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PRECISE SURVEYS FOR MOUNT ROYAL TUNNEL

By J. L. BUSFIELD, B.Sc., A.C.G.I.

The Canadian Northern Railway have under construction a double-track tunnel about 3½ miles long through Mount Royal, on the west side of the city of Montreal. This tunnel is being built in order to bring the lines of railway from the east and west of Montreal right into the heart of the city, where a large terminal station is to be built.

The construction of a long tunnel usually means that very precise surveys and measurements have to be made as a preliminary step to the actual work of boring, and the Mount Royal tunnel is no exception to the general rule.

In driving a tunnel it is customary to work from both ends towards the centre, and in this case a shaft was sunk down to the level of the tunnel at an intermediate point and the tunnel is being driven both ways from this shaft, as well as from the ends. In order to insure that all these workings will correctly meet, it is essential that their locations with regard to each other should be very carefully established, both with regard to alignment and also for elevation and distance apart. To obtain the correct alignment, a line is, when possible, run on the surface in the same vertical plane as the tunnel, and precise transverses or triangulation must be resorted to for the distances. The necessity for accuracy will readily be understood on account of the fact that once the lines and levels are transferred into the tunnel no further check is obtained until the different workings meet.

Fig. 1.
Letting up Spider.

Fig. 2.
Chainman Reading Tape; Tension Wheel at Left.

On account of the steep and inaccessible slopes of the mountain it was deemed advisable to make transverse surveys around the side in order to obtain the exact distance from the east to the west portal, and also to the intermediate shaft at Maplewood Avenue. Suitable routes were selected and at all the angle points (called stations and given consecutive numbers for reference) small copper plugs were set into the sidewalks, or, in the few cases where there were no sidewalks, into the solid rock.

In order to make the transverse sufficiently accurate, the length of the route being about 4½ miles, it was necessary to adopt some form of base line measurement. The form decided upon as being eminently suitable for use on sidewalks and roads was that of portable measuring points called "spiders," used in conjunction with a steel tape supported at twenty-foot intervals, with a tension of twelve pounds applied by means of a weight attached to a cord passed over a bicycle wheel on an adjustable frame. These spiders are illustrated in Figs. 1 and 2, and weighed about sixty pounds each. The tension wheel is shown in Fig. 2.

Previous to making the precise measurements "spider" points were marked on the sidewalks by means of a chiselled cross roughly every ninety-nine feet on the lines of the transverse, being put in line between the angle points either by eye or with a transit. The necessity for exact alignment not being very great as an offset of 0.43 feet on either side of the line would only introduce an error of one thousandth of a foot in the length of the line. Where the lines were not on sidewalks, stakes or ship spikes were driven to mark the spider points. While these were being laid out by one party, a leveller would follow and take the elevations of all the spider points and enter them up in a book provided for that purpose.

In making the base line measurements 100-foot steel tapes were used of ¼-inch steel, divided into feet, tenths and hundredths, the thousandths being estimated by the observer. One steel tape was sent to the Bureau of Standards to be standardized under the same condition as the tapes were to be used under in the field, i.e., supported at 20-foot intervals with a tension of 12 lbs. It was compared with the government standard at a temperature of 62 degrees so all temperature corrections made later were to this figure.

All the tapes to be used in the base line measurements were compared with this standard tape. The standard tape and the one to be compared were fastened at the zero end to two adjusting screws over a brass plate with a fine straight line on it; at the 100-foot end they were both attached to cords passing around two bicycle wheels with a twelve-pound weight attached to each. (See Fig. 3). The two 100-foot ends of the tapes rested on another brass plate with two scales on its face divided into thousandths of a foot; after the two zero ends had been placed exactly over the line on the first plate the readings on the scales at the other end were taken. The two tapes were then reversed and corresponding readings again taken. This process was repeated several times for each tape and an average taken.

All these preliminary arrangements being completed, the actual measuring was commenced, the method of procedure being as follows:—

First.—Two men would take the spiders and place them as nearly as possible with the cross marks vertically over the spider points. (Fig. 1). At the same time two other men would be setting up the tension wheel frame at a short distance to the rear of the rear spider. This frame is illustrated in Fig. 2, and needs no special description, except that it had adjustable legs and wheel so that it could always be put at the right height, even on the roughest ground encountered. At the front spider a forestay was set up to hold the front end of the tape. This forestay was simply a fairly heavy cast iron plate with a vertical post, upon which was a sliding clamp to which was attached an adjustable cord for holding the tape. A heavy weight was placed on the back of the plate to resist the pull of the 12-lb. tension weight.

Second.—The rear chainman would call out "Ready for tension" and thereupon the first chainman would attach the front end of the tape to the forestay and the rear chainman applies the tension of the weight by shortening the adjusting cord.

Third.—The rear chainman now stoops down until his eye is on the level and in line with the tops of the two spiders, and lines in the four wooden standards for supporting the tape at twenty feet intervals, so that the hooks are all in the same straight line between the tops of the spiders, and then the tape is hooked up into the hooks. The standards were made of a wooden base with a 1-inch-square vertical post with a sliding block held by a spring, a cord with a hook for holding the tape was hung from the block. A thermometer was also hung on each block in such a position that its bulb was as close to the tape as possible.

Fourth.—The chainman, having seen that there were no twists in the tape, they would take up their positions at the spiders, and the "recorder," who kept all the field notes, would take his position midway between them, calling out "ready to read" as soon as everybody had taken their place. On this signal the two chainmen would call out in turn the height of the top of the spider above the spider point on the ground which they measured with folding rules. This gave the correct elevations of the tops of the spiders, hence the slope of the tape. The head chainman then calls out the readings at his end of the tape at the intersection of the scratch on the spider, and the recorder enters it in his book, the rear chainman reads his end of the tape at the same instant as the head chainman, but does not call out until the recorder has had time to enter the first reading. The recorder then calls "change," and the tape is allowed to move bodily a very small amount one way or the other, so that a different reading is obtained at both ends, which are again called out to the recorder. This process is repeated until the recorder gets five or six readings which do not vary more than a thousandth or so. While this is being done another man is reading the four thermometers on the standards, the mean reading of which he gives to the recorder. The following is an example of the booking of one set of readings:—

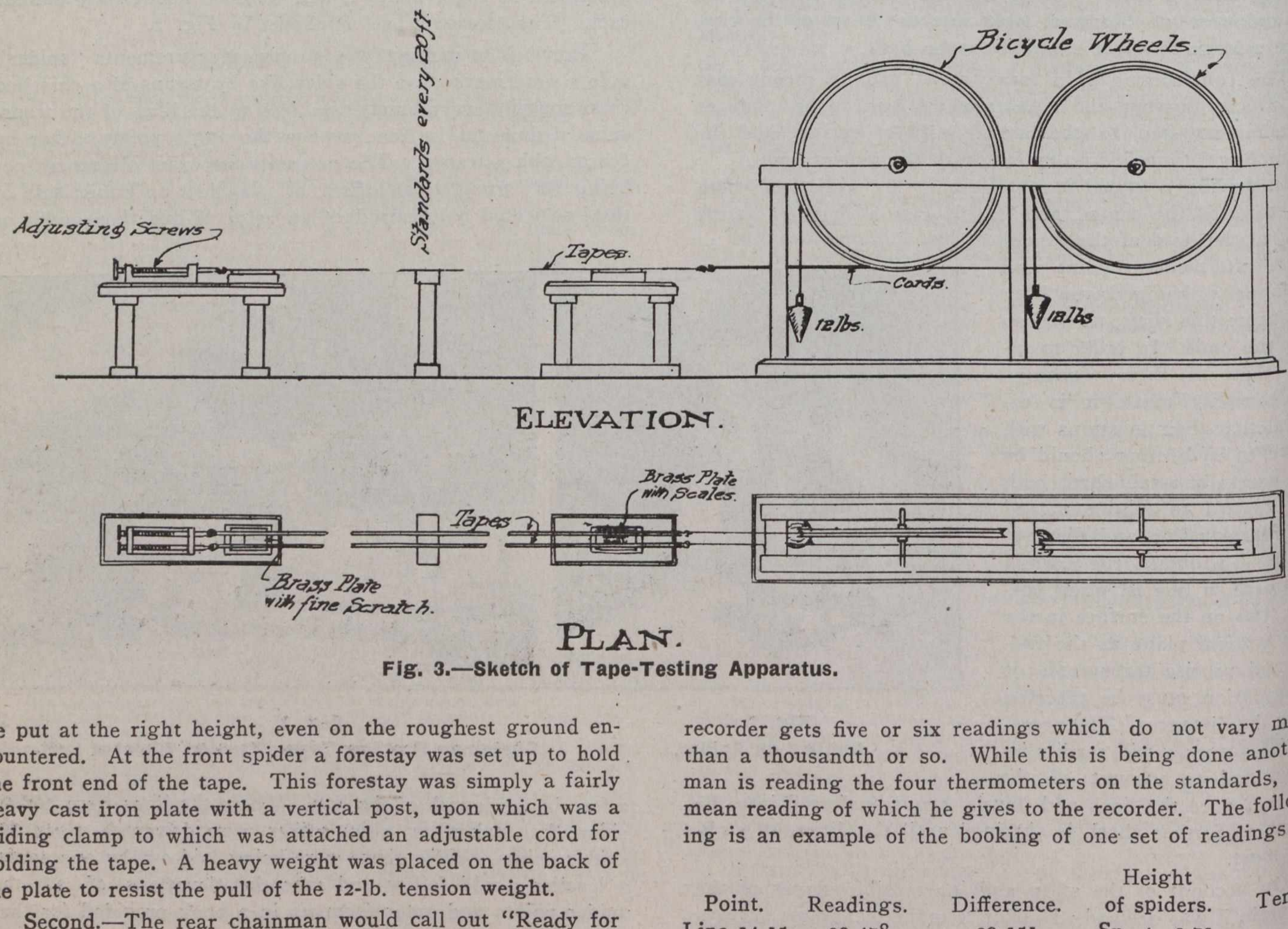

Fig. 3.—Sketch of Tape-Testing Apparatus.

Point.	Readings.	Difference.	Height of spiders.	Temp.
Line 14-15	99.478	99.151	Sp. 4 1.71	
	0.327			
Sp. 4 to 5	99.506	99.150		74.0°
	0.356			
	99.575	99.151		
	0.424			
	99.594	99.151	Sp. 5 1.69	
	0.443			

Fifth.—Having obtained a good series of readings, the recorder calls "unhook," and the tape is unhooked and the whole apparatus is moved forward to the next spider-point, the rear spider being left in its position to retain the measurement in case the one just measured to should be disturbed. Whilst the actual measuring is taking place two men carry up a spider and place it at the next spider point ahead.

At the starting point and all rivet stations, instead of one of the spiders being placed over the rivet it was placed a foot or two ahead merely as a support for the tape, and the reading on the tape was obtained by transferring the point on the rivet up to the tape by means of a transit placed a short distance away and at right angles to the tape.

This method of measuring required ten men, namely, chief of party, transitman, recorder, two chainmen, two spider-placers, one thermometer reader, one man for forestay and one man for tension wheel. Under favorable conditions as many as 15 to 18 stations were measured in an hour, but 10 stations per hour would make a good average for a day's work.

The majority of the work was done in the daytime but in the busy sections of the city it was done during the night, no difficulty being experienced from the darkness, acetylene miners' lamps being used.

Having made the measurements in the field, the correct distances between the stations were computed in the office, making the necessary corrections for the reduction of the distance to horizontal, for temperature, and the tape correction to standard, the two former being obtained from diagrams plotted for that purpose.

Great care had now to be taken in reading the angles of the transverse. A Berger transit, 7-inch plate reading to 10 seconds was used. In setting the instruments up over the angle points a second transit was used to insure the vertical axis of the instrument being exactly over the centre of the cross on the rivet. At the two points sighted at, wooden targets were used, being set up vertically and precisely over the points by means of a transit. These targets were made of wood 4 inches wide and about 3 feet high, and were divided into red and white triangles. Adjustable tripod legs were used to support them. In reading the angle one observer would read the angle once, and then wrap it up five times, and then go backwards until zero was reached again on sighting at the first target, to insure that the plates had not slipped. This would give a very close determination of the angle to 2 seconds, and this process was repeated by an independent observer, thus giving a mean determination down to 1 second. Every precaution was taken to eliminate any instrumental errors, and also to protect the instrument from the heat of the sun. In a circuit five miles long with 33 angles there was only an error of closure of .1 second, and in another of three miles and 10 angles the transverse closed exactly by the angles, and in none of the circuits was there an error of more than a few seconds. All the important transverses were duplicated by independent routes giving a complete series of closed transverses, and from the base line measurement an average degree of error was found to be about 1 in 40,000.

The measurements around the mountain being completed, it was necessary to project a line over the mountain in the same vertical plane as the tunnel centre line.

To do this the minimum number of transit points were selected and permanent concrete monuments built to hold the line. In setting up a transit at a monument plumb-bobs were discarded entirely and the transit was bucked into line until the cross hairs intersected both the far away back sight and also the cross scratched on the monument close to it. The line was then projected to the monument ahead time after time, reversing the instrument between each sight.

A mean was taken of all the points obtained at the foresight monument and the line thrown ahead from that point in the same way.

The surveys for the whole work were tied into the same system of base lines and a series of co-ordinate lines was adopted so that the latitude and departure of any point could be readily obtained, hence its distance and bearing from any other known point. All the survey alignment points in the tunnel are also being referred to the same co-ordinate lines. The levels were transferred from the city to the west portal in as accurate a way as possible with standard instruments; 18-inch wye levels were used with target rods. The level was set up three times for each turning point, these never being more than about 100 feet from the instrument and equidistant therefrom. The whole operation was repeated four times with independent observers. The difference in their elevations of corresponding bench marks being only a few thousandths of a foot.

In the city itself it was decided to put in permanent survey monuments at the more important and strategic stations. These monuments (Fig. 4) were made by digging a hole about 7½ feet deep and filling the bottom to a depth of about 2½ feet with concrete, in which was set the monument proper, made of 6-inch cast iron pipe at the bottom, with a 4-inch pipe inserted into it at the top with a leaded joint, the object of this being to enable the top of the pipe to be easily lowered again in case the whole pipe should be heaved by frost. This, of course, is an unexpected contingency. In the top of the smaller pipe a piece of brass was cemented and on this the precise cross scratch was made, and also the precise elevation taken. After the concrete had set, the space surrounding the pipe was rammed with earth or sand taken from the hole, and on top of this a cast iron cover plate and base set with concrete into the sidewalks was placed, thus making a good permanent point free from disturbance and easily accessible.

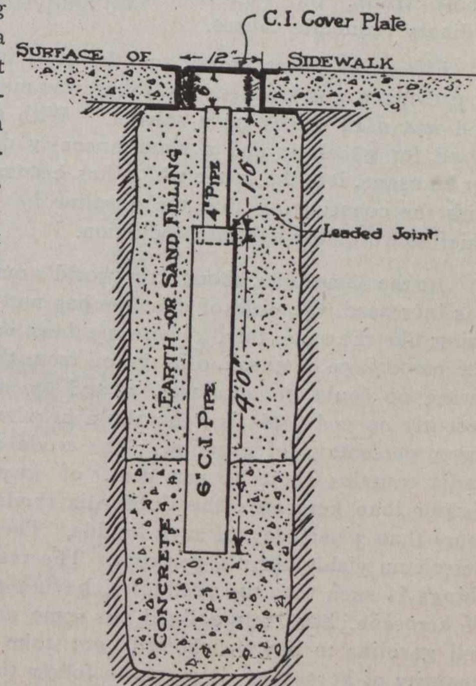

Fig. 4.—Permanent Monument for Tunnel Survey.

