbacks that the practice of engineering may experience would be hard to find. Engineering, as the term is used in its most familiar sense in Canada, cannot be said to include in its various branches many of the same that have been spurred on to working double shifts as a direct result of the European crisis. As a general thing the opposite exists, and half time, or less, prevails. Sherman may not have had engineering prominently in mind at the time, but what he said applies, nevertheless.

The Canadian Engineer has received assurances from the Federal Government, from various departments of the Provincial Governments, from numerous industrial, and from a few municipal bodies, that the war is not causing a material cessation of present undertakings, small or large, and that all engineering work that can possibly be continued will not be interrupted. It is very obvious, nevertheless, from the numbers of engineers with little or nothing to do, that the former assertion does not universally apply, while the latter gives little assurance for the future even to many who are still the proud possessors of work in hand. It all emphasizes the dependency of the present-day engineer upon financial interests over which he has little or no control. It is a fact that no other learned profession is suffering so acutely from the present condition of affairs and the lesson is profoundly brought home that, while it is no disgrace at all for a good and capable engineer to be at present out of a job, there is at all times room for a broader aspect on his part, when judged in conjunction with the execution of the material duties upon which mankind depends. For the past 10,000 years or more the engineer has been doing the important things in the improvement of civilization, and the time is about ripe for him to have a little more to say in connection with their administration. This has been the feeling oft repeated by *The Canadian Engineer*. Adherence to the old definition of the engineer might well be more concrete. Or, the following definition advanced by Parsons in his "The Philosophy of Engineering" might be applied with better advantage to the new engineer as he should be found in the 20th century: "The man of commerce, industry, business, who makes engineering a means rather than an end—the man of affairs." Although the above is faintly apropos of the present circumstances in engineering work, it is well for each engineer to weigh carefully the soundness of his method of conducting his business. Many have now time to do it. Engineering is business and there should be better business methods in engineering.

As for a pronounced revival, in the near future, of engineering activity, it is useless to predict. There are, however, frequent instances where engineering services are to be required and it is wise for the engineer to devise and employ suitable means of keeping in continuous touch with these new developments, though they may seem few when compared with the constructional activities of the past few years. The Construction News section of this journal, for instance, is a medium which reports weekly what undertakings of note are about to be entered upon or proposed throughout the Dominion. It would be surprising to many of our readers, perhaps, to learn what advantages are derived therefrom by the many who have learned its value and follow it closely. The impression entertained by some is incorrect as to its items being of use only to engineering and industrial corporations. The engineer out of employment might well apply what it offers to his own needs, and with material benefit; it displays to him an additional service of which he may not have availed himself heretofore, to wit, a list of opportunities—and opportunities appear to be what many are most interested in just now. We are not unintentionally encroaching upon the field of this journal's circulation department in expressing our belief that *The Canadian Engineer* can be of distinct service to the unemployed. Apart from its other services, it is able to afford a channel of access to employment, at this stage when employment bureaus, our own included, are choked at one end with applications for work, and are food for the ivy green at the other.

This is a time when the engineer must be more systematic and persevering than ever in keeping in touch with what is going on. Emerson's man in the depth of the forest, whose ability in some line of work would compel the world to wear a road through the wilderness to find him, has no place among conditions as they are.

THE ENGINEERING STUDENT AND THE CRISIS.

In our universities and colleges an atmosphere pervades, the like of which has never been known to Canadians of the present day. It is the atmosphere of war, and it has associated with it evidences of loyalty of which we might well be proud, even if the Canadian coasts formed a prominent part of the setting of the great European struggle. The circumstances clustered around the cause for which Britain is so staunchly contending may or may not be clearly understood by all our young men, but the justness of her stand is not for a moment being made a topic for deliberation. Every step toward military training adopted by our engineering schools, relieves but momentarily the pressure from behind, owing to the students' eagerness to uphold her principles.

Through it all, however, the importance of the investment which he is making in an engineering training must not be lost sight of by the student. The dividends therefrom should be regarded by him as the future source of his daily bread, or, if he does not deign to consider them as such, engineering is to be, at least, the prominent part of his life's work. The state of war, though it may be more immediate at present, is momentary compared with his engineering career. The former may demand his services in the field for a short period of time or not at all. The latter will surely demand his services throughout the remainder of his efficient lifetime.

With this in view, then, the engineering course must not be forced into the background. After graduation he will deal in a professional way with the public and with public officials. In this capacity he may become an exemplar in the application of his training to public service; or, he may drift along "without giving offence to anybody and without accomplishing anything progressive." It depends upon him and the benefit he derives from his technical course. He must strive toward usefulness to his country in peace as well as in war.

This will entail greater effort on his part at the present time. His military study will encroach upon the time intended by him for sport and pastime and to a degree perhaps, upon his time for academic work. But it remains for him to make his training his business, and to adhere to the Empire's slogan, "Business as usual."

ENLARGEMENT OF THE LACHINE CANAL.

The Department of Railways and Canals has completed the widening of the Lachine Canal above Cote St. Paul, thereby removing a difficult curve and effecting a decided aid to navigation. The work has been under way since last March and only a few scattered jobs remain unfinished. Before the opening of navigation last spring the necessary length of the canal was dewatered and concrete construction brought up above water-level at the Cote St. Paul lock. This was completed without interfering in any way with navigation. Excavation work was then commenced and during the summer the narrow curve approaching the lock has been converted into a wide basin.

COST OF OILING STREETS AT FORT WILLIAM.

A report presented last week at a meeting of the Board of Works, Fort William, presents some interesting figures on the cost of oiling streets, compared with the cost of watering. The streets were oiled three times during the past season, these three oilings having been found sufficient to keep the dust nuisance in check throughout the whole summer, and it is thought that next year the same streets will only need one or two applications, thereby furthering the reduction in cost.

The cost per foot frontage for oiling amounted to 5.7 cents, or 1.9 cents per foot frontage per operation. The corresponding cost per foot frontage for watering these streets regularly day after day was 5.6 cents. Moreover, as stated in the report, the latter method of settling the dust during hot weather was efficient only for an hour or so. In view of the above results the Board of Works has recommended the installation of a storage tank to provide a larger capacity for oiling streets in future.

The hydro radial project is meeting with favorable reception. Eleven out of thirteen municipalities in the counties of York and Ontario carried municipal by-laws on Monday, authorizing the signing of contracts.

DON SECTION, BLOOR STREET VIADUCT.

THE accompanying illustration is a view of one of the alternative designs submitted in connection with tenders for the Don section of the Bloor Street viaduct. It will be remembered that tenders for this section were advertised for late in July, to close October 5th. This date was later extended to October 13th. At that time eleven tenders were in the hands of the Board of Control. One, however, was irregular, while another one referred only to the superstructure. The nine valid tenders, five of which were for concrete and four for steel structures, were referred to Mr. R. C. Harris, Commissioner of Works, for a report.

The following is a list of the tenders and prices:

For Steel—

(1) Quinlan & Robinson, Montreal ....$ 996,564.81
(2) Wells & Gray, Toronto 1,009,760.75
(3) Navin Bros., Moose Jaw 1,316,954.12
(4) Sherwood & Sherwood, Toronto ... 1,353,074.91

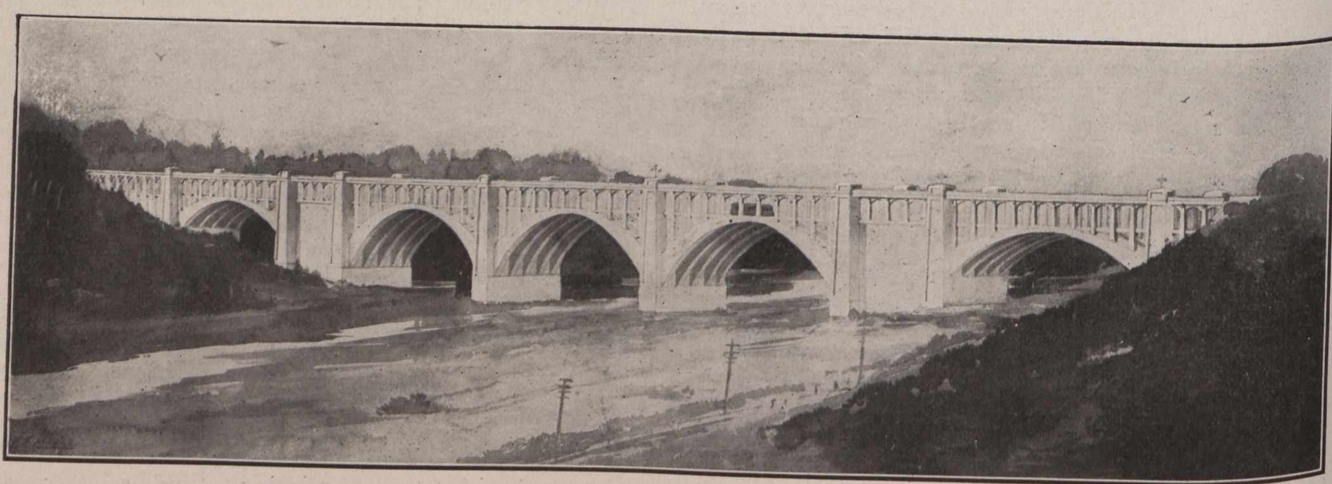
For Concrete—

(1) Jones & Girouard, Ottawa ....$ 849,055.35
(2) Barzaghi-Vought Co., New York .. 875,000.00
(3) Daniel B. Luten, Indianapolis, Ind. 1,098,781.82
(4) C. E. Deakin & Co., Toronto 1,125,000.00
(5) Jas. Cowlin & Sons, Montreal 1,249,701.00

Of the steel tenders, the first two are stated to be based on designs prepared by the Canadian Bridge Co., Walkerville, Ont., and the remaining two on designs of the Dominion Bridge Co., Montreal.

Of the alternative designs in concrete tenders No. 1, 2 and 4 are understood to be based on a design prepared by James, Loudon & Hertzberg, consulting engineers, Toronto, (illustrated herewith). The third tender is based on Mr. Luten's own design, while we are informed that the fifth is an English design.

At the time of writing no award has been made. It is expected that the Commissioner's report will be in the hands of the City Council next week.



Alternative Design in Concrete for Bloor Street Viaduct (Don Section).

THE RELATIVE VALUE OF DIFFERENT PAVING MATERIALS.

In considering the different kinds of material it is necessary first to establish a standard for a perfect pavement and study its different properties. A perfect pavement should be cheap, durable, easily cleaned, present light resistance to traffic, be not slippery, be easily maintained, favorable to travel, and sanitary. Admitting that a perfect pavement should have these properties, it must be understood that they are not all of the same importance and, therefore, a discussion of these properties is enlightening.