The surveys and measurements for the tunnel, which were all carried out under the immediate supervision of the writer, although requiring great accuracy, were comparatively simple, compared to the alignment work in the tunnel, because frequent checks on the work could be obtained, whereas in the tunnel no checks are obtainable until the headings are run into one.

The government owned telephone system of Alberta yielded a surplus of receipts over operation and maintenance expenses during 1912 of $62,283, while the earning capacity of the system on a basis of the capital expenditure amounted to 12.1 per cent. In the six years, 1907-1913, the system has yielded a profit of $407,592.

THE REPLACEMENT OF GASOLINE.

By H. Poynter Bell.*

The great and rapid increase in the price of gasoline is, not unnaturally, exercising the minds of the owners and users of gasoline motors all over the world. In New York, for instance, the price rose from 9 cents to 16 cents per gallon between January and July of last year, and the New York Garage Association is giving serious attention to ways of meeting the situation.

Two ways seem to have commended themselves. Firstly, the encouragement of competition in the sale of gasoline, and secondly, the establishment of a uniform standard of of quality, which may allow of increased production. The first way depends upon the suggestion that the increase of price is due, wholly or partly, to the action of the "Trust." There may be some truth in this, but it is certainly not the whole truth; the increase is largely, at any rate, due to ordinary economic causes.

Fifteen or twenty years ago the most important product of petroleum was kerosene; gasoline was merely a by-product and was used chiefly as a solvent. With the increased demand for gasoline, and a simultaneously decreased demand for kerosene, it is the latter which has become the by-product, with the consequence that the gasoline has now to bear the chief share of the cost of production.

At the same time, though the world's output of petroleum has increased, the yield of gasoline has not increased at anything like the same rate. There has been some falling off in the percentage of gasoline in the oil from the older oil fields, owing no doubt to evaporation, and the oil from the more recently opened fields is generally a heavier oil containing a lower percentage of gasoline. The crude oil from Pennsylvania contains about 16 per cent. of gasoline and liquids lighter than kerosene; the California crude oil contains not more than 3 per cent. of such liquids. The Russian (Baker) petroleum yields about 6 per cent. The resulting position of things is such that the producers, having too large supplies of kerosene, have felt obliged, in some cases, to refuse to sell gasoline to buyers who will not take a corresponding quantity of kerosene. It seems to follow that, under the circumstances, no great or long continued reduction of price can result from competition by rivals of the Standard Oil Company or other large producing organizations.

Rather more may perhaps be expected from the fixing of a legal standard for commercial gasoline. The production of so great a variety of motor spirits as is now sold must necessarily be more or less wasteful. If a liquid of fairly high specific gravity and boiling point could be made the standard, there would be an increased production from the present supply of crude oil, while there would be, at the same time, greater safety in the handling and storage of gasoline. To be of any real use, the standard would have to be fixed by law, and it may be doubted if this is likely to happen, since public safety is hardly concerned, as in the case of the flash point of kerosene.

In any case, measures of this kind can only give temporary relief and not permanent cure. Calculations of the duration of the world's supply of petroleum need hardly be taken into account. Such calculations have been made by Prof. Vivian Lewes, in England, and others; but apart from the fact that the quantity of the known supplies is very hard to estimate, no good guess can be made at the quantities which remain to be discovered. Assuming, however, that the demand for volatile liquid fuel continues to increase at the present rate, it will certainly exceed any increase of the supply which can reasonably be expected from the oil fields. That is to say, the users will, sooner or later, have to face not merely rising prices, but an actual shortage of supply.

The consumer of the future will, therefore, have to be resigned to paying more for his fuel, and must be satisfied if he can get it in such quantities as he wants. To produce even this result a liquid capable of replacing gasoline is likely to be needed, and for the production of such a liquid a prize of the value of $100,000 has recently been offered by the International Association of Automobile Clubs at their meeting in Paris.

The substance required is one which cannot be rigged or cornered by any nation or combination of national interests. It must, therefore, be capable of being produced in almost every part of the world, and must, further, be made from some raw material of which the supply is either practically unlimited or capable of being continually renewed. No fuel can be obtained from the atmosphere; no liquid fuel can be obtained from water, so that the only unlimited or renewable sources are animal and vegetable matter, of which only the latter is likely to be of much use. It may be that a method can be found of making, sufficiently cheaply, gasoline, or some similar liquid, direct from vegetable matter. At present there is one, and only one, liquid known which can fulfil the required conditions, that is, of course, alcohol.

Alcohol is suitable, in most respects, to replace gasoline, though its heating value is, unfortunately, considerably lower than that of gasoline. The value varies, of course, with the proportion of water which the alcohol contains, but pure alcohol has only about 7/11 of the calorific value of an equal weight, or about ⅔ of that of an equal volume of gasoline. That is to say, that to replace a gallon of gasoline there will be needed not less than 1½ gallons of alcohol. The disadvantage is not necessarily prohibitive, and it may be that consumers will have to put up with it. Alcohol can, of course, be produced in practically unlimited quantities, and at a low cost. The cost can certainly be reduced if a large enough demand arises, since little, if anything, has been done so far in the direction of selecting and cultivating plants with a view to a maximum yield of industrial alcohol. The matter will be one of the problems of utilizing the sun's heat for producing fuel which were indicated by Prof. Ciamician, of Bologna, in his lecture on the "Photochemistry of the Future," before the International Congress of Applied Chemistry, at New York.

The chief difficulty in connection with the use of alcohol will consist in reducing the restrictions and the excise and other duties, which are placed on the sale of alcohol by practically all governments. It will be for automobile associations and similar bodies to attack this side of the matter, while chemists may have to satisfy the requirements of the governments by finding substances which will render alcohol undrinkable.

Alcohol is, no doubt, not an ideal substitute for gasoline, but it appears that there may be only the choice between developing the production and use of alcohol and waiting, perhaps in vain, for the discovery of some better substitute.

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The English shipbuilding firm, Messrs. Swan, Hunter and Wigham Richardson, whose president, Mr. W. G. Hunter, is now in Montreal, will submit tenders for work on the Georgian Bay Canal, if that project is proceeded with, and for the construction of ships for the Hudson Bay line.

FISHING STATION SURVEY IN THE GULF OF ST. LAWRENCE.

By J. A. Macdonald.

The accompanying map and text is interesting from the viewpoint of the methods employed in making the survey.

The survey was made, among others, for a fish-canning company, who have in operation a hundred or more canneries, situated at various points on the shores of the Gulf St. Lawrence.

The company are continually establishing new fishing stations and closing others as business warrants.

Before establishing a station at any new point they usually have a careful survey made of the shore: shelter for boats, large or small, ownership of property rights, accessibility to a public road and railway, survey of the fishing grounds, showing distance from shore of the various depths of water, or "fathoms deep," and distance from shore or harbor of the various fishing grounds, as herring, lobster, salmon, etc. In order to obtain all this information requires an expert hydrographic survey of the harbor or cove, and this is really what this is.

In the map the methods of measuring the depths of water in order to be plotted are shown by the dotted lines.

Two methods of ascertaining the contour or fathom depths were used, involving the use of both the transit and sextant.

In the one case the angles were read by transits on the shore—two transits one at each end of the base line AB—and in the other case by reading the angles with a sextant in the boat on the water. This later method is known as the "Three Point Method."

Let A′ B′ C′ be the three shore points, being defined by the two distances A′ B′ and B′ C′ and the angle of B′. Let the two angles at P′ be measured at the point P′. The problem then is to find the distance A′ P′ and C′ P′.

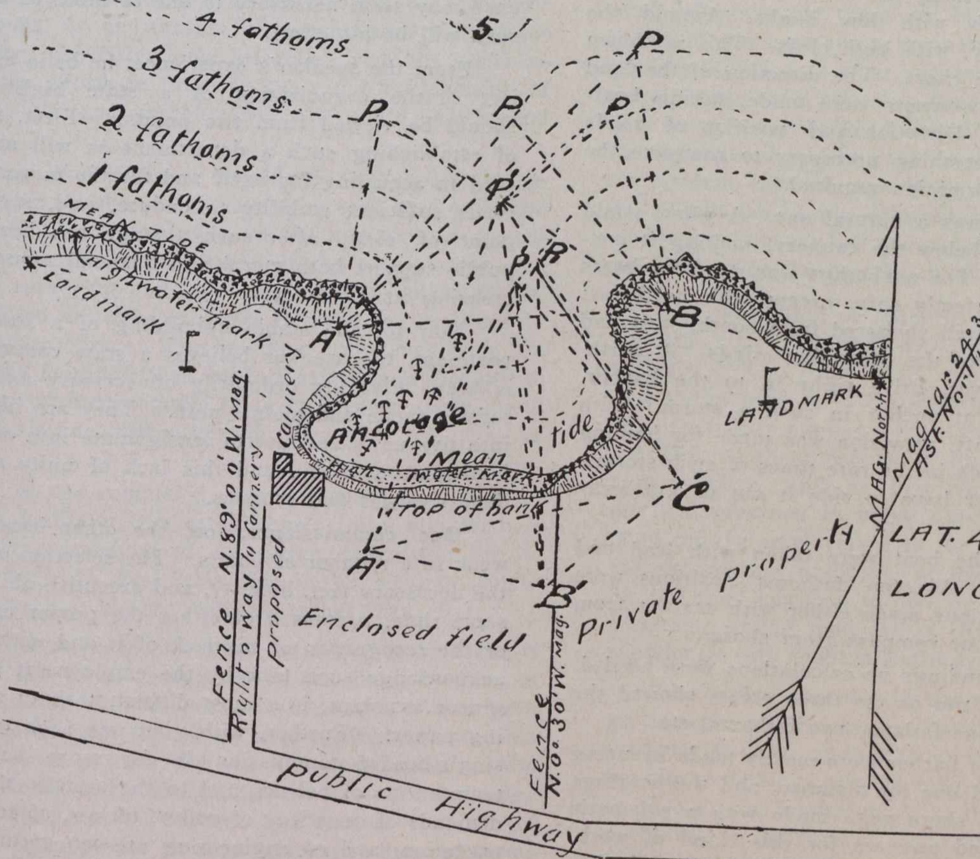
There is an analytical solution for this which, however, does not seldom need to have to be performed. It involves a good deal of figuring. The angles at P′ and the angle B′ are known, but the angles P′ A′ B′ and P′ C′ B′ are unknown. However, the formula gives:—

$$\cot. P'A'B' = \cot. R \left(\frac{A'B' \sin P'}{B'C' \sin P' \cos R} + 1 \right),$$

$$\text{when } R = 360^\circ - B'P'C' + B'P'A' + A'B'C'.$$

I repeat that it is seldom necessary to use this analytical formula, though it is well to use it once in a while as a check, and should be used in all hydrographic surveys of this kind.

The so-called mechanical solution is simple and rapid by using a three-armed protractor. It is the common method of plotting soundings when two sextant angles have been read from the sounding boat.



Plan-Chart of Fishing Station in Gulf of St. Lawrence.

The angles in this case were laid off graphically on tracing paper by lines of indefinite length, and this laid on the plot and shifted in position until the three radial lines coincide with the three stations on the ground, A′ B′ and C′, when their intersection marks the point, P′, of observation. This is a most ready method of plotting such observations when no three-armed protractor is available.

By this method only one observer is required in locating the soundings, and no time is lost in changing stations, and the party are all together, and there is not likely to be any misunderstandings in regard to the work.

The other method here shown, two angles read on shore, two instruments are required, one at A and one at B on shore, and the angles subtended by the other fixed point and the boat P, as A B P and B A P, be read by both instruments. When a sounding is taken, the intersection of the two pointings to the boat, when plotted on the chart containing the points of observation duly plotted, will be the plotted position of the sounding.

Two observers are required, which makes this method somewhat objectionable, and these must be transferred at intervals as the work proceeds, and in order to see the boat, P, at all times. Usually, three or more readings can be made from each position. For example, in the plot four positions of the boat at P are taken.

The base, A B, across the bay, was made by a stadia reading. The transit was set up at A and the rod held at B. Two other base lines were also laid off, as shown in the dotted lines, one from A westerly to point shown as landmark, and the other from B easterly to "landmark. For the three-point readings flagpoles were erected about the centre of the base lines and to the south in the same manner as A′ B′ C′ in the plot. These are shown in the plot.

The shore line was first traversed at the water's edge. Offsets to the bank were estimated, and sometimes paced; no measuring was done. The first part westerly was rocky, with high, steep banks. Along the cove, or natural harbor, there was a sandy beach, with low banks. Around the point, again, it was rocky, with high cliffs. This is shown by the topography on the chart. The direction of the land lines, width, and property-owners were made, taking bearings with the compass. Direction and position of roads were determined, and everything necessary to complete the plot and give all the information required.

The cove or harbor was a natural one. A wharf could be built, and was later, below the cannery, making it convenient for landing fish. The anchorage was good for boats and small craft, and perfectly safe, except with north-east winds. The harbor was well sheltered from south, west and north-west, and these were the prevailing winds. A north-east storm would, however, drive right in to the harbor, and no craft could live at anchor in such a storm. With regard to the smaller craft, provision was made for hauling them up on the sand beach in the rare times of such storms. Larger craft would either have to ride it out or get away in good time.

The soundings in the boat were taken with lead and line marked in fathoms. At even fathoms positions were taken and the triangulations made either with sextant from the boat or with transit or compass from shore.

In plotting those soundings no calculations were needed. The intersections of the two or the three points showed the position of the boat at one fathom, two fathoms, etc.

The soundings in the harbor were mostly made by using a long 30-fathom marked line for distance, and the bearings from a known point on shore were made with a prismatic compass. No one method answers for this kind of work. One has to have a certain amount of initiative or originality in this kind of work.

Latitude and longitude were ascertained, the former by a reading of the sun's altitude with the sextant at apparent noon, and allowing for dip, semi-diameter, paralex, etc. The sextant is much more convenient and accurate for taking astronomical observations than is the transit. Longitude was calculated from the ascertained longitude of a lighthouse some twenty miles distant, assuming, of course, that the longitude of the lighthouse was correct. The magnetic declination was ascertained by an azimuth observation of the sun.

Surveys of this nature are very rare, and confined to marine and fisheries in Canada and to the coast and geodetic surveys in the States. In the building of breakwaters and harbor improvements by the Public Works Department such hydrographic surveys are always made. It is, therefore, confined largely to Government work, though in the case here described it was of a private nature.

ORGANIZATION OF A STATE HIGHWAY DEPARTMENT.*

By Maj. W. W. Crosby.†

The essentials for a successful state highway department may be said to be:—

1. An established demand for it.
2. A proper organization of it.
3. Sufficient funds for its work.
4. A well defined policy.
5. An honest, tactful, capable head.
6. Suitable locations for its headquarters and branches, proper equipment, and loyal and skilled employees.
7. Perfection in designs for its work and efficient execution of such designs.
8. A comprehensive system of accounting from which intelligible public reports are regularly made.

The title of this paper, and, as I understand, its purpose, confine the speaker to the second essential except as reference may seem necessary to one or more of the others, and such will be his effort.