In a paper read by Geo. W. Tillson, consulting engineer, New York City, before the Cleveland Engineering Society the author assigns a percentage value to each type, assuming that a perfect pavement has a value of 100. Following are portions of his paper.

Cheapness.—It may be said that cheapness is not a physical characteristic of any material. While this is undoubtedly true, at the same time it must be admitted that it is an important factor in the selection of a material. It matters not how good or how adaptable any material may be, unless the authorities have money enough to use it, it is not available. So that cost must be considered as much in the examination as it would be by a private individual if he were about to purchase any article for himself. The question then resolves itself into what is the best that can be obtained for the money at hand. Cheapness, therefore, is given a value of 15.

Durability.—This is an economic and an important factor. It depends, however, upon a great many conditions. There are some materials which have a certain life only, no matter what the traffic, because they will be destroyed by the action of the atmosphere. This is true of asphalt and untreated wood, and treated wood to a certain extent. With stone, brick and such materials the durability depends almost entirely upon the amount and character of the traffic. The influence of traffic, however, is governed by several conditions, *viz.*, the width of roadway, character of the pavement, presence or absence of street car tracks, state of repair, and how well the pavement is cleaned.

It can be easily understood that the width of the roadway is an important factor, although of course traffic should be measured by the tonnage per foot or yard of width. This, however, must be somewhat modified, as in a narrow roadway the traffic both ways is confined almost to the same lines, so that the wear will be greater for the same amount of traffic than if the roadway were wider, permitting vehicles to move freely in the portion of the roadway assigned to their use.

By character of pavement is meant the detailed method used in laying the different materials; for instance, if a block pavement is used, the character of the foundation, joint filling and method of laying; asphalt pavement, according to the mixtures; and wood pavement, whether the same is treated or not and the method of laying.

The presence of car tracks on a street makes a material difference in its life, for the reason that the traffic is confined almost to one line on each side of the track. In a report to the City of Buffalo, where careful records have been kept of the life of asphalt pavements, it is stated that the presence of street car tracks will diminish the life of the pavement two years.

Whether or not a street is kept in good condition makes a great difference in the life of the pavement. The old proverb, "A stitch in time saves nine," applies undoubtedly to street pavements as forcibly as to any other class of construction. If a pavement be kept smooth so that traffic can be brought upon it perpendicularly, the wear will be reduced to a minimum. If, however, the pavement is allowed to be rough so that the wheels of vehicles strike it irregularly and with abnormal force, the wear is much greater than it should be. While this is particularly true of a block pavement it applies to a certain extent to sheet pavements.

The effect of street refuse on a pavement depends entirely upon the character of the pavement itself. If it be of asphalt, and the refuse is damp or moist to a considerable extent, it will have an injurious effect upon the surface. If, on the other hand, the pavement be of stone or brick, the refuse on the pavement will reduce the wear from traffic and not injuriously affect the material itself. This question, however, is not as important as it was some years ago, as all cities recognize the necessity of keeping pavements clean. Taking all things into consideration, durability is given a value of 21.

Easiness of Cleaning.—This is an economic factor, although the state of cleanliness of a pavement has a bearing upon its sanitary influence, so that the degree to which a pavement can be cleared by ordinary appliances and without undue expense is important. For that reason a value of 15 is given easiness of cleaning.

Resistance to Traffic.—This is an exceedingly important consideration. Street pavements are constructed primarily for the transportation of vehicles throughout the city, and anything that will reduce the traction required to move the loads is highly important. This property, therefore, has been given a value of 15.

Non-Slipperiness.—The slipperiness of a pavement depends upon its material and detailed construction, also its condition. The efficiency of a horse varies with its foothold. It does not matter so much what his strength is, if he cannot apply it to the best advantage. Any material that will allow him to do this has a particular value. It is varied to a great extent by the condition of the pavement; for instance, the presence of sleet or snow. Taking all matters into consideration, non-slipperiness is assigned a value of 7.

Maintenance.—The maintenance of a pavement is closely allied to first cost, and in considering the entire cost of a pavement the expense of maintenance is an important factor. This of course depends not only upon the character of the material itself, but also upon the traffic the street receives. It is unquestionably a fact that a certain amount of traffic is beneficial to wood or asphalt pavements, as it keeps the upper surface of the pavement dense and to a certain extent impervious to water, while as has been said before the imperishable materials wear in accordance with the amount of traffic. This property has been assigned a value of 10.

Favorableness to Travel.—By favorableness to travel is meant the ease and comfort which are enjoyed by driving over a smooth pavement and also the decrease in wear and tear on vehicles on a smooth pavement as compared with one that is rough and uneven. The first of these characteristics can be appreciated by anyone driving in the streets. While the wear and tear on vehicles cannot be exactly computed, information obtained from large department stores in Brooklyn shows that the changing of the old cobblestones of the borough into asphalt has very materially reduced their cost of repairs. In a paper read before the Institution of Civil Engineers in England in 1871 it was stated that the new pavements which had recently been constructed in Liverpool had made a saving of $50,000 per year for every mile of pavement on the dock lying streets, without counting the reduction to the wear and tear on horses and vehicles. This property will be of more value and is receiving more attention on account of the introduction of automobiles and motor trucks. At the present time it is assigned a value of 5.

Sanitariness.—The sanitariness of pavements is increasing in importance from year to year as more attention is given to health conditions in our large cities, and the fact that certain pavements can be more thoroughly cleaned and that the material itself does not absorb moisture are not the only considerations. Schools and hospitals are increasing in number in all of our cities, and it is a recognized fact that as noiseless a pavement as possible is necessary in front of both. Not only that, but in the large office buildings where a great many clerks are employed from day to day the noise caused by heavy vehicles driven over a rough stone pavement has a disturbing effect upon their nerves. While this may seem a little extreme, it is an important consideration. This property, therefore, is rated at 13.

Having thus obtained a tentative standard for a perfect pavement, the different paving materials can be compared and in this way a value obtained for each material. Taking up, therefore, the materials that have been referred to as standard, the stone will be first considered.

Stone Pavements.—Granite and the harder sandstones are those that are principally used in the stone block pavements of this country. The particular kind to be used will depend upon the availability and cost. It would be foolish to consider granite as a material where it must be obtained at great expense and where a good sandstone is available. In this study, however, granite is considered, as it is a material that is used in New York City and one with which the author is most acquainted.

In this connection it should be stated that the figures arrived at in this study by the author must be varied in every locality and must vary to a great extent according to the judgment of each individual engineer. He wishes it understood, however, that he does not consider the exact figures as of so much importance as the method of obtaining the results. So that too much importance should not be given to the results shown.

The granite pavements of to-day are very much better than those that were laid even four or five years ago. It has been found that on account of their being laid on a concrete foundation it has been possible to reduce the depth of the blocks and make them of somewhat smaller size otherwise, thus rendering it possible to get a better cut block at the same expense as before and allowing the blocks to be laid with a closer joint, thus reducing abnormal wear.

The locks are laid on a sand cushion on a concrete base, the joints being filled with cement grout, tar and gravel, tar pitch alone, and sometimes a combination of pitch and sand. The author believes that with a small joint and a combination of good pitch and sand the best results will be produced. While a cement grout joint makes a smooth pavement, it is often difficult to close the street long enough to allow the cement to set, and it also makes a pavement that is exceedingly difficult to repair after it has been torn up for any substructure purpose.

In considering the value of different materials as applied to different streets it is assumed that an intelligent selection of the different materials has been made, as upon that will depend the results entirely. For instance, a granite pavement could be laid on a residence street with light traffic, where its durability would be long and the cost of maintenance practically nothing. On the other hand, an asphalt pavement could be laid upon a heavy business traffic street, where its life would be short and the cost of maintenance enormous. If, however, an intelligent selection of material is made for all streets of the city, what will be the natural life and cost of maintenance will be found.

In 1913 in the Borough of Brooklyn the granite pavements cost 3.9 cents and the Medina sandstones 6 mills per square yard, all on concrete.

Considering all the properties of a perfect pavement, and taking them up in detail, for granite pavements values have been given as shown in the accompanying table.

Wood Pavements.—Wood pavements have been laid at intervals in this country for some seventy years. The first pavements were not only of untreated wood, but of wood selected without much regard for its natural durability. The result was failure, as could have been expected. The repeated failures of the different kinds of wood, however, although they delayed, did not prevent entirely the establishment of wood in this country as a standard material. The success of the wood pavements in Europe made it positive that they could be laid successfully in this country under proper conditions.

The first treated wood pavement in this country was laid on Tremont Street, Boston, in 1900. This pavement has been in use during this entire period with very small repairs, and is in good condition at the present time. It is composed of blocks treated with a composition made up of one-half creosote oil and the other half resin. Pavements of this character were laid in New York and other cities, but on account of the increased price of resin it was dropped out of the mixture and creosote oil only used.

There has been a great deal of controversy as to the character of the creosote oil to be used for this purpose, the principal point being the specific gravity. The theory of mixing the resin with creosote was that, it being a more stable material, it would prevent the volatilization of the creosote and so preserve the blocks from decay for a greater length of time. The object of treating the wood is to prevent decay and also to make the blocks stable by preventing the absorption of water so that they will not shrink in dry weather or swell in wet and thus cause bulging. It was thought that by using a heavier oil this result could be obtained as well as by the use of a light oil with resin. The relative values of the heavy and light oils have never been determined, but the author has always been in favor of the heavier oil.

The present method of laying wood pavements in this country has not been in use long enough to determine what the cost of maintenance is, but figures obtained from St. Louis, Minneapolis and other cities indicate that it is exceedingly small. The first pavement of this character to be laid in Brooklyn was in 1902, and it has had practically no repairs for wear and tear since laid. It is, however, on a light traffic street. The total cost of maintenance of the wood pavements in Brooklyn in 1913 was 1.4 cents per square yard on pavements that had been in use from eight to eleven years. This cost, however, included, besides actual wear and tear, damage caused by openings in the pavement, although not the cost of repaving the openings themselves. In Paris in 1911 the cost of repairs was 26 cents per square yard. In London the average cost is 20 cents per square yard.

The fillings for joints in wood pavements are sand, asphalt or coal tar pitch, and cement grout. The practice in Brooklyn has been to fill the joints with sand, and first-class results have been obtained. Some people, however, prefer the bituminous and others the cement filler;

either will give good results when properly used, although the author does not look with much favor on the cement grout filler.

There is no question that wood block is an important paving material, and on streets where the traffic is heavy and noise is a great detriment it is most advisable. Its strongest point is its noiselessness and its weakest its slipperiness. It has been given a value as shown in the table.