From the speaker's experience, he believes that the subject of the organization of a state highway department should be viewed from two points. First, from the point of establishing such a department as will most likely succeed in acquiring for itself and for the movement for better roads sufficient stability to endure, and, second, from the point of view, after such a stage has been reached and public support both moral and financial assured, of then increasing its efficiency.

Now for the stable upbuilding of a state highway department, the speaker believes a state commission of three is best. Five are ordinarily unnecessary and less likely to form a facile and mobile unit. They are likely to separate into five units and not to amalgamate into one uniform and homogeneous body, and this lack of unity will surely produce rivalries and schisms.

One commissioner, on the other hand, is ordinarily weak in a number of points. The selection of one man with the necessary tact, honesty, and executive ability, and, at the same time, possessed of either the proper engineering skill or the recognition of his lack of it and with the breadth to acknowledge such lack by the employment of a skilled engineer assistant, is a most difficult task to set any appointing power. Further, with "but one neck to be lopped," a single-headed commission is far more susceptible to the temptations of politics and to the attacks of enemies. The demands of questions of policy, of law, of administration, of execution, and of engineering are too great and diverse to be satisfactorily and permanently met by more than one man in a thousand and the chances for the appointment of that man in any case are probably not one in one hundred when the various influences concerning such appointments, the salary likely to be offered, and all the other factors are considered. With a commission of three, properly selecting and protecting its engineer, the latter can do the public, his board, his subordinates and himself, much more nearly actual justice than if he is obliged to act as both commissioner and engineer.

Under any commission there should be employed a trained and competent chief engineer. Probably the commission will also need to employ a secretary and certain book-

* From a paper read before ninth annual convention of American Road Builders' Association, held at Cincinnati, December, 1912.

† Chief Engineer, Maryland Geological Survey.

keepers, clerks and stenographers reporting to and under the authority of the secretary. Legal counsel may be generally advisable and should report directly to the board or its chairman. A right of way agent may be necessary and he may report to the counsel or to the secretary, as deemed advisable. The chief engineer should be the chief executive officer of the board, and he should be given all the authority necessary to make this fact fully and finally realized. As such, his responsibility to the board would be definite and the board should do nothing to muddy the waters of this situation.

The speaker wishes to say here that it seems to him that more inefficiency, with its waste of money and unsatisfactory results, has come from division or lack of clearness in responsibility than from incompetence.

In such a position as above described, a chief engineer can not only afford to be perfectly open and frank in expressing his opinions to his board, but he is encouraged to do so to the extremes of his ability. The board may then act more intelligently. In cases, where in its opinion the other considerations outweigh the engineering ones and the decision seems to be against the recommendations of the chief engineer, the latter feels his relief from the responsibility, and his efforts to properly carry out the decision of the board should, and probably will, be more earnest and effective.

Under the chief engineer should be two assistant engineers selected by him—as, it might be said here once and for all, should all the employees of the engineering department. One should be in charge of the construction, the other of the surveying and planning. But the plans should always go up to the chief engineer through the assistant in charge of construction. The benefit of criticisms from the workers in the field will then be had before it is too late to make changes without complications or serious expense and many of the routine difficulties of execution will thus be avoided.

As soon as the completed construction has reached an aggregate to justify it, the establishment of a maintenance division and the selection of an assistant engineer for its head should be had. Preferably this important step should be taken before it is clearly justified, rather than after.

The vast importance of proper maintenance of roads is beginning at last to be recognized by the states. One, at least, of the reasons for the better maintenance of European roads is unquestionably the absence, to a great extent, from the minds of those in authority over the roads there, of construction problems and consequently the concentration there possible on the minute, tedious, and recurrent details of maintenance. The proper solution of construction problems is not only of interest to almost all, but is also generally accompanied by early and shining rewards. That of the maintenance problem seldom, if ever, is quick or spectacular. Naturally construction problems attract, while those of maintenance seem drudgery. Long, persistent effort in little ordinary matters is demanded of the maintenance division. No greater mistake can, in the speaker's opinion, be made than to expect the maintenance to be satisfactory where the engineer in charge of construction is required to look after it also. This holds good surely above the point when the maintenance expenditures are up to 10 per cent. of its construction expenditures annually.

Division engineers, resident engineers and inspectors will be arranged and needed according to the territory to be covered and the amount of work going on. Probably also, facilities for testing materials will have to be provided and the man in charge of such should report to the head of the construction of maintenance division according to the amount of work being done for each by him; or, he may report to both under some circumstances.

Under the assistant in charge of the surveying and planning will be needed one or more survey parties, draftsmen, calculators, etc., the number of each depending on circumstances, as may readily be seen.

If the amount of work to be done annually is large, scattered and complex, the chief engineer will also need clerical assistance in the shape of a chief clerk or secretary, possibly a purchasing agent for materials for force account work, clerks and stenographers. The purchasing agent may report to the assistant in charge of construction or to the chief engineer directly, as deemed best. The chief clerk should report to the chief engineer directly and the clerks and stenographers to the chief clerk.

The responsibility for the entire engineering department resting clearly on the chief engineer, should be delegated by him only as may be warranted by the exigencies of the situation, and when so delegated, it should be done so clearly and definitely that there can be no doubt nor failure in the mind of anyone having business with the organization in understanding just what authority the subordinates have, at least so far as it concerns their business. There should be left no opportunity for a contractor to say that certain work or materials should be paid for in full "because the inspector or resident engineer saw it go in," nor should a contractor be able to say he was referred from one party to another for a decision on a point and, unable to get anything definite, he "had to do the best he could."

The delegation of authority, especially in a newly organized state highway department, must be made conservatively. The commission and its chief engineer may be new to the work or to the situation, even if the engineer has been trained in similar work elsewhere. Naturally the public will look to them personally for decisions and for locating responsibility, and at first surely demand their personal, physical presence in many cases. The customary requirement for the employment as far as possible of local men for the subordinate positions, at least, will render it advisable for the chief engineer to take on many bright and otherwise admirable young men except that they may be deficient in experience with modern highway work.

The rapid progress in the underlying science and the art of such work, makes it difficult for many beside the chief engineer to keep up-to-date in it, and, therefore, necessary for him to retain, until his subordinates become fully trained as regards the fundamentals of their work at least, sufficient authority, in perhaps a slight excess, for the best results. Further, the speaker has found that far less difficulties with contractors over points arising in connection with their work under the specifications become serious when considered and decided by the chief engineer in person than in cases where such decisions are left to younger and more inexperienced men. In fact many of these points are never raised when contractors know that the chief engineer himself will decide them and can be counted on to abide fairly by the specifications. Of course, unless the commission leaves the decisions provided by the contracts to be made by the chief engineer in the hands of the latter, and supports him in such, those contractors or others anxious to have their claims arbitrated by inexperienced or prejudiced parties may create, by appealing to the commission for decisions, an even worse situation than that in which the authority of the chief engineer's subordinates is not clearly defined or too much delegation of authority has been made to them. But relief from such a situation is from outside the remedies of organization.

From the foregoing may be had an explanation of the speaker's inclination toward the employment in new organizations of inspectors rather than resident engineers on the jobs to be done under him as well as for the retention in his own hands, while chief engineer, or perhaps more of his authority, as such, than in the similar work of many other organizations.

After the final establishment of a definite policy towards its roads on the part of a state; after the proper provision of funds for the carrying out of this policy for at least a reasonably appreciable time; after the public has become accustomed to and a decent majority has settled down to the support of such a policy, and after the employees in the organization, who, are likely to perhaps need authority, have become properly grounded and trained to support satisfactorily certain responsibility, then a change or development of the organization above outlined may be, and generally is, desirable for the sake of greater efficiency in the results from expenditures.

We may, therefore, now look at the matter of the organization of a state highway department from the second point suggested at the outset.

Efficiency should, of course, be kept in mind as described in the earlier consideration, but there as may have been hinted at least, it was not the only object, and consequently in the earlier days of the work, the efficiency from a purely financial standpoint may have been obliged to retire at times in favor of what seemed to be for the ultimate public good.

Now considering efficiency alone, the speaker believes that:—

The commission of three may well give way to that of one, or even in the latter case that a competent individual may satisfactorily fill such a position as engineer-commissioner, and the position of chief engineer, as well as the board of commissioners, be avoided. That the position of assistant engineer in charge of surveying and planning may, perhaps, with the central department for his work, be abolished and the work better done under the division engineers assigned to sections of the state. This, however depends entirely upon local conditions and no general rule can be here laid down concerning the point. That it is possible to say the same concerning the assistant engineers respectively in charge of construction and of maintenance, as said immediately above; but in such a case, the necessity for avoiding any serious distraction from maintenance problems by those of construction, should be clearly and constantly kept in mind. That the delegation of more and more of the authority of the chief engineer may be advisable as the training of the subordinates proceeds and the reliance on them is warranted.

With these steps taken at the proper time, the expense for overhead charges should be reduced without depreciation in the value of the physical results and thus the efficiency of the organization increased. Inappropriately taken, they will quickly produce the opposite results on a large scale. The difference between a proper organization and an improper one may be only five per cent. of the total expenditures in the work and this difference can be readily offset many times by the difference in the quality of the physical results, the expenditures for which will probably amount to nearly 90 per cent. of the total expenditures.

The necessity for the proper organization of a state highway department should be recognized by all, but unfortunately the instances of such recognition, or at least the evidence by results of it, seem to be in the minority.

The speaker hopes that the discussion here of the matter, which discussion he has attempted to stimulate by a brief outline of some of his views, may be fruitful in good results.

SLUDGE DISPOSAL.*

By Karl Imhoff.†

Sludge results from all methods of treating sewage. The problem of handling this sludge satisfactorily is just as important as the treatment of the sewage itself, for experience has shown that sludge which has been poorly handled is much more objectionable than the worst sewage.

Wet Sludge.—Fresh wet sludge contains ordinarily more than 90 per cent. water and can be pumped out of the settling tanks in the same way as sewage or water. It would therefore seem a simple matter to get rid of it by pumping it onto low-lying ground and allowing it to remain there with the hope that it would in time become firm. Such treatment is unfortunately almost always without success. Sludge deposited in deep lays does not dry, and the ground remains wet. This treatment is therefore useful only when the sludge is spread out in very thin layers. The sludge can also be discharged into shallow trenches. Under these conditions the sludge dries in some weeks, and can be plowed into the ground for agricultural purposes. The sludge thus becomes used, as it were, for irrigation, just as with sewage. There is the disadvantage, however, that a large area is necessary, and that objectionable odors cannot be prevented.

In the case of cities located near the ocean, the problem becomes simpler. Such cities can send their sludge in ships out to sea and allow it to sink. Since it becomes necessary to carry the sludge a considerable distance from the shore, the cost of this method of disposal is quite high, and it is very probable that some of the cities which have been using this method of sludge disposal could now accomplish the desired ends cheaper by adopting another method of disposal.

In general, one can say with assurance that the cases are very few where it is desirable to dispose of sludge in a wet condition.

Dry Sludge.—As soon as sludge has been properly dried, it has lost most of its objectionable characteristics. In any case, dry sludge can be used as easily for agricultural purposes as other kinds of fertilizer. Its value, however, for agricultural purposes depends more on its physical characteristics than on its fertilizing value.

Dry sludge can also be used for filling low land just as well as ordinary earth. In almost every case this method of disposal is the most economical, if it is not possible to use it for agricultural purposes. Especially with cities which use their refuse for filling is this method of sludge disposal particularly adaptable, because the dry sludge has a volume only about one-fifth of that of the city refuse, and if a city has sufficient ground for dumping its refuse, there will also be sufficient area for the sludge.

In cities where the refuse is burned, consideration should be given to the possibility of burning the dry sludge with the refuse. In such an event, however, there is the danger that the slag will not be so good. In addition to the incineration of sludge, it is not worth considering other methods of artificial disposal of dry sludge; such, for example, as using it for the production of gas or for the reclaiming of the fat contained in it.

As incineration is carried out on a large scale only in one instance (Frankfurt-am-Main) it may be concluded that for the disposal of dry sludge there are left only the two

*A paper read before the International Congress on Hygiene and Demography, Washington, D.C., Sept. 24, 1912.

†Chief Engineer, Sewer Department, Emscher, Genossenschaft, Essen, Germany.

natural methods—its use for agricultural purposes and for the filling of low land.

Methods of Drying.—From what has already been said, we may conclude that the best system of sludge disposal is that in which the sludge is first dried. There are, of course, difficulties connected with this drying.

Science has, up to the present time, interested itself principally in artificial methods of drying. Of first importance in this connection is the pressing of sludge, which has been used for many years in England. The excess water in the sludge is pressed out through filter cloths. Sewage sludge can be pressed only when it is properly treated, for example, with lime or coal powder. This system is a good one, and for the foregoing reason is especially applicable to chemical precipitation works, where the chemicals necessary for the precipitation are added to the sewage. The cost of the system is, however, so high, that, outside of England, it has been used very little.

In comparison with sludge pressing, the centrifugal drying machines used in Germany (Frankfurt and Hanover), are a step in advance, since the fresh sludge is handled without the addition of chemicals. There is, however, the serious disadvantage that the water separated from the sludge is much more objectionable than in the case of sludge pressing. This water contains a very large part of the organic matter of the sludge.

A more natural treatment, and one especially applicable for small plants, is the mixing of the wet sludge with drying matter, which absorbs the moisture. Refuse and street cleanings are especially applicable for this purpose if the sludge is to be used for agricultural purposes.

The simplest of all methods of drying is just to discharge the sludge upon a drying bed, which should consist of 10 in. of porous material with a perfectly horizontal surface, and underlaid with drain pipes laid approximately 12 ft. c. to c. It must not be forgotten that there should be spread over the surface of the bed a thin layer of fine sand, which will have to be frequently renewed.

This simple natural arrangement for drying was formerly very little used, because all attempts to drain fresh sludge were unsuccessful. The sludge must first be made drainable. Without question, this can be done by artificial means, as with the addition of lime or coal powder, in the same way as with sludge pressing. But all these methods of drying are uneconomical.

Automatically, by itself, the sludge becomes drainable while undergoing a process or natural decomposition. We have known this fact for a long time from the "septic tanks," through which the sewage slowly flows, and as a result of being in contact with the decomposing sludge, becomes foul itself and smells. In comparison with these septic tanks, a step in advance was made by separating the decomposing sludge from the flowing sewage, by removing it into a separate tank.

This idea of separate sludge decomposition was, so far as I know, first brought forward by H. W. Clark, of Boston, in the year 1899. It was not possible, however, in the experiments made by Mr. Clark, as well as in other places, to effect, in a separate sludge tank as good a decomposition as with the ordinary septic tanks.

The first success along these lines was made in the year 1906 at the sewage-disposal works of the Emschergenossenschaft in Essen. The type of works referred to are spoken of as Emscher tanks, a special type of double-deck tanks, which consist of an ordinary settling chamber and a sludge-decomposition chamber below, through which there is no flow.

After a short ripening time, there was found in these sludge-decomposing chambers a sludge black in color, and with a slight ordor of tar. In spite of small water content, ordinarily of about 75 per cent., the sludge flowed easily through pipes, and when spread upon a drying bed to a depth of 10 in., became firm and spadeable in a few days. The decomposition was practically odorless, and the sewage flowing out of the settling chamber was totally unaffected by the decomposition of the sludge.