Brick Pavements.—The first brick pavements in this country were laid in Wheeling, W. Va., in 1870, but the material did not come into general use for some time. Many failures have occurred in brick pavements because people did not understand the difference between bricks, and it was not easy in the early days of the industry to determine previous to its use whether a certain brick would or would not make a good pavement, and then it was not known what was the best method of laying. Both of these matters, however, have been fully threshed out, and, in the judgment of the author, this is mainly due to the work of the National Paving Brick Manufacturers' Association, which has maintained a paid secretary to look after the interests of the brick manufacturers, not simply to enable the manufacturers to sell their product, but that every city should get the best possible brick pavement obtainable.

With the present knowledge of the art of making brick and the methods of testing and laying, it is as possible to determine in advance what the results will be with brick as with any natural material.

It is conceded, of course, that brick pavements, like all others, must have a good foundation so that the question at issue, after the bricks themselves have been determined upon, is principally the cushion on the concrete and the character of the joint filling. The National Paving Brick Manufacturers' Association has always been very strong in advocating a 2-inch sand cushion laid upon the concrete. Most engineers in the east, however, believe that only 1 inch is necessary and that no more should be used, the idea being that all that is required is to have a sufficient quantity to allow the brick to be well bedded and have an even bearing over its whole surface. If, however, experience demonstrates that a 2-inch cushion is better than a 1-inch, the extra expense is negligible and it should be adopted.

Three kinds of joint filling have been used: sand, coal tar pitch, and cement grout. At the present time sand is not used to any great extent, as it is conceded that a material should be used that will protect as much as possible the corners of the bricks so that the wear may be in accordance with the principle previously laid down in this paper—as nearly vertical as possible.

The question of coal tar pitch and cement cannot be so easily dismissed, however. The advocates of both materials are very many and present strong arguments, and it must be admitted that good results have been obtained with both kinds of filling. The author believes, however, that if proper care be taken in the laying and in the application of the filler, cement grout will give the best results, as it will come more nearly to making the pavement a monolith. Some trouble has occurred in the past with this filler on account of the rumbling of the pavement under traffic. This trouble, however, has been nearly if not entirely obviated. There is the objection to a cement filler, however, that it is more difficult to open a pavement and replace it in case it becomes necessary on account of the subsurface work.

It is almost impossible to set any figure for the life of a brick pavement or the cost of repairs, as these depend almost entirely upon traffic. The figures given in the table have been made out principally from data received from large cities, and undoubtedly they would be modified if obtained from the State of Ohio, for instance. But as has previously been said, all figures of the table must be adapted to local conditions. The results determined upon are shown in the table.

Asphalt Pavements.—Under the head of asphalt will be considered sheet asphalt, asphalt blocks and bitulithic, although the latter is perhaps more often used with coal tar pitch than with asphalt.

Sheet Asphalt.—The first pavement of any note of this character was laid on Pennsylvania Avenue, Washington, D.C., in 1876. So great was its success that it soon came into general use all over the country. While called asphalt pavement, it is almost entirely composed of sand, as the standard pavements have but 10 to 12 per cent. of bitumen, which is the valuable property of the asphalt, the rest being made up of sand and a small portion of stone dust. The pavement is pleasing in appearance, smooth, not noisy, and on light traffic streets seems to be almost ideal. It is more slippery than the hard block pavements, and in the coast cities it is not generally laid on grades over 3 or 4 per cent. In the interior, however, where the atmosphere contains less moisture, it is often used on grades as high as 7 per cent. without trouble.

Data collected from the cities of Brooklyn, Boston, Buffalo, Chicago, New York, Philadelphia, St. Louis and Washington show that these cities in 1890 had a total of 246 miles of asphalt pavement, and in 1911 2,348 miles. This gives an idea of the popularity of the pavement, although it must be taken into consideration that this was during a period when there was great activity in laying new and smooth pavements. In Brooklyn, for instance, in 1895, there were 18 miles of asphalt pavement, while at the present time there are 540 miles. Brooklyn is a residential city, without many steep grades, and one to which this material is particularly adapted.

The cost of repairs to the asphalt pavements in the Borough of Brooklyn in 1913 was 3½ cents per square yard, and in the Borough of Manhattan for 1912 it was 14.1 cents per square yard, this being due to a great extent to the difference in traffic in the two cities. In the City of Paris in 1911 the cost was 19½ cents per square yard.

In Berlin asphalt repairs are made by contract. The price paid is for streets from 5 to 20 years old, 10 cents per square yard; from 20 to 30 years old, 12½ cents per square yard; from 30 to 40 years old, 15 cents per square yard.

In London the contract price on Cheapside per yard per year was 56 cents for 15 years beginning after the pavement had been down 2 years. The average cost of repairs in London is 30 cents per yard.

Asphalt Block.—This is another form of asphalt pavement and consists of blocks, made under heavy pressure at a central plant, composed of asphalt and broken stone aggregate rather than sand, as is used in the sheet pavement. The mixture of the material can be absolutely regulated and the pressure made uniform, so that the blocks produced should be uniform in density and quality. On account of the stone aggregate being coarser (say from ¼ inch downward) than the sand, the surface of the pavement affords a better foothold than the sheet asphalt, and also on account of the joints between the blocks. So that where a smooth pavement on grades is desired asphalt blocks are particularly desirable. They are used, of course, to a great extent on streets of light grades.