Since we know that it is possible with separate sludge chambers to have the principal advantage of the septic tank, namely, the drainability of the sludge, the septic tanks have lost their importance. Their disadvantages, especially the objectionable odor of the effluent, render them impossible for many purposes. They are to-day suitable only for very small plants.

In most cases, it is desirable to keep the sewage fresh; in other words, to treat it in ordinary settling chambers, and to remove into a separate chamber only the sludge, which requires decomposition, in order that it can be easily drained and dried. It is not to be assumed that the Emscher tank is the only arrangement for bringing about these results. It is possible, without question, to bring about the natural decomposition, which takes place in Emscher tanks, with any properly built tank, filled in the right way with sludge, and operated according to certain principles. I do not yet know of any plants with separate sludge tanks, however, where exactly these results have been obtained. And it seems to me as if all possible scientific methods of bringing about these results, with plants in which the sludge is pumped from the settling tanks to special decomposition tanks, will be much more expensive both for construction and operation.

Practical Tests of Sludge.—In the sense of what has been said, good sludge may be considered as sludge which dries quickly and has no objectionable odor. The following information shows the possibility of easily determining the character of sludge.

Appearance and Odor.—Good sludge is black, and uniformly granular. It moves easily, it has a slight odor of tar or burnt rubber. Bad sludge is grey, full of fibres, soapy, sticky, and has a bad odor.

Adhesiveness.—A white enamel-lined dish pan is filled with sludge and then emptied so that only enough sludge remains to just cover the surface of the enamel. Good sludge will separate itself at once from the water, so that in 10 or 15 sec. the surface is broken up by white lines. Bad sludge sticks to the entire surface. This experiment is especially important because it gives the information at once.

Gas Content.—Newly withdrawn sludge is placed in a measuring glass to a height of 1 ft. After six hours good sludge separates itself from the water which collects below the sludge. With bad sludge, the water collects on top.

Drainability.—Sludge is placed on a sand filter to a depth of 10 in. In the case of good sludge, considerable clear water will drain out in the first few hours. In three days, during dry weather, it will be firm and spadeable. With bad sludge, only a small amount of water drains out of the sludge, and this takes place very slowly.

Conclusions.—The two best methods of disposal of sludge are (1) its use for agricultural purposes, and especially (2) filling of low land. In both cases, the sludge must first be dried, and this is best effected upon a drying bed after the sludge has decomposed in an inoffensive odorless manner in a separate tank through which sewage does not flow.

GAS-ENGINE RESEARCH.

On Thursday, January 30th, Professor B. Hopkinson delivered a lecture at the Royal Institution, London, England, on "Recent Research on the Gas-Engine." In his opening remarks Professor Hopkinson pointed out that during the last thirty years, though expectations had been realized with regard to the economy secured in the gas-engine as compared with the steam engine, as regards development in the way of size, anticipations had not been realized owing to limiting factors which were not foreseen many years ago. The Selandia had engines of 2,500 horse-power, but that was developed in sixteen small cylinders. On that scale large modern vessels would require from 200 to 250 cylinders, which was altogether out of the question. The rapid progress made by the steam turbine, which was now being made in 40,000 horse-power units, was in great contrast to the development of the gas-engine, which engineers found to be hampered by serious difficulties. It was the province of engineering science to investigate such conditions as these, and it was to the credit of this country that it had contributed largely to the advance in gas-engine research in recent years. That had largely been the result of the work of the British Association Committee on Gaseous Explosions.

In order to explain the nature of the difficulties encountered, Professor Hopkinson described the ordinary gas-engine cycle, and pointed out how, in it, waste might be saved by increasing the expansion. In order that that might be accomplished, it was necessary to compress to a greater extent, with resultant increase of pressures on firing. That, however, necessitated a much more heavily built engine. The flame of gas in the cylinder parted with its heat at a great rate, and the metal had to be kept reasonably cool to ensure satisfactory working. In order to demonstrate what went on inside a gas-engine cylinder Professor Hopkinson fired, inside a closed vessel provided with a glass window, a mixture of gas and air identical with that consumed in a Bunsen burner. Whereas the Bunsen flame was practically non-luminous, the flame in the closed vessel was seen to be luminous. The pressure in the vessel rose rapidly and fell off quickly, but more slowly than it rose.

To determine the extent of the heat-flow to the walls of a vessel in which an explosion took place, a vessel lined with a continuous spiral of insulated copper strip had been employed, and the varying electrical resistance of the strip of copper had been recorded, the pressures resulting from the explosion being recorded simultaneously. The heat-flow was found to be about 10 calories per sq. cm. per second, which was about the rate of radiation from molten steel. That flow of heat caused the chief troubles in the gas-engine. To deal with it the water-spaces had to be exceedingly large compared with the working space, while they were also extremely complicated. The exigencies of design further rendered a uniform heat-flow an impossibility, so that some parts were much hotter than others, with the result that bad stresses were set up, and castings often broken. Although large differences of temperature were thus most undesirable, they were essential to the maintenance of the necessary heat-flow. Unless this was sustained some part might become sufficiently hot to ignite the gas prematurely.

Till recently it was imagined that the heat-flow was due chiefly to convection and conduction. It had now been shown to be greatly due to radiation. Gaseous molecules were in constant vibration, and when, in the combustion of the gas mixture, chemical combinations took place, the vibrations were intensified, with resulting increase of radiation. Explosion experiments had been made in closed vessels with black interiors, absorbing radiant heat, and again in vessels polished inside. The effect in the latter case was to retard the heat-flow, and consequently the rate at which the pressure fell. Cooling was roughly only two-thirds as fast with the polished as with the black surface. Radiation during combustion had been measured by a platinum grid placed outside a fluorite window in the wall of a closed vessel, and it was found that about half the heat of combustion in the vessel was radiant heat. As the volume increased the radiant heat increased. That had been proved by David, who got twice the amount of radiation at the window of a vessel polished inside that he did when black, the polishing being equivalent to an enlargement of the volume.

The difficulties were, therefore, cumulative as regards large gas-engines. In the larger sizes, owing to the increased dimensions, large differences of temperature were necessary in the castings, in order that the heat-flow should be sustained; and as the increase of the volume of the flame added further to the heat to be dealt with, still greater temperature differences had to be employed.

MEXICO'S OIL PRODUCTION.

The oil industry is rapidly developing in Mexico, and this has now begun to assume proportions of such magnitude and is destined to be so far-reaching in its effects on the world's commerce generally that it is worthy of closer attention.

The total investment in this industry is now upwards of $80,000,000 gold, and its development has practically all taken place within the last five or six years. Broadly speaking, the petroliferous zone has been found to extend for 250 miles along the Gulf coast and fifty miles inland (12,500 square miles), with the port of Tampico near the centre. The present production (though many wells have been closed after testing, pending the development of transportation facilities) is conservatively stated at 214,000 barrels, of forty-two gallons each, per diem. Not 10 per cent. of the wells drilled have failed to show oil, and the average yield per well is 2,000 barrels per day, as against 42.56 barrels in California, which is the largest of the United States oil fields. It is true that the average yield is greatly increased by the production of a few very large wells, but these latter are situated many miles apart with innumerable "strikes" between, so that this average will probably be maintained as development progresses.

The world's total production in 1911 was 345,000,000 barrels of forty-two gallons, or 53,000,000 tons. The present potential production in Mexico is 78,110,000 barrels, and this from not more than a hundred wells. According to the latest figures to hand, Mexico has jumped from a production of 1.02 per cent. of the word's total in 1910 to a potential production during the present year equal to over 22½ per cent. of the total for 1911. This is second only to that of the United States and 8,000,000 barrels more than Russia produced in 1910. In accomplishing this less than 1 per cent. of the proven oil area has been prospected, and the country has only to increase its production threefold to become the largest producer in the world, a position which, with the same success as has been experienced in the past two years, she may very speedily attain, and even then not have tapped one-twentieth of her petroliferous zone.

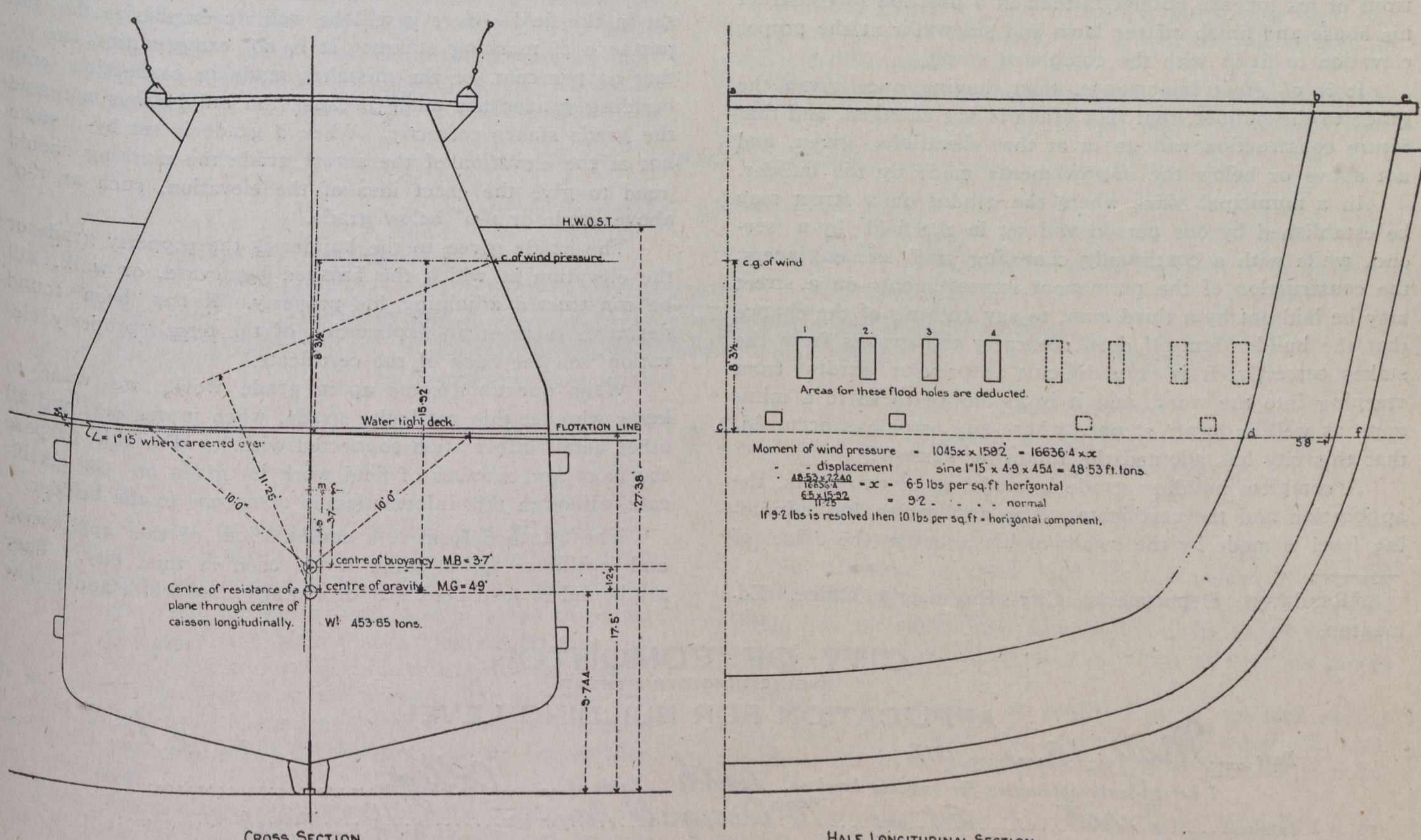
The chief difficulty in the way of this development lies in the lack of transportation facilities. The total number of oil tankers registered at Lloyds is below three hundred, whereas, allowing for the present ratio of increase, it is estimated that it will soon take three times that number to transport the oil supply of the Gulf coast alone. In anticipation of this most of the shipyards in Europe are congested with tankers under construction.

CALCULATIONS FOR THE CAREENING OF A CAISSON.

By Leonard Goodday, C.E., M.E.*

The caisson, as illustrated in the diagram below, was constructed a few years back for the entrance to a "dock basin" in the east.

A caisson, as with any vessel, has to be built with great accuracy, so that when its keel is horizontal the vertical planes, both longitudinally and transversely, are square to one another, i.e., the vertical plane through the centre line from stem to stern is at right angles to the vertical plane athwart the beam when it is in equilibrium as a floating body. This is so when its centre of gravity is in the same vertical line with the centre of gravity of the fluid displaced. When it careens or gives a list to leeward from any external pressure, these centres of gravity alter their position, and if a vertical line is drawn through that of the fluid displaced



Twice the area of the surface a.b.c.d = 858 sq. ft
" " " " " a.e.f.c = 1045 "

Horizontal wind pressure on 1045 sq. ft. necessary to careen the caisson over 3" = 6·5 lbs per sq. ft
Normal " " " 1045 " " " " " " 3" = 9·2 " " "

Caisson at Basin Entrance at Dockyard—Diagram Showing Wind Pressure Necessary to Careen Caisson Over 3 Inches.

until it meets the axis of the body, then that point will be the meta-centre of this body. Stability is always maintained when the meta-centre is above the centre of gravity, and unstable if below.

When being moved from the "Chamber" or any other place to the entrance, a caisson is liable to encounter fresh winds, and it has been known to have too much of a list, which makes it very troublesome to place in position. The hydrostatic pressure will assist in making it come to its bearings when in place, when the water is being let in for sinking it.

These conditions being fulfilled, an approximate calculation is made before the construction takes place to determine the wind pressure required to careen the caisson to an angle, causing the flood openings to be just awash.

Now, by calculation and measurement, the angle in this case will be 1° 15′ to the vertical.

Height of meta-centre above the centre of buoyancy (C.B.) equals moment of inertia (M.I.) of water plane 58′ × 23′ divided by the displacement in cubic feet equals

$$\frac{\text{Length} \times \text{Beam}^3}{12} \div 454 \text{ tons} \times 35$$

$$(35 \text{ cu. ft.} = 1 \text{ ton sea water}) = \frac{58 \times 23^3}{12 \times 454 \times 35} = 3.7 \text{ M.B.}$$

Height of C.B. above C.G. = 1.2 ft.

Height of meta-centre above C.G. = 4.9 M.G.

Height of centre of wind pressure (when horizontal) above the centre of resistance = 15.92′

Moment of wind pressure = 1,045 sq. ft. × 15.92′ = 16636.4

The righting moment at an angle of 1° 15′ = sin 1° 15′ × M.G. × displacement = .0218149 × 4.9 × 454 = 48.53 ft.-tons A

Total pressure of wind on the side of the caisson to balance A = 16636.4 × x (when x = pressure per sq. ft.)

Therefore, the horizontal pressure of wind necessary to careen the caisson 1° 15′ = $x = \frac{48.53 \times 2240}{16636.4} = 6.5$ lbs. per sq. ft.

If normal, the pressure becomes $\frac{6.5 \times 15.92}{11.25}$ (11.25 being the leverage of wind = 9.2 lbs. per sq. ft.

* Late of the British Admiralty.

If 9.2 is resolved, the horizontal compound = 10.0 lbs. approximately.

According to Molesworth, this nearly equals a very high wind, which would be from 7.8 to 9.9 lbs. per sq. ft.

Under these conditions the caisson will practically remain in equilibrium under all conditions of weather.

BUILDING GRADES AS GIVEN BY THE CITY OF EDMONTON.