An objection to them is that as they have to be manufactured at one location the entire surface of the pavement must be transported from the plant to the street, while with sheet asphalt the plant can be located at a convenient point so that the haul is not so large. This makes a difference in the expense against the asphalt blocks. On the other hand, however, an asphalt block pavement can be repaired without the use of a mixing plant, as the blocks can be purchased and brought upon the street and used when desired.

Asphalt block pavements in the Borough of Manhattan in 1912 cost 9.8 cents per square yard for repairs, and in the Borough of Brooklyn for 1913 1.2 cents per square yard.

Bitulithic Pavements.—This pavement was first laid about ten years ago. A gentleman who had formerly been interested is asphalt pavements conceived the idea of improving the then existing methods of laying a macadam pavement by filling a portion of the voids with a bituminous product or bitumen mixed with some other material. By the gradual elaboration of his original idea there was evolved a pavement which is now known as "bitulithic." It is essentially a macadam pavement of selected and graded stone, so that the voids in the stone shall be as small as possible, the binder being a bitumen, either coal tar or asphalt, both having been used. The pavement, being formed of coarse materials, can be laid on quite steep grades with satisfactory results. It has been laid very extensively in this country and would undoubtedly have been used to a greater extent if it were not patented. It is considered as standard and ranks with asphalt pavements.

Sheet asphalt, asphalt block and bitulithic pavements are given the same values, as shown.

The table then is as follows:

	Per cent.	Granite.	Wood.	Asphalt.	Brick.
Cheapness	14	8	8	14	11
Durability	21	21	16	15	16
Easiness of cleaning...	15	10	14	14	15
Light resistance to traffic	15	13	14	12	15
Non-slipperiness	7	7	4	5	6
Ease of maintenance ..	10	10	8	6	6
Favorableness to travel	5	2	5	4	3
Sanitariness	13	9	13	12	10
Totals	100	80	82	82	82
Cheapness eliminated ..		72	74	68	71

Heavy traffic.				High-class residential.				Ordinary residential.			
Gran.	Wood.	Asph.	Brick.	Gran.	Wood.	Asph.	Brick.	Gran.	Wood.	Asph.	Brick.
21	16	15	16	10	14	14	15	Omitting			
13	14	12	15	7	4	5	6	light			
7	4	5	6	2	5	4	3	resistance			
10	8	6	6	9	13	12	10	to traffic.			
51	42	38	43	28	36	35	34	67	68	70	87

Knowing, however, the kind of material and the properties thereof are not sufficient for the official whose duty it is to determine the particular one to be used. He should also know the requirements of the streets to be paved. In order to do this he should have records of the kind and character of the traffic upon each street, or upon typical streets. Of course it is not necessary to get a total census of traffic on all residential streets, but of those where by an inspection it can be told to what class they belong.

And in speaking of traffic it should be understood that as at present considered the words "heavy," "medium," and "light" traffic mean very little, except with reference to any one particular city. There should be a standard unit of traffic, so that when the traffic on a certain street is given it could be distinctly comparable with traffic in another city. To do this it is necessary that the effect upon the different materials be known. Little attempt has been made to determine this, but within the last two or three years the English Road Board has constructed a machine for making this determination, and a somewhat similar machine was exhibited at the American Highways Association meeting in Detroit last fall.

It can be easily understood that a vehicle weighing with its load 15 tons will have an entirely different effect upon a pavement than fifteen vehicles each weighing 1 ton. It makes a difference, too, whether the tires are steel or rubber, whether they are 1 inch or 3 inches in width, and whether the vehicle is moving at a rate of 6 or 30 miles an hour. Experiments can be made so that the wear of the different vehicles under different loads can be ascertained and referred to one unit, and until this is done the adjectives "heavy," "medium," and "light" must be considered very indefinite.

The borough engineer of Fulham, London, has established what he thinks is the wear that will take place on wood pavements under a certain traffic, and, having observed the traffic on any particular street, he figures out how long a wood pavement should last. This, however, is indefinite for the reasons before given.

And even after the value of the traffic unit has been established it will be difficult to apply it positively, as in every case the weight of the vehicles upon it must be estimated.

Then, after all that has been determined, there are certain local conditions which must also be taken into consideration. For instance, if the traffic requirements are such that a brick or stone pavement should be used for economic reasons, it is possible that hospitals, school houses or churches may be situated on certain portions of the streets, so that it would be necessary to lay wood on account of its noiseless property. Then, too, the official will learn that the wishes of the users of the street and those doing business on it must also be taken into consideration, and he often finds that the two will conflict, as the truckman cares nothing about the noise and the businessman cares little for tractive or non-slippery properties. So that, despite all information that can be obtained, in order to arrive at a satisfactory result the different conclusions must be treated together and intelligently. If, however, all these matters are taken into consideration, it is seldom that an improper determination will be made.

It might be in order to discuss to a certain extent the economics of the different kinds of pavement. When an original pavement is paid for by assessment upon the abutting property, with repairs and repaving done by the city at large, it often becomes necessary to establish legally just when a street should be repaved. This is more easily determined by inspection in a block pavement than in a sheet pavement, as it can easily be seen when the blocks are worn out, but with a sheet pavement patching can be carried on for a long time and to a great extent without there being any formal repaving. Take for instance the case of an asphalt pavement, and assume for the sake of the illustration that the original pavement is paid for by a bond issue continued during the life of the pavement, which in this case is assumed at 18 years. The

The items of cost in the maintenance of this pavement on a street are:

First cost;

Interest on the bonds;

Annual repairs;

A sinking fund to be collected each year to pay for the bonds when they mature.

Assume that an asphalt pavement will cost $2 per square yard, that the interest on the bonds is 4 per cent., and that it will cost on an average 4 cents per square yard per year for repairs. This can be shown in a formula, such as:

$$A + CI + \frac{R}{N} = \text{annual expense,}$$

—when A equals sinking fund charges, C equals first cost, I equals rate of interest, R the estimated cost of total repairs during the life of the pavement, and N the life of the proposed pavement.

Substituting these values in equation we have:

$$.078 + .08 + \frac{72}{18} = .198 \text{ for the first period;}$$

—that is, the cost to be raised by the city every year to maintain this pavement would be 19.8 cents per square yard. When, therefore, the annual repairs on a street approximate this amount the question of repaving should be carefully considered. If, however, the same pavement is continued upon the street, succeeding pavements would cost less, as the foundation must have a material value.

RUSTING OF IRON IN WATER.

Many years ago Crace Calvert concluded that the rusting of iron in water was occasioned by dissolved carbonic acid and oxygen, the former being the predisposing cause, since no action occurred in its absence. These conclusions have since been widely supported. Experiments conducted by W. A. Bradbury, according to Chemical News, show that rusting takes place very rapidly in tap-water, while in well-boiled tap-water no rusting should occur. During rusting atmospheric oxygen is absorbed. The solution of iron by carbonic acid should result in the production of hydrogen, thus $Fe + 2H_2CO_3 = FeH_2(CO_3)_2 + H_2$, but in experiments with tap-water no gas could be collected after over a week. Water saturated with CO_2 did evolve considerable quantities of gas. These experiments confirm the view that rusting is due to the combined action of oxygen and carbonic acid, and show that the oxygen is utilized in two ways: (a) in the oxidation of the nascent hydrogen liberated, and (b) in the oxidation of the iron bicarbonate to rust. Further tests showed that magnesium chloride solution does not act on iron in the absence of carbonic acid, although it has been stated that such solutions do react with iron, even in the cold, according to the equation—$Fe + MgCl_2 + 2H_2O = Mg(OH)_2 + FeCl_2 + H_2$.

NATURAL GAS PRODUCTION IN UNITED STATES.

The production of natural gas in the United States last year was the greatest in the history of the industry. The total gas production in 1913 is estimated by the United States Geological Survey at 581,898,239,000 cubic feet, valued at $87,846,677, an average price of 15.10 cents per 1,000 cubic feet, as compared with a production of 562,203,452,000 cubic feet, valued at $84,563,957, an average price of 15.04 cents in 1912. Of this total product, about 32 per cent. was utilized for domestic purposes, at an average price of 27.33 cents per 1,000 cubic feet, and 68 per cent. utilized for industrial purposes, at an average price of 9.4 cents. The industrial consumption includes gas used for both manufacturing and producing power.

Coast to Coast

Saskatoon, Sask.—Twelve carloads of cement are weekly being mixed and placed on the new bridge over the South Saskatchewan, at 25th Street, Saskatoon. A pneumatic concrete mixer is being used, and it is expected that the arch rings of the bridge will be completed before the frost sets in. Each arch ring contains about 500 yards of concrete, and the mixer and placer fills one of these in 17½ hours. When completed, it is said, the bridge will be one of the largest and most beautiful arch bridges in Canada.

Edmonton, Alta.—The offer recently made by the Wabamun Power and Coal Company to the city of Edmonton is to supply the city with electrical energy delivered to any point within the limits, the first 25,000,000 k.w.h. at 1 cent, the next 10,000,000 at .95, the next 15,000,000 at .90, then 20,000,000 at .70, and the following 20,000,000 at .65 per k.w.h. In addition, the foregoing prices would be considered as taking care of the load of the city at time of delivery, which would not be later than the fall of 1915. The property of the Wabamun Power and Coal Company is located 28 miles west of the city on the main line of the G.T.P., and includes a mile on the shore of Lake Wabamun, which makes readily available an unlimited supply of water for boiler purposes. Though the company will agree not to sell power to any outside concern at a lower rate than that offered to the city, yet the company is negotiating for the establishment of a plant of sufficient capacity to supply power also to the towns of Wabamun, St. Albert, Calder and other communities along its route to Edmonton. The term of the contract offered for consideration is for 25 years; though the company would agree to supply Edmonton's electrical energy for a period of 150 years. Also, the contract contains the proviso that the company will sell to the city at any period agreed upon the entire plant, transmission line, mine and all assets of the company at a price equal to the cost and 10 per cent. profit.

Cedars Rapids, Que.—A report recently issued by the Cedars Rapids Manufacturing and Power Company covering the progress made upon the company's plant during the four months ending August 31, showed 93 per cent. of the rock and 97 per cent. of the earth excavation completed; while four months ago, 58 per cent. and 73 per cent. respectively were the amounts reported. Of the rock excavated, 94 per cent. had been transported and placed; and of the earth excavated 97 per cent. had been replaced. The concrete in the power house structure was completed, all that remained to be done being the placing of the stone protection, 50 per cent. of which was completed. Half the work on the transformer house was done during the past period, the other half still remaining to be completed. The power house building was substantially completed, and work had been started on the wing dam at the north end. The north end of the building had also been closed in. According to the report, the removal of the balance of the material in the tailrace would be substantially completed by October 1; and the tailrace coffer-dam would then be removed. Three generators had been completely erected in the power house, and were ready for operation, and work was well advanced on all the remaining units. The transformer house, 60 per cent. of which was already completed, was constructed by the unit method, with the exception of the columns, which were cast in place. Practically all of the slabs which go to make up this building had been cast; and the work of assembling them was progressing rapidly.