By C. C. Sutherland.*

In Edmonton, as in other cities, we find people building in advance of local improvements, and in order that their door-steps and lawns may coincide with the finished street, it is necessary for the City Engineer to give each builder the elevations at which the future improvements will be constructed.

With these elevations marked on grade stakes at the front of his lot, the builder is then in a position to construct his house and finish off the lawn and sidewalks at the proper elevation to fit in with the completed street.

It is of great importance, then, having once given the grade to the builder, that this grade is not changed, and that future construction will go in at the elevations given, and not above or below the improvements made by the builder.

In a municipal office where the grades on a street may be established by one person and set in the field by a second, while with a continually changing staff of engineers, the construction of the permanent improvements on a street may be laid out by a third man, to say nothing of the chance that the builder himself does not carry the grades from the stakes correctly, it is very difficult to prevent errors from creeping into the work, and it is to reduce these to a minimum as well as locate at once where any error has occurred, that this city has adopted the following system:

A complete building grade is made up of two parts, the application and the certificate. The application for a building level is made by the owner or his agent at the office of the City Engineer, giving the location of his lot, by the street boundaries as well as the lot and block number. This is a good check and has saved considerable trouble, as the public are more familiar with their street name than lot numbers. The application is then signed and a fee of five dollars collected before any work is undertaken.

The certificate for a building grade is made a complete record of the work done, starting with the office down to the marking of the grade stakes.

When a building grade has been given off a profile, it is good practice to mark the building grade number on the plan above the profile, together with the elevations to be set in the field. This will act as a caution point and immediately check any intended change in grade unless such change was absolutely necessary. The number refers you to the detail description in the record book. Some engineers keep a map marked up-to-date with each building grade set, but we have found the method of marking the profile much more convenient.

The elevations are now given to the instrument man to set in the field. Here it will be well to emphasize the importance of marking stakes. It is no exaggeration to say that 90 per cent. of the mistakes made in connection with building grades are made because the builder has not read the grade stakes correctly. When a grade is set by a stake not at the elevation of the actual grade the marking should read to give the exact idea of the elevation, such as 1'-0" above grade or 1'-6" below grade.

The grade given to the builder is the property grade or the elevation at which the finished boulevard, or walk, will be constructed adjoining his property. It has been found desirable to print an explanation of the term "property elevation" on the back of the certificate.

When questions come up in grade work, we want to know who set this particular grade, when it was set, and all other detail information connected with it. For this purpose the page and number of field work is given on the certificate, although this information is of no use to the builder.

The attached form is a combination of the application and certificate for building levels used in this city. They are bound in field book size of 100 alternate white and yellow

*Roadways Department, City Engineer's Office, Edmonton.

CITY OF EDMONTON FORM E.D. 3
ENGINEERING DEPARTMENT

APPLICATION FOR BUILDING LEVEL

Date May 16 / 1912 *No.* 675

I hereby make application for building level on North *side of* College *Street*
between First *St and* McDougall Av. *for lots* 10 *Block* 4
Plan R.L. 6, *and agree to pay $5.00 for the same.* J. J. Smith
OWNER or AGENT
Mailing address 425 Sixth St.

CERTIFICATE FOR BUILDING LEVEL

Date set May 17 / 1912 *F.B. No.* 190 *Page* 50 *Set by* W. Milne

STATION	LOT	BLK.	PLAN	PROPERTY ELEV.	ELEVATION SET	STAKE MARKED	REMARKS
S.E. corner	10	4	R.L.6	240.20	241.20	1.0' above grade	nail in stake
S.W. corner	10	4	R.L.6	240.80	240.80	grade	nail in stake

Bench Mark No. 76 *At* N.W. corner College and McDougall
Elevation 243.76

CITY ENGINEER

pages, the white pages being perforated so that they may be taken out and sent to the builder. By using carbon paper the yellow page is made a record.

On receiving this certificate the owner gets all the information connected with the building grade and is in a position to have this grade checked if at any future time he thinks his grade has been altered, while the Engineering Department have a complete book of record of all the building grades set in the city.

BRICK PAVEMENTS FOR COUNTRY ROADS.*

The use of brick for surfacing country roads is rapidly gaining favor with highway engineers and the general public.

In 1909, the New York State Highway Commission decided to use a more permanent form of construction than macadam for the main highways leading into the larger cities, as any of these macadam roads were in bad condition, due to heavy traffic and lack of systematic repairs.

Experience has shown that macadam roadway under heavy traffic, either wagon or automobile, is not economical, mainly on account of the high cost of maintenance. The New York State Highway Commission, after extensive investigation, decided to use brick construction on their main highways; and, as a result, in 1910, about 20 miles of brick highways were constructed in the vicinity of the city of Buffalo. These roads proved so satisfactory to the travelling public, as well as to the Maintenance Department (the cost of maintenance being so low) that the mileage of brick roads in the vicinity of Buffalo at the present time is about one hundred miles, and this mileage will be greatly increased during the year 1913 if the present plans of the Commission are carried out.

These brick highways connect the city of Buffalo and Fort Niagara (at the mouth of the Niagara River) by way of the city of Niagara Falls, and reach out, with Buffalo as a centre, to all points of the compass; and I feel confident that it will not be long until every important highway leading into Buffalo will be of brick construction. This is also true of many of the larger cities of New York State; and the villages are now adopting brick construction under State aid.

The process of manufacturing brick for paving purposes has become more scientific as the demand for brick has increased and the methods of construction improved.

Streets built twenty to twenty-five years ago were paved with wire-cut bricks of the same size as building brick. Later, re-pressed brick of the small size were used. When the constructing engineer asked for a projection on the brick which would separate each course so as to allow the filler to enter and bind the bricks, the manufacturers placed their trade mark, in the form of raised letters, on the side of the brick. Later, more pronounced lugs were demanded; these raised letters, or lugs, require a re-forming of the brick in stamping machines (erroneously called a re-pressing machine), and as a consequence the so-called re-pressed brick with lugs drove the old wire-cut out of the market. The size of the brick was also increased to that of the present block.

Highway engineers still demand a block with lugs, and in 1910 a wire-cut lug-block was placed on the market for their consideration.

The brick with its lugs being cut by a machine at one operation shows, consequently, all lugs of uniform size, while on a re-pressed block many of the lugs are malformed or a part remains in the mould.

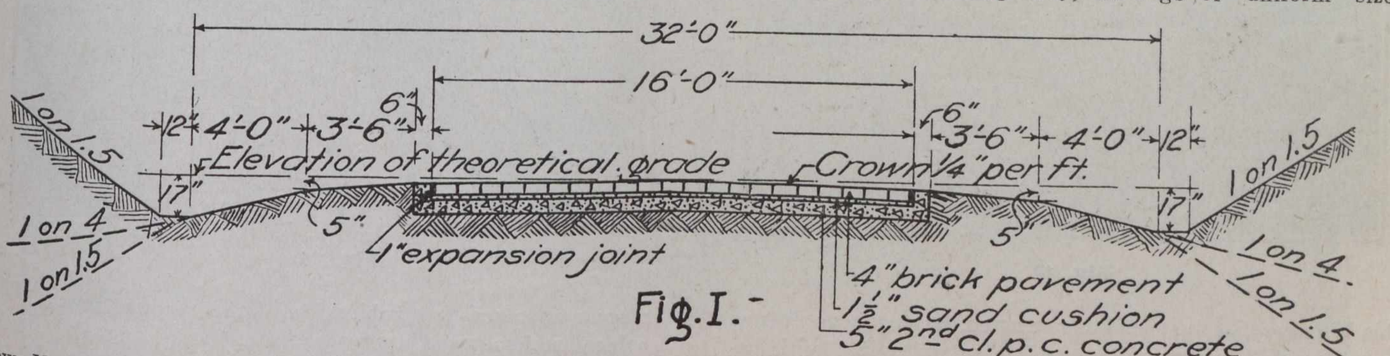


Fig. I.

Fig. 1 shows the New York State standard section for a brick country road, which calls for 16 ft. of brick surfacing, 1½ in. sand bed (this will be increased to 2 in. in 1913), and a foundation of 5 in. thick of concrete mixed 1 to 2½ to 5.

The brick surfacing is confined by a concrete edging 6 in. wide, flush with the pavement, and separated from the pavement by a well-defined expansion joint ⅞ to 1 in. wide.

For surfacing wider than 16 ft., these longitudinal expansion joints are increased proportionally to the width of pavement. No transverse expansion joints are used. In 1910, transverse expansion joints, placed fifty feet apart, were used with disastrous results, the blocks having become loose and crushing on each side of the joint. The shoulders or wings on each side of the edging are of earth, 7 ft 6 in. wide, making the width of the roadway 32 ft. between ditches; normal ditches are 1 ft. wide and 17 in. below the centre of the road or theoretical grade; back slopes of ditches, 1 on 1½; if necessary for proper drainage to

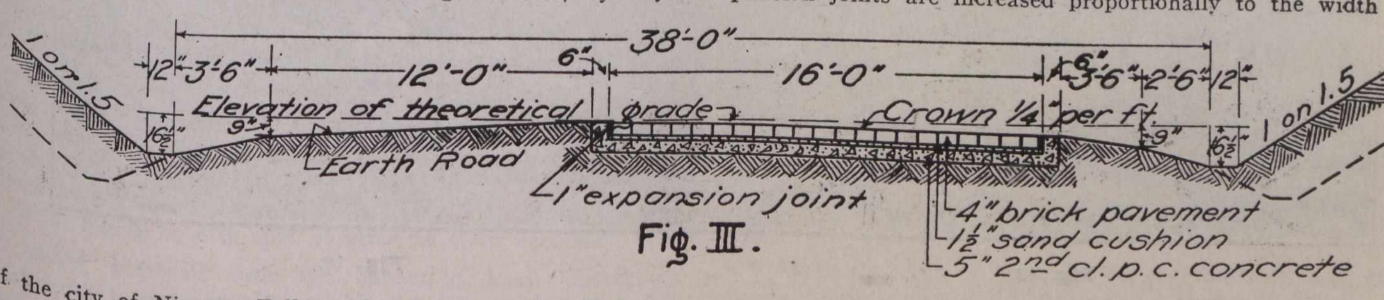


Fig. III.

* Presented at the Cleveland meeting of Section D of the American Association for the Advancement of Science by William C. Perkins, Resident Engineer, Department of Highways, State of New York, Niagara Falls, N.Y.

deepen the ditches or on embankment, the slopes are made 1 on 4 or 1 on 1½, but if the steeper slope is used, grade-rail is necessary. The crown of the brick section is ¼ in. per foot.

Fig. 3 shows a special section, combining a brick and earthen road, used on the highway between Niagara Falls and Buffalo. This is very similar to the section used on the roads around Cleveland. This section has 16 ft. of brick surfacing, with necessary edging and wing on one side of highway, and a 12 to 16 ft. earthen road on the other side.

Fig. 12.

This highway has just been constructed, having been opened for traffic on Christmas Day, and is 17 miles in length between the city lines. Fifteen miles of this highway is laid with wire-cut lug-blocks, the other two miles having been built in 1911 of re-pressed block. The traffic, especially automobile, will be very heavy. No traffic census has been taken, but on a Sunday afternoon (two weeks before the road was opened), at a time when it was necessary to make several bad detours, 256 automobiles passed a specific point in one hour.

The surface drainage is carefully examined, and concrete culverts used for the larger waterways and cast-iron pipe for the smaller.

The construction of a brick highway is in charge of a construction engineer, with a force of inspectors, and he is held responsible for the proper construction of the road and for all lines and grades. The method of construction is as follows:—

The road is first rough-graded, and when sufficient material has been excavated the sub-grade is rolled with a self-propelled road roller until it is thoroughly consolidated. Any weak spots that may develop are dug out and properly taken care of by either a sub-base course or a tile drain.

Fig. 15.

In some instances a combination of the two are used. The surface is then trued up by means of picks and shovels to conform to the cross-section.

The concrete used for base is made of 1 part of Portland cement, 2½ parts of clean, approved sand, and 5 parts of crushed stone or screen-washed gravel. The mixing is done by machines of the batch type.

Great care is used in having the concrete base smooth and of the same cross-section as the finished template, which rests on the edging forms, and is drawn as the work

Fig. 13.

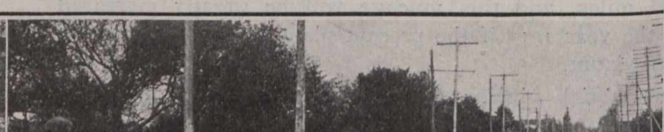


Fig. 16.

In the preparation of plans for a brick highway on New York State work the designing engineer carefully examines the surveyed plan, making a new location of the centre if, in his judgment, it will improve the alignment; avoids all sharp turns, taking new rights-of-way if necessary. Easy grades are designed for the main highways, which often necessitates the cutting down of hills and the filling in of hollows.

progresses. Upon this concrete foundation a bed of clean, dry sand is laid, which is 1½ in. thick when pavement is complete. This sand bed is rolled with a hand-roller weighing about two hundred pounds, and then brought to the exact form and crown by means of a template of the proper shape resting on the edgings, or on scantlings embedded in the sand. The template is drawn forward and backward immediately in front of the brick-laying, so that the sand cushion is maintained constantly at the proper cross-sections.

On this sand bed the bricks are laid on edge at right angles to the edging, except at road intersections, where they are laid at such angles as directed by the engineer. All longitudinal joints are broken by a lap of one-half the length of the brick. The bricks are laid in close contact with each other by experienced bricklayers, with the lugs in the same direction.

After a stretch of pavement is laid it is inspected, and all soft, broken or misshapen bricks are removed. Any brick slightly spalled or kiln-marked is turned over, and, if the opposite face is acceptable, it is allowed to remain in the pavement, otherwise it is removed. Any unevenness or irregularities of the surface, after rolling, is removed by means of ramming.

The pavement is then thoroughly wet by sprinkling and the filler applied. This filler and its proper application is one of the essentials of a good brick pavement. The filler used is composed of one part Portland cement and one part sharp, clean sand, mixed in small quantities and carefully applied to the brick surface by means of scoop-shovels and swept at once into the joints by means of push-brooms or squeegees.

Before the cement has attained its initial set, the same portion of the work is gone over a second time, using the same mixture of grout, care being taken in each instance to thoroughly fill all joints flush with the top of the brick. Blocks with imperfect lugs, in order to secure flush joints, a third, fourth or fifth coat of grout is often necessary.

When sufficient time for hardening has elapsed, a coating of sand is spread over the whole surface and kept moist during the heated period of the day, in order to obtain as uniform a temperature as possible while the grout is setting. The roadway is then allowed to remain absolutely free from disturbance or traffic of any kind for a period of ten days. Some engineers advocate a weaker grout than a 1 to 1 mixture; others, a pitch filler, but my experience has been that better results can be obtained with a 1 to 1 cement filler, properly mixed and properly applied. The object of a filler is to make the surface waterproof, prevent undue wear of the individual block, and to join all the blocks together in a monolithic structure. The joint should become part of the pavement, and, as near as possible, of equal strength with the brick, all expansion and contraction to be counteracted by the use of well-constructed longitudinal expansion joints.

In constructing longitudinal expansion joints, two clapboards, or wedge-shaped boards, are used in each joint while the brick surface is being rolled and the cement filler applied. After the filler has been applied the boards are removed, the outside board being removed first in order to avoid loosening the blocks adjacent to the joint. The joint is then thoroughly cleaned to the full depth of the block and the pitch or asphaltum applied.

On all sharp curves we find it an advantage to use a wider expansion joint on the outside of the curve, as the tendency of the pavement is to move in that direction and away from the inside edging.

Fig. 14.

All bricks are subject to tests for abrasion and impact, according to the standard methods prescribed by the National Paving Brick Manufacturers' Association. In 1910 and 1911, when the old form of rattler was used, a block which lost over 19 per cent. was rejected. In 1912, all tests were made on the new standard rattler, and all blocks which lost over 24 per cent. were rejected. Samples are taken at the roadside from every 200,000 block, or from any shipment which may be questionable.

As to the cost of brick paving on country roads, this varies according to local conditions. Highway contractors made use of various labor-saving devices to decrease the cost of construction. All unloading of stone and sand is done by machines. Many contractors are using traction engines for the hauling of material; some use small-gauge tracks with locomotives and cars. A modern concrete mixer is very necessary.

From data obtained from various roads a fair estimate of cost would be as follows, based on—

	Per hour.
Labor	$0.17½
Teams	0.50
Foreman	0.35

No office or incidental charges estimated.

Labor per square yard, brick paving in place, exclusive of concrete base:—

Unloading and piling brick	$0.035
Hauling brick one mile	0.040
Laying and rolling	0.070
Making sand cushion	0.020
Grouting	0.028
Expansion joints	0.007
Culling, replacing, etc.	0.005
Total labor, per square yard	$0.205

Fig. 17.

The manipulation of the concrete for the base varies from 40 to 60 cents per cubic yard, using batch machines and depending on gravel or stone concrete. The average bid price for brick pavement in western New York, including concrete base 5 in. thick, but excluding excavation, is $2.05 per square yard.

The brick highways constructed by the State of New York have given general satisfaction to the travelling public. Brick is the ideal pavement for heavy traffic; is smooth to the automobilist; originates no dust; is thoroughly sanitary; and, properly constructed, will be an inheritance appreciated by our children's children.

AMERICAN STATIONARY ENGINEERS.

The following is an abstract of the report made lately to the president of the National Association of Stationary Engineers by the National License Committee of the United States:—

The Indiana bill, endorsed by all of the State engineers' organizations, provided for a board of examiners of four members, the chief examiner acting as president, and the examining, licensing and classification of engineers and firemen. The examination fee is $3, and the fee for renewals, to be made annually, is $3, thereby making the department self-sustaining. The examintion board is authorized to reduce the fees when they exceed the expense of operating the department. This bill was approved.

The Oregon bill, which combines an engineer's license law and a boiler inspection law, is a model of its kind and framed to meet present-day requirements. It provides for a board of rules of four members, a chief inspector, ten deputy inspectors and a secretary; all inspectors to be selected by the merit system. The fee for internal boiler inspection is $5, and that for inspection while in operation, $2. It further provides for the examination, classification and licensing of engineers and firemen. The application fee is $1, and the license is issued for an indeterminate period, to be revoked for cause and renewed upon affidavit, when destroyed or lost. Penalties of fines and imprisonment are provided for employers and engineers violating the law. The annual renewal and license fee is eliminated. This, together with the requirement that the engineer keep a daily record of the condition and repair of all boilers carrying over 251 pounds pressure are two very important features that should commend the bill to the favorable consideration of both the steam user and the engineer. This bill also was approved.

Delaware reported that, having made four attempts to secure a State law, it may compromise on an enabling act, thus giving cities the right to enact local ordinances. Mr. Case, of New Jersey, has secured over 10,000 signatures to his petition for a license law, with good prospects of passage at the coming session of the legislature. Mr. Lee, of the New York license committee, will call a meeting later to determine the future policy of that committee. The Maryland committee reports progress on its proposed bill. South Carolina, which some years ago made a futile effort to secure a law, again desires to take up the matter, and will negotiate with the National License Committee to that end. The prospect of presenting a bill to the Pennsylvania legislature during the coming session is likely.

Mr. Coughlin reported that as the Kentucky legislature would not meet until 1914, license work in that State would be deferred until that time; that prospects in Indiana, with all engineer's organizations united on a bill, looked favorable for its passage at the coming session of the legislature.

Mr. Wirmel reported favorably on the Michigan, Illinois and Wisconsin state bills and on the Aberdeen (S.D.) ordinance; that the work in Ohio to broaden the scope of the boiler inspection law and to eliminate the engineers' license renewal fee would be submitted to the legislature.

The Canadian Engineer

ESTABLISHED 1893.

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CONTENTS OF THIS ISSUE.

OUR POTENTIAL WATER POWERS.

Nature has endowed Canada with vast resources in the water powers so thickly scattered throughout the country. These sources of power, by far the greater proportion of them still in potential form, will in the near future form one of the most valuable natural assets we have.

Cheap power is one of the fundamental requisites of a successful industrial community. With power available at a low cost, whether this be due to cheap coal, crude oil, gas or favorable hydraulic conditions, transportation conditions will usually adjust themselves.

Pennsylvania's supremacy in the iron and steel field is due to her vast supplies of coal and iron ore. The New England States, on the other hand, have developed as a result of the available water powers.

Ontario, unfortunately, has no local coal supply, but Nature has been kind in the ample provision she has made for the province in the many water powers throughout the province. These water powers, as the present sources of fuel become exhausted or their supply is restricted, will become more and more valuable. It is probable that the next decade will see a tremendous increase in hydro-electric developments in Central Canada. It is safe to predict that within twenty-five years there will be at least three million of electrical horse-power in daily use from the water powers of the Province of Ontario alone.

For many years to come it is probable that Ontario, and perhaps Quebec, will see more activity in the development of water powers than other parts of the Dominion, due to the distance necessary for transporting coal, and to the large number of cheap and available developments.

British Columbia is also most advantageously located with regard to possible hydro-electric power, and, no doubt, many of these, additional to those already used, will be exploited. With the vast coal fields of that province, however, there is not the same driving necessity for the immediate development of the water power resources.

If these water powers throughout the country are to be used in the best interests of the public, great care must be exercised in the allotment of franchises for their use. The several provincial governments and the Federal Government must be exceedingly cautious in granting rights of development to private corporations. Development should only be allowed with stringent regulations, and under short-terms leases.

PRECISE SURVEYING.

It is almost always a matter of satisfied and gratifying pride to the engineers, a subject of bewildering surprise to laymen, that tunnels starting miles apart, with intervening hills and mountains in between, can be made to meet as exactly as they do. Curving tunnels or straight makes no difference with the way they finally slap up against each other, squarely, face to face, and on the same level. When we consider the labor and money lost if they do not meet, the importance and responsibilities of the preliminary surveys that lead to the final alignment of tunnel then take on their true value.

In an article in this issue by Mr. Busfield, engineers not acquainted with the care exercised in this kind of work will find an able and interesting description of it in its details. It is the last word in modern precise surveys. Everything, from the standardizing of tapes, making allowance for temperature changes and elevation of measurements, and finally taking only the mean of several readings, each read to one thousandth of a foot, was done. The instrument work for angles and levels was just as carefully carried out to the last practical and known point of human carefulness and instrument accuracy. After reading it, it is with the utmost confidence one looks ahead to Mount Royal Tunnel, and its several workings finally joining up perfectly true and exact as per plans.

GOOD ROADS.

A Good Roads Exhibition, the first of its kind in Canada, is being held in the Exhibition grounds, Toronto, the 24th inst. to March 1st. The Ontario Good Roads Association is also holding its annual meeting the 26th, 27th and 28th of this month in the same city. In connection with the present agitation for good roads, an agitation which extends from coast to coast of Canada, and which is gaining in strength and popularity with all classes, it is, perhaps, well to note the start of the movement. As far as we can learn, the Ontario Good Roads Association, organized in 1894, was the first association actively trying to interest the people in better roads. They instituted quite a campaign of education on it, and by 1900 a considerable number of townships had abolished statute labor, and road-graders and machinery was superceding former modes. To-day, provincial and federal aid for highways in considerable amounts is becoming part of the financial expenditure of Canadian legislatures. Moreover, there is at present before the Ontario legislature a bill regulating the width of tires, etc., on vehicles, which ought to greatly help in economically maintaining and improving the general state of roads. Heavy loads and narrow tires, while they have been for years most destructive to our roads, do not appear to have so impressed the people, and seem to have passed unnoticed in their destructiveness, as far as producing legislation has gone. It is a cheerful sign to see this bill before the House, and let us hope it will pass.

This paper would like also to congratulate the Ontario Good Roads Association on its untiring work for years towards better roads. Below is a copy of the programme for their general meeting.

PROGRAMME OF ONTARIO GOOD ROADS ASSOCIATION.

ELEVENTH ANNUAL MEETING.

Toronto, February 26th, 27th and 28th, 1913.

First Day.

Morning Session, 10 a.m.

1. President's Address—T. L. Kennedy.
2. Report of Executive—George S. Henry.
   Report of Committee on the Constitution.
3. Appointment of Committees.
   Inspection of Machinery Exhibit.

Afternoon Session, 2 p.m.

1. Address—H. C. Hocken, Mayor of Toronto.
2. Address—Colonel Henry Brock, President Toronto Board of Trade.
3. Address—Sir Edmund Walker, President Canadian Bank of Commerce.
4. Address—C. J. Foy, K.C., Perth.

Inspection of Machinery Exhibit.

Second Day.

Morning Session, 10 a.m.

1. "The Township Road System," D. W. White, Clerk of Middleton.
   Discussion.
2. "County Road Organization and Construction," W. A. McLean, Chief Engineer of Highways for Ontario.
   Discussion introduced by Dr. C. O. Fairbank, of Petrolea.
3. "Technical Course in Highway Engineering," A. T. Laing, Toronto University.

Inspection of Machinery Exhibit.

Afternoon Session, 2 p.m.

1. Address—Hon. J. O. Reaume, Minister of Public Works for Ontario.
2. "Road Maintenance," Dr. L. I. Hewes, Engineer in charge of Maintenance Division, United States Office of Roads, Washington, D.C.
   Discussion introduced by E. A. James, County Engineer for York; John Roger, County Engineer for Perth, and James L. Tailor, County Road Superintendent for Wentworth.
3. "Stone and Gravel Roads," E. R. Blackwell, County Engineer for Leeds and Grenville.
   Discussion introduced by T. V. Anderson, County Road Superintendent for Lennox and Addington; R. H. Fair, County Road Superintendent for Frontenac; R. H. Jupp, County Road Superintendent for Simcoe.

Inspection of Machinery Exhibit.

Third Day.

Morning Session, 10 a.m.

1. "Town and City Streets," G. G. Powell, City Engineer, Toronto.
   Discussion introduced by T. H. Jones, City Engineer, Brantford, and J. C. Gardiner, C.E., Niagara Falls.
2. "Steel Bridges," C. R. Young, C.E., Toronto.
   Discussion introduced by H. J. Bowman, C.E., Berlin.
3. "Concrete Bridges," Charles Talbot, County Engineer for Middlesex.
   Discussion introduced by R. W. Farley, County Engineer for Carleton.

Inspection of Machinery Exhibit.

Afternoon Session, 2 p.m.

Reports of Committees.

Election of Officers.

Unfinished Business.

Meeting of Executive.

STORM WATER DISCHARGE.

By R. O. Wynne-Roberts* and T. Brockmann.†

(Continued from last week).

Impermeability of Surface.—It is palpable that rain falling on the surface of the earth will be absorbed in some proportion to the permeability of the soil, etc. Very little rain will run off sandy ground, but if the ground is hard clay, or close-grained rock, more will flow over the surface and be drained away. If the ground is already saturated, most of any rain falling upon it will flow off by gravitation to the lowest point. In the case of intense rainfall, the ground is unable to absorb the same proportion of water as it would if the rain fell in gentle showers, and consequently a larger percentage of it is drained away.

Following this method of reasoning, it will be observed that in the case of towns with well-paved streets and yards, and houses built closely together, the storm water discharge will naturally be expected to be greater than where the streets are constructed of more absorbent material or where the streets are not made at all. Where the buildings are further apart and the degree of permeability is greater, the discharge to be dealt with will be less.

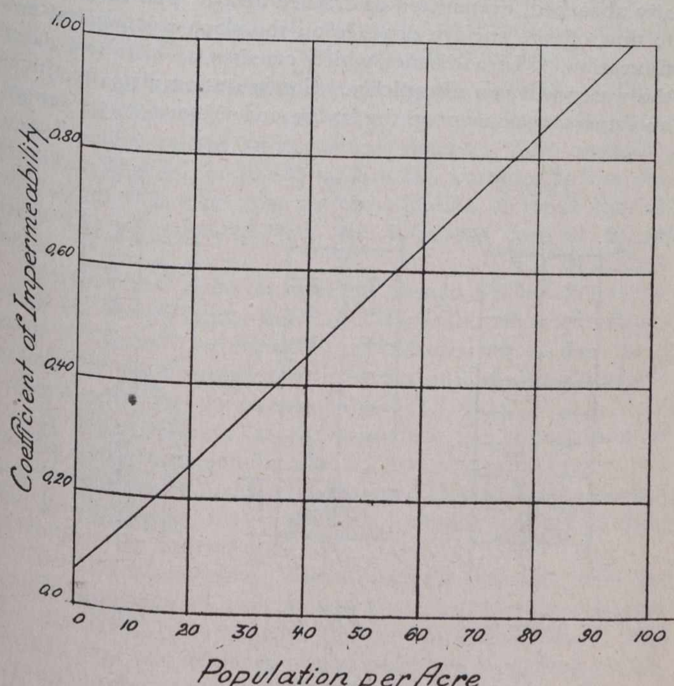


Fig. 1.

Mr. Wallington Butt, in a paper which he read in 1907 on the subject of "Calculation of Storm Water Discharge," rightly stated that the extent to which a town area has been built upon is, in some measure, also an indication of the impermeable area; in other words, the density of the population bears some relation to the area of impermeable surface in that district.

Mr. Wallington Butt, at the same time, submitted a diagram which he considered would assist to ascertain this factor, and this diagram is now reproduced for our present purposes. It is well, however, to point out that the limitation of this diagram is a population of 100 persons to an acre. Some towns have a much greater density of population than this, for instance, in Manhattan, New York, it approaches 1,200 persons per acre, but where it exceeds, say, 100, it can be assumed that the area in question is entirely built upon and the factor will be almost unity.

It is, of course, essential that the drainage area should be divided into smaller districts, the number of houses in each district be counted, and, allowing a certain number of inhabitants to each house, the population per acre is ascertained, and the diagram (Fig. 1) will give the coefficient of impermeability.

The following comparison of German and British standards will be useful:—

German classification of areas.	Equivalent British standard in population per acre.	Coefficient of impermeability.
(a) Area densely built upon	75	0.80
(b) Area less densely built upon with larger yards	55	0.60
(c) Area having houses with larger gardens and yards	45	0.50
(d) Area openly built upon, detached villas, etc.	25–35	0.30–0.40
(e) Rural districts with gardens, meadows, etc.	15	0.20
(f) Parks, forests, etc.	5	0.10

Retardation.—In addition to the foregoing factors, which influence the manner in which storm water is discharged from any area, there is still another.