PERSONAL.

H. A. McLEAN is leaving Sarnia, Ont., where he has for some years held the position of city engineer.

R. J. McLELLAN, city engineer of Kingston, attended the convention of the Electric Railway Engineering Association in Atlantic City.

J. HENRI DUBUC, previously engineer of highway bridges in the city engineer's office, Montreal, has been appointed chief clerk in addition to his former duties.

R. A. CAMPBELL has resigned his position as superintendent of the Tagona Water and Light Company, Sault Ste. Marie, and has been succeeded by R. D. S. BECKSTEDT, B.A.Sc.

J. E. ALDRED, of New York, president of the Cedars Rapids Manufacturing and Power Company, paid a visit last week to the company's power development now under construction near Montreal.

E. J. REED, formerly sales manager of Miles, Sykes and Son, Limited, and for several years chief publicity writer for the British Westinghouse Company, has been appointed advertising manager of Ed. Bennis and Company, Limited, of Bolton, England, manufacturers of mechanical stoking apparatus.

M. C. HENDRIE, hydraulic engineer, Water Power Branch, Department of the Interior, Ottawa, addressed the recent Irrigation Congress in Calgary on the power and storage investigations of the Department on the Bow River, west of Calgary. These investigations, as has been already stated in these columns, show that there is available for development over 50,000 dependable 24-hour h.p.

OBITUARY.

An accident occurred on August 12th in the vicinity of La Tuque, on the construction of the National Transcontinental Railway in which Mr. A. H. Johns, resident engineer, lost his life.

CANADIAN SOCIETY OF CIVIL ENGINEERS, OTTAWA BRANCH.

The annual meeting of the Ottawa Branch of the Canadian Society of Civil Engineers was held on Oct. 7th in the rooms of the Commission of Conservation, through the courtesy of Mr. James White, assistant to the chairman of the Commission.

The retiring chairman, Mr. Geo. A. Mountain, gave a very suitable address, reviewing the work of the past year and commenting favorably upon the large attendance at meetings. On several occasions over 300 were present. The Committees on Library, Rooms, Entertainment and Papers presented reports. The Secretary-Treasurer's report indicated that the affairs of the Branch are in very satisfactory condition. It was announced, however, that new headquarters will shortly be required.

The membership of the Branch has increased since the last annual meeting. Three deaths, however, have occurred in the persons of Ambrose Duffy, R. W. Farley and T. H. Schwitzer. A number of members have gone to the front.

The election of officers resulted in the following executive:—

Chairman—A. St. Laurent, Assistant Deputy Minister of Public Works, Canada.

Secretary-Treasurer—A. B. Lambe (re-elected).

Managing Committee—W. J. Dick, R. de B. Corriveau, W. F. Cochrane, Alex. Gray and W. S. Lawson.

MANUFACTURE OF ASBESTOS PRODUCTS IN CANADA.

A list of engineering supplies used, but not manufactured, in the Dominion was published in *The Canadian Engineer* for Oct. 8th, page 520. It was compiled from a more exhaustive list issued by the Department of Trade and Commerce, Ottawa, serving as suggestions for manufacturers.

The list included asbestos pipe covering as an article not manufactured in this country. On the contrary, however, the Asbestos Manufacturing Company, Limited, Montreal, with a large plant in operation at Lachine, Que., turns out all kinds of asbestos products, including pipe covering.

It is 85 per cent. magnesia pipe covering that is not manufactured here.

MR. JANIN'S ENGINEERING CORPS.

A formation of an engineering corps for active service with the English and French forces in the field has been effected by Mr. Geo. Janin, chief engineer of Montreal. Membership in the corps has been over-applied for. Subscriptions aggregating about $6,000 have been raised for the purposes of organization. The men are training at the Engineers' Armory in Point St. Charles.

MANITOBA BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

On Oct. 8th the Manitoba Branch held its first meeting of the season, Professor E. Brydone-Jack presiding. The speaker was W. G. Chace, B.A.Sc., chief engineer of the Greater Winnipeg Water District, who explained many of the features of the Shoal Lake water project now under way. He traced the efforts made by the city to obtain an adequate water supply, and leading up to the adoption of the present undertaking.

CALGARY BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

On Oct. 6th the Calgary Branch entertained the engineers in attendance at the International Irrigation Congress. The banquet was presided over by Mr. H. B. Muckleston, assistant engineer, Department of Natural Resources, Canadian Pacific Railway, and chairman of the Branch. Mr. F. H. Newell, Director of the United States Reclamation Service, was a speaker. The keynote of his remarks was the necessity of an engineer getting into close touch with the men who would prove out his work. Mr. S. M. Savage, supervising engineer of the St. Mary's Milk River project; Mr. D. W. Ross, consulting engineer, California, and Mr. Wm. Young, comptroller of Water Rights, British Columbia, were prominent among the speakers of the evening.

The Manchester Municipal School of Technology, England, has recently issued a notice to all graduates in the hope of securing a complete return with a view to ascertaining how many of its students, past and present, have enrolled for service, whether in the Navy, in the Regular Army, in the Territorial Force or on Medical or other service. We trust that those of our readers who are members of the college, and who have been out of touch with the registrar, will comply with the request which this notice implies.