If the time required for the storm water to flow from the upper end of any sewerage system to any other given point is longer than the duration of the storm, then the water from the furthermost limits will reach the latter point when the water from the vicinity of that point has already been drained off, and thus the whole area, in such a case, will not be contributory simultaneously. In other words, the water from the remotest parts of the drainage area, owing to the distance it has to travel to the point in question, has been retarded from being discharged at the same time as the water from the parts near the lower point, hence the term "retardation." Mr. Baldwin Latham, one of the leading British engineers, stated that although rain fell in Manchester for 151 hours and 10 minutes, it took 1,008 hours for the water to flow off through the sewers, and this he attributed to an "extenuation of the flow."

To arrive at an appreciation of the influence of retardation, we may consider the subject in the following manner:

Let "L" denote the length of a sewer and "V" the mean velocity of the flow of water in the sewer, then if we consider a small quantity of storm water entering the upper end of the sewer, the time it will take to reach the given point or outlet will be $\frac{L}{V}$. If "D" denotes the duration of a storm, then the total time "T" from the commencement of the storm to the moment when the storm water will practically cease to flow through the sewer will be:—

$$T \text{ equals } D + \frac{L}{V}.$$

That is, the time for discharge, whether the water flows in an open water-course or in a close sewer, will be greater than the actual duration of the storm. But this fact does not warrant the sectional dimensions of the sewer being diminished, for such a reduction is possible only when the duration of the storm is less than the time required for the water to be discharged through the sewer, that is when "D" is smaller than $\frac{L}{V}$ or when "L" is greater than V × D.

* Consulting Engineer, Regina.
† Civil Engineer, Regina.

With storms of great intensity and of small duration retardation will take place, even in short lengths of sewers, but when the storm continues for hours, retardation will have no influence, even if the sewers are of considerable length. It will depend upon the duration of the maximum precipitation assumed and on the velocity of flow in any particular sewer, whether or not retardation will take place.

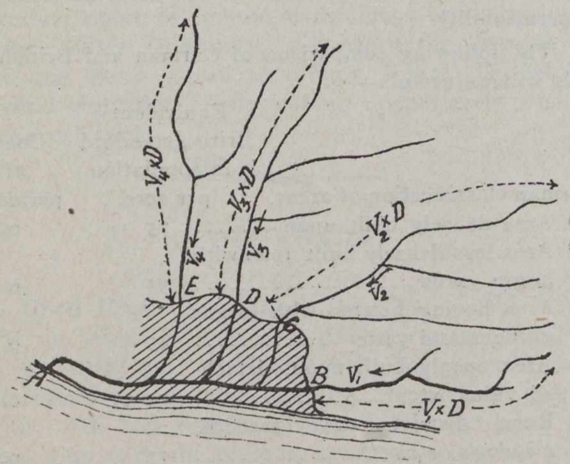


Fig. 2.

If the drainage area is within that part of a city which is built upon, then "V" will be determined solely by the inclination given to the sewer. The time required for the water from the roofs, yards and paved streets to drain into the sewers will be so short in comparison to the period which the storm water will take to reach the outlet, that is can be ignored. In the case of rural districts or openly built upon areas of a city, it will be necessary to allow a minute or so for the water to reach the sewers.

If an area such as is represented by Fig. 2 is considered, the value of V × D for the upper lengths of each sewer can be computed, and then the points B, C, D, E will indicate the limits of the area in which retardation will occur and must be taken into account.

In most cases the duration of a storm which will give rise to the maximum rate of flow will be not less than 20 minutes, or 1,200 seconds.

"V" is usually greater than 2.3 feet per second, therefore, in sewers shorter than 2,500 to 3,000 feet in length retardation may be considered as exceptional.

The question will now, doubtless, be asked, what will be the effect or influence of retardation on the discharge of storm water?

Such influence may be made clear in a simple manner if we consider a rectangular area E, F, G. H in Diagram F.

The line A-B represents the main sewer which drains the area bounded by the rectangle E, F, G, H. At the commencement of a storm of duration "D" the water from the vicinity of B will be the first to reach the outlet, and this is represented by the triangle H-C-B, which is shaded in Figs. 6 and 7. During the storm the adjoining area will be drained as indicated in Fig. 8. When the storm ceases, then the water from the vicinity of B will cease to flow, and this is indicated by the unshaded triangle H-N-G in Figs. 9 and 10. The length of the shaded part is equal to V × D. When the point C of the shaded part has reached the upper limit of the drainage district, then the extent of the figure representing the discharge will gradually diminish until the last portion of the storm water is drained away, as shown in Fig. 11.

Let "q" denote the quantity of storm water discharged per unity of drainage area.

"A" denote the extent of the drainage area.

"a" denote the contributory area,

then the ratio $\frac{q \times a}{q \times A} = \frac{a}{A}$ equals "R" the factor by which q × A has to be multiplied so as to obtain the actual quantity of storm water discharged. This factor is called the factor of retardation.

Example: Let "L" equal 12,000 feet; "V" equal 2.3 feet per second; "D" equal 1,200 seconds.

Then R equals $\frac{a}{A} = \frac{V \times D}{L} = \frac{1{,}200 \times 2.3}{12{,}000} = 0.23$ of the area.

By the foregoing discussion and diagrams it is manifest that, in addition to rainfall intensity, the configuration, extent, and shape of the drainage area, as well as the velocity of flow in the sewers, are the essential factors which may cause retardation.

Drainage Area, Configuration.—It is manifest that the permeability of a surface must be a question of degree, for even dense clay will absorb water if it is given time. If the drainage area is very flat and even rain water will naturally remain on the surface for a longer period, and will be gradually absorbed, evaporated or drained away. The time it takes to flow off the surface depends on the slope and general configuration. In a district which consists of hills and dales, the water will run off quickly. Configuration also constitutes an important element in the laying out of storm water sewers.

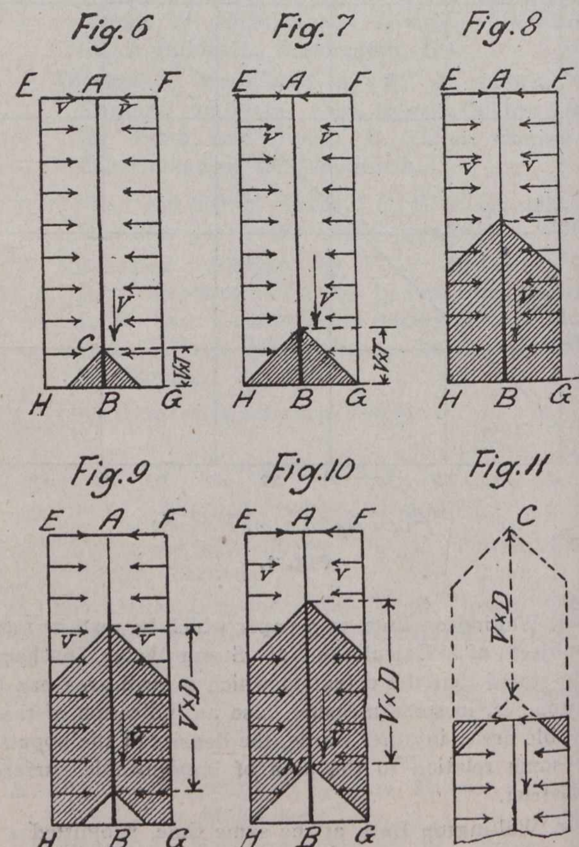


Diagram F.

Extent.—The extent of a drainage area, as far as retardation is concerned, is a matter of importance, so far as it is a function of its length. For it will be agreed that the time required for the water to concentrate at any given point will depend on the distance it has to travel and, according to statements already made, the intensity of a storm will vary inversely in proportion to the length of the sewers.

Shape.—The shape of a drainage area is another factor which has to be considered, for if the area is long and narrow, it will be observed that the period of concentration will be greater than if the area is compact.

Velocity of Flow in Sewers.—The factor of retardation is controlled by the velocity of flow in the sewers, inasmuch as the latter directly determines the time of concentration, that is T equals $\frac{L}{V}$. If the sewers are laid with steep grades, a larger drainage area will be contributory, in a given time, than if the grades were made flatter. High velocities tend to eliminate retardation, whilst low velocities cause retardation to take place sooner.

Generally.—It is a matter of considerable importance that protection should be afforded the public against flooding, for apart from the disagreeableness of such an occurrence, it is also a menace to the health of a community. There is, however, a limit to which the engineer is justified in expending large sums of money in the construction of sewers of such dimensions as to be absolutely safe against flooding or gorging.

If the greatest rainfall intensity ever observed in any district is assumed as the basis for calculating the dimensions of sewers, it may be found that the sewers will be of such inordinate sizes that they will rarely be used to their full capacity and be so costly as to be financially impossible.

To adopt lower rainfall intensities will mean the facilitating of the execution of such works, but this may also incur some liability caused by occasional floods. The question, therefore, for the engineer to carefully consider is the disadvantages that may arise by the adoption of lower rainfall intensities as compared with the increased cost of larger sewers.

In Germany about 70 litres per second per hectare represents the lower limit, but this, according to observations made in Berlin, for instance, is exceeded about five times each year. To exceed 150 litres per second per hectare is recommended only in exceptional cases.

In districts such as Basel, where the annual rainfall (840 m.m.) is considerably greater than in Berlin (597 m.m.) a greater rainfall intensity is assumed, for instance, Burkli-Ziegler considered 125 to 200 litres per second per hectare as suitable for Switzerland.

Both Hawksley and Burkli-Ziegler's formulae were intended to include all circumstances which tended to diminish the discharge. Subsequent to their investigations, it was realized that the influence of the different conditions of impermeability of the surface deserved more attention and consequently other engineers introduced a separate co-efficient to cover that point. Following this slight development of the problem, however, German engineers have more fully developed the important features of the factor of retardation. Many capable American engineers have endeavored to construct a formula which will be generally applicable for computing the discharge of storm water, but they have met with very little success, because they tried to combine the heterogeneous factors affecting such discharge.

Mr. Lloyd Davies and Mr. Wallington Butt stated that the maximum discharge is attained when the duration of the storm equals the time of concentration. As the intensity of a storm varies inversely with its duration, in the case of sewers having great lengths the intensity will consequently be considerably reduced.

In many instances, however, it is not a storm of long duration and low intensity, but a storm of short duration and a great intensity, will cause the maximum rate of flow in sewers, even if only a fractional portion of the area is contributory. For example, in a district having an irregular shape, where the area near the outlet constitutes the major part, then during severe storms the water from that portion will concentrate quickly at the lowest point, whilst that from straggling and remote parts will require more time to reach the same place. It in such a case the intensity is derived from the time of concentration, then it will be too low.

It also often occurs that rainfalls of high intensity and short duration cannot be ignored, as they may happen when the sewers are already filled by the runoff of the preceding rainfall.

In an important case, it is highly desirable to ascertain which kind of rain will give rise to the maximum rate of flow.

A rainfall of high intensity will generally be assumed and the discharge ensuing is to be considered in its different stages. This can be effectively done only by constructing flow-areas as has been suggested by the late Prof. Frühling, of Dresden.

Such flow-areas can be drawn on squared paper, the horizontal lines—abscissae—will represent the time in minutes and the vertical lines—ordinates—will represent the volume of storm water in cubic feet.

The method suggested by the late Prof. Frühling will be explained in the next issue.

(To be continued).

INTERURBAN TROLLEY FREIGHT SERVICE AND RELATION TO HIGH COST OF LIVING.*

By Edward C. Spring,
Assistant to President, Lehigh Valley Transit Comany.

No agency in modern times has done more for the development of communities, the building up of municipalities and the revolutionizing of the social life among the masses of this country than the trolley systems of the United States. They have brought the farmer in close touch with the markets of the civilized world. They have brought the farmer's family in close touch with the educational advancement which this country offers, and to-day it seems to me that the interurban trolley lines of the country can do more to break down the middleman's profit and to place the product of the soil at the door of the consumer with greater dispatch and less variations in price than any other agency.

Recent legislative enactments in many of the States favorable to the handling of freight and express matter by the electric lines have caused the operators of such roads as are affected to establish a freight or express business. Hitherto the handling of trolley freight has received comparatively little attention in the East, considerably less in general than the attention given to it in the Middle Western States. But the roads of the Middle West have not fully demonstrated or satisfied themselves as to the best course to be pursued in taking care of this new branch of the service. The diversified conditions that exist among the various roads and the difficulty in harmonizing these various conditions present a situation which must be met. The growth of the freight and express business during the past four years has been wonderful. The frequency of service and the connecting of small towns between cities hitherto isolated from the outside world have been two of the greatest factors for the development of this branch of the service.

The number of advantages offered by the electric lines in the handling of commodities is fast becoming more apparent each day. The placing of the farmer in close touch

* Abstract of paper read before the City Club of Philadelphia January 18th, 1913.

with the markets of the world, through the medium of the electric lines, offers in itself one of the greatest inducements to the interurban lines running through a farming community. The establishing of freight stations and platforms in the various towns and cross-roads enables the handling of freight and express more carefully and with greater dispatch, and also makes a convenient place for the transfer of the merchandise. As the industrial and commercial needs press the interurban roads to keep pace with the demand for greater freight transportation, this need will be met in the same energetic and progressive manner as has characterized the past development of passenger transportation.

The great ease with which agricultural products can be brought into the large cities has enhanced farm values through the various territories served by the electric lines, together with the shipments of local produce into the cities, the counter-current of development of groceries and other store products to the various towns along the line takes place. That the various municipalities may be benefited from this new class of service, the farmer must be brought into close touch with the benefits of this service, as it concerns him.

Much has been told the farmer by the State Agricultural Institutes how to prepare the ground, till the soil and plant. to produce the best results, but very little has been told him how to find a market for his product after its development. It has been my interesting work in the Middle West, and is at present with the company that I represent, to bring the farmer's attention to the most important agency that has wrought a revolution in bringing the country into close proximity with the city and to familiarize him with the intermediate relations which exist between the transportation companies and the farmer. I am a firm believer that as the farmer goes, so goes the nation. To anyone who has studied the farming conditions in the Middle and Western States, this is most forcibly impressed. It is not a question to-day of the farmer taking his cue from Wall Street, but Wall Street being subservient to the will of the farmer.

The community in and about Philadelphia is splendidly served as far as the farmer is concerned by the up-to-date service of the transit companies, which have recently established a fast express service at freight rates between the various points and the city of Philadelphia. The company with which the writer is connected has established a brokerage department in connection with its express and freight service between Allentown and Philadelphia along the Lehigh Valley and through the North Penn region, whereby the farmer can secure a market for his commodity without going to the city or taking up his time. The company does not charge the farmer for this service. This is a great feature of the express service, and one which has never been handled by an Eastern trolley line before.

The time is past when the farmer does not put a valuation upon his own time and that of his team. To-day in the management of the farm, these two factors are entering in the maintenance account to a large extent. When the farmer can place his commodities upon the cars of the trolley lines, he can not only utilize his own time, but that of his team to greater advantage at home, rather than driving to market.

I have purposely tried to impress upon you the close relationship that exists between the farmers and the electric transportation companies in the great work and development of the farms and the products and the placing of the same within the reach of the masses at sane and rational prices. The farmer in the aggregate is not receiving for his product to-day any more than he did ten years ago, but the consumer in our large cities is paying from 50 to 100 per cent. more for the same goods, and it is certainly evident, even to the casual observer, that the middleman is the one who is reaping the major part of this advance, and to-day the one agency that is doing more to break down the middleman's profit is the freight and express service of the interurban lines.

The electric lines of the United States occupy no mean position in the commercial and mercantile interests of the country, and are in a position to play a very important part in the future development of the country. According to the last census, there are in the United States 1,279 operating companies, 40,088 miles of operated track, operating 89,601 cars. These companies have a total stock and bond issue, authorized, of $7,182,781,212, and outstanding, $4,682,106,217.

I firmly believe that the establishment of city markets at various sections of a large city, with tracks running directly to the same, so that the market garden products may be delivered directly to these markets, also various freight terminals to be established as near the centre of the metropolitan districts of the city as conditions may permit, would be one of great advantage to such city.

The city of Philadelphia, unfortunately, owing to the wide gauge of the city tracks, cannot allow direct communication without transfer from most of the outlying electric lines.

These matters should all have the attention and the endorsement of the engineers in laying out the future transportation plans for the city. The desire of the farmers to ship their goods over the electric lines in preference to steam roads is an evidence and proof of the benefits of this service.

The company, which the writer represents, is probably doing more to-day than any other electric railway company to develop this class of business, and transversing as it does the highly productive counties of Montgomery, Bucks and Lehigh, for a distance of fifty-eight miles to the north of Philadelphia, this company is in a position to serve the city to great advantage. So rapidly has the business of transporting farm products developed that this company has ordered several new cars to give increased service. The field of transporting farm products by the trolley lines, as far as the section in and around Philadelphia is concerned, has hardly been entered into as yet, and the large volume of business which will be developed by the trolley companies and the increased advantages which will revert to the city of Philadelphia cannot be estimated.

The recent advent of one of the largest old-line express companies on the Lehigh Valley Transit Company's line is but an added feature to the progressive and up-to-date methods that are being instituted for the benefit of the Philadelphia markets.

The key to the success of any interurban trolley service is its terminal facilities in the large cities. A system of trolley freight terminals must be established to better bring the producer and the consumer in close touch, eliminating all possible chances of the middleman. A fair adjustment of rates on the part of the city line with the interurban roads must be made, that the through rates for transportation between the farming districts and the city will be so attractive that the farmer will ship his product by means of the trolley rather than by any other. These are all factors which must be taken up in the city of Philadelphia in order to bring about the desired results. At the present time the city lines are receiving the same percentage of the through rate for a haul of five or six miles as the interurban lines are receiving for thirty or forty miles. It seems to me that these two factors, namely, terminal facilities and rates charged by the city lines, are most important and of vital interest to the city of Philadelphia in the development of the electric freight service.

A HIGHWAY DEPARTMENT ORGANIZATION FOR A LARGE CITY.*

By Wm. H. Connell.†

The most important and most neglected branch of the municipal governments to-day, is the division of highways. This is probably due to the fact that only within the past few years has the public taken an active interest in the condition of the streets. Wide avenues, good pavements and clean streets are not only appreciated but demanded by the public to-day, which accounts for the significant fact that every live municipality is struggling to develop a highway organization that will enable it to meet the demands of the public.

The time has arrived when municipalities must develop highway organizations commensurate with the present day requirements of this all-important branch of municipal government. It is needless to say that the development of up-to-date municipal highway organizations, like the good roads movement, is in its infancy, but the two go hand in hand and have come to stay, and if any governing body wishes to be popular with the public, it will be well for it to look to its highways. The highways represent the most conspicuous show case of the municipal government—thus the importance of paying particular attention to the goods placed there. It pays and pays well for business establishments to design attractive show cases, place their best goods in the window, and maintain a clean and attractive display; and so it would pay municipalities well to design attractive highways, lay good pavements, and maintain clean and attractive streets. It must be remembered, however, that this cannot be done by wishing. But unfortunately a half-hearted policy has been the one most in evidence in many municipalities to satisfy the popular demand for attractive highways and good pavements. The solution of the problem is an up-to-date municipal highway organization, made up of the right kind of personnel working as a unit.

No matter how large or how small the municipality may be, the underlying principles constituting the foundation of the highway organization are the same. If a lawyer or business man were going to build a house, he would employ an architect, tell him how much money he had to spend, give him an idea of the size of the house wanted, and leave the rest to him. He would also select an architect with experience in the design of the type of structure he wanted. The same procedure should be followed in organizing a municipal highway division, and it is a very simple one to follow. Select an engineer whose experience has been gained in highway organization work; tell him about how much money he will have to spend; give him an idea of the mileage and area of streets and the scope of the work coming under his jurisdiction; and he will build up a successful organization —provided he follows the same principles the architect must to design a substantial house, namely, select the materials best suited to support the structure. The highway organization, like the house, to be substantial must be composed of of men capable of upholding and controlling the respective divisions of the organization coming under their control. If this procedure is followed, the organization will be permanent and will stand, unless seriously interfered with, even in the absence of the engineer who built up the organization, member by member. When an organization is perfected, it is in the same category with the completed house, simply requiring maintenance to hold its own. But if it is to be kept up-to-date, it will require changes and improvements commensurate with the demands of the time, and increased population—the house as well as the highway organization.

The outline of the underlying principles governing the procedure to be followed in forming a municipal highway organization makes it very evident that at most it is not a difficult task to start right, but right here municipalities only too often have failed. The lawyers and business men placed at the head of the public works departments have not followed the procedure they would in building a house or doing something else that would require a like amount of intelligence in the selection of the tools to work with. They have either attempted to build up the organization themselves, or have selected engineers whose principal qualifications have been that they were specialists in reinforced concrete, waterworks, sewer works, etc., or in short anything but highways. And what has been the consequence? These men spend three or four years or more groping in the dark, studying the rudiments of the requirements of a highway organization, and by the time they are just beginning to find themselves, and appreciate that highway engineering is a special branch of the engineering profession, the public has become impatient, and justly so.

This we all know has occurred only too often with well-intentioned administrations. Such control of the highway situation retards the advance of modern highway organization and engineering just as much as the old-time political administration of the highway bureau, and the reason is that the public expects something from the well-intentioned administration and doesn't get it, while in the latter instance they did not expect much and usually were not disappointed.

A proper start usually results in a good finish, but not without a hard fight, and even though the right engineer be selected to head a highway organization, his path is not strewn with roses. There is so much that is wrong and so little that is right in many of our municipal highway organizations, that the opportunity for constructive work is almost unlimited, aside from the efforts required even to keep abreast of the times with the construction work, and above water with the maintenance.

Assuming that a highway organization has reached the stage of development where its personnel is qualified to handle the work, the next and most important step toward efficiency and economy is to centralize the control of streets.

It may appear rather odd to some, but nevertheless it is a fact, that very few, if any, highway organizations control the streets coming under their jurisdiction. The control is usually divided up between the street railways, telephone, telegraph, electric light, gas, and other corporations. If when these companies tear up the streets they are permitted to make their own repairs, there results a confusion which takes away from the highway bureaus the direct control of street repairs. Such arrangements as are necessary should be made to place all repair work directly under the highway bureau. If the repair work is done by contract, the contract should be with the city. The highway bureau should have sole authority to repair or order repairs, of whatever nature, that are to be made. This would give the bureau a direct control over the contractors, and place the responsibility on the bureau for the condition of the streets and do away with the excuses we so often hear from city officials, that "The railway or telephone company is responsible for such and such repairs, and we are doing our best to push along the work." With this divided responsibility for the condition of the streets we can never expect to reach the highest point of efficiency in our highway organizations. The parkways

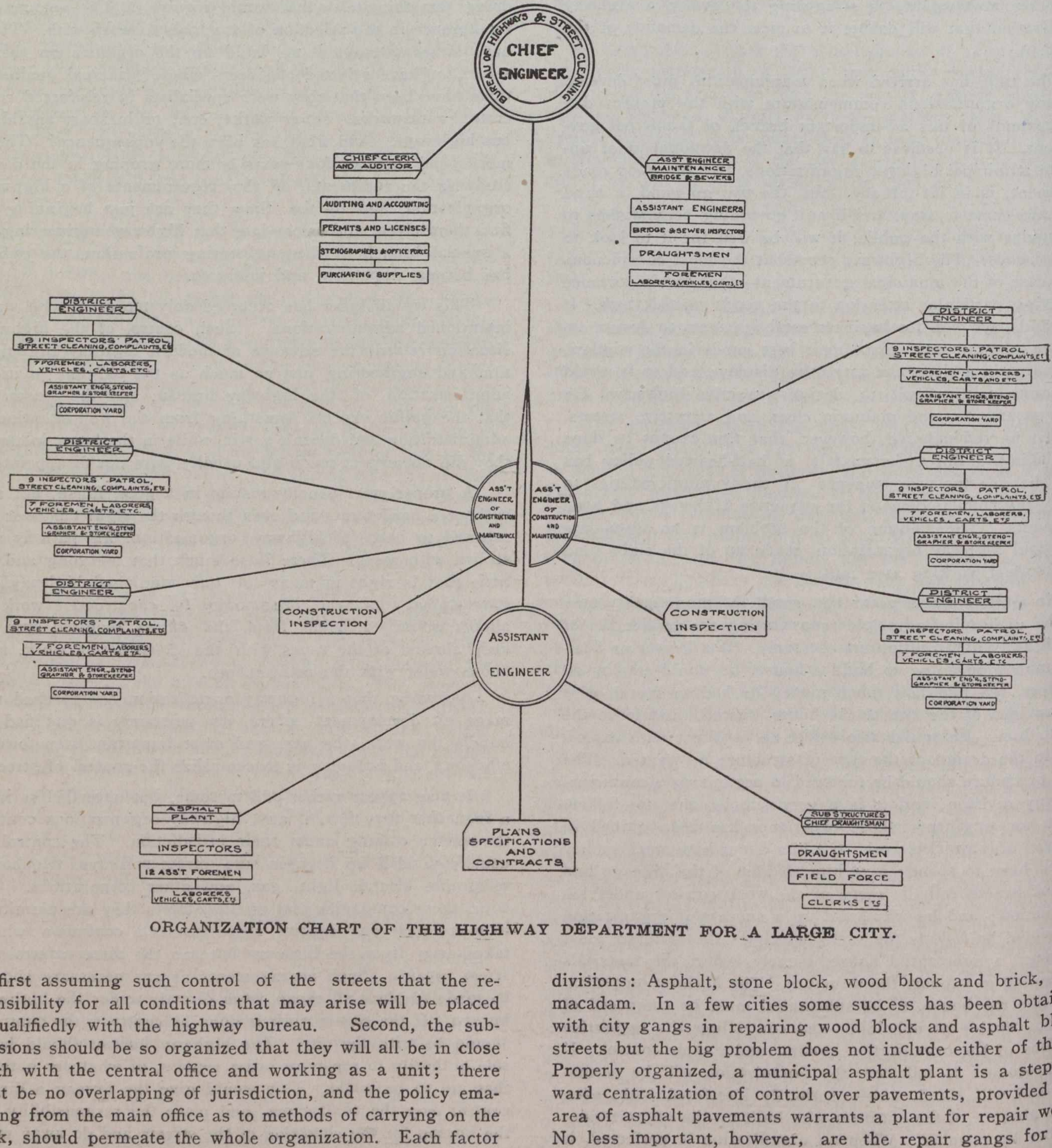
* From a paper read before ninth annual convention of Ameircan Road Builders' Association, held at Cincinnati December, 1912.

† Chief, Bureau of Highways and Street Cleaning, Philadelphia, Pa.

and main park driveways should also be under the control of the highway bureau as there should be but one system of highway construction and maintenance in the municipality.

The principle of centralization of control is the governing factor in a municipal highway organization, as it is also in any other organization of whatever nature. No business enterprise can compete with other business enterprises and be successful, unless the control of the organization is centralized and all the branches and subdivisions are co-operating and working as a unit for the success of the enterprise. This can be accomplished in a highway organization only of control, and such control cannot exist unless each individual in the organization is charged with his responsibility. If more attention were paid to the old saying, "Men will be led, but not driven," there would be less disorganization in municipal highway and other organizations.

Another very important step toward the control of street repairs is the establishing of municipal repair forces. The city should not be forced to depend upon contracts for work of this character and indeed, the only way to control completely wear and tear repairs as well as cuts is through municipal forces. Such repair forces naturally fall into four



ORGANIZATION CHART OF THE HIGHWAY DEPARTMENT FOR A LARGE CITY.

by first assuming such control of the streets that the responsibility for all conditions that may arise will be placed unqualifiedly with the highway bureau. Second, the subdivisions should be so organized that they will all be in close touch with the central office and working as a unit; there must be no overlapping of jurisdiction, and the policy emanating from the main office as to methods of carrying on the work, should permeate the whole organization. Each factor in the organization, from the common laborer up, should be schooled in a sense of his responsibility and know where it begins and ends. No man will do his best work unless he be instilled with a sense of his responsibility. The success of the organization at large depends upon co-operative efforts which can be brought about only through the centralization divisions: Asphalt, stone block, wood block and brick, and macadam. In a few cities some success has been obtained with city gangs in repairing wood block and asphalt block streets but the big problem does not include either of these. Properly organized, a municipal asphalt plant is a step toward centralization of control over pavements, provided the area of asphalt pavements warrants a plant for repair work. No less important, however, are the repair gangs for the granite, brick and macadam pavements.

It is only within the last few years that the engineer has been finding out that city labor, properly handled, is far superior to that obtained through contracts. Ease in administration requires a municipal force for repair work as mobility cannot be obtained through any other than city forces. In addition to this fact, it might be well to add that results obtained recently in various cities show a substantial saving by reason of the abandonment of contracts for repair work, and the substitution of city labor.

Too much emphasis cannot be placed upon the importance of centralizing the control over the pavements right in the highway bureau itself—and the larger the municipality, the more important it is that all street repairs be made by municipal forces. In any event, even though the organization is not equipped to handle the work, all contracts for repairs to cuts should be made directly with the city and not with the public service corporations. The most efficient and economic method of handling repairs, however, is by municipal forces.

After planning and working out a highway organization adequate for the requirements of the municipality, the first and most important step toward efficiency and economy in carrying out the work is the establishment of unit cost records, covering all classes of work carried on under the bureau. The basic principle of these records is simply to bring out by comparison the weak and strong points of the organization, which will act as a guide in planning and conducting the work in an efficient and economical manner. Comparisons of different subdivisions of one function of the organization may be made one with the other, or comparisons of like functions in different organizations, all of which tends to improve the methods of carrying on the work, impresses the men with their responsibility and at the same time arouses the sense of pride they should have in their work. Unit cost records are simply a modern system of records designed to raise the standard of efficiency and economy in conducting work. All maintenance work should be initiated through job orders issued from the main office, with the exception of emergency repairs, which work should be controlled through a job order issued by the superintendent or engineer in charge, a carbon copy of which should be transmitted to the main office. The foreman should be supplied with a force account and daily report sheets, through which labor hours, foreman's time, team time, and material used could be charged under their respective job order numbers and each day transmitted to the main office where the unit cost records would be compiled.

The accompanying chart illustrates a proposed organization of a bureau of highways which embraces construction and maintenance of highways, street cleaning, collection of garbage, maintenance of bridges and maintenance of sewers in a municipality, with a population of about 1,600,000 and 1,500 miles of streets and roads to care for, of which 1,000 miles are paved with first-class pavements, 300 miles with water bound and bituminous macadam and 200 miles of dirt road. It is assumed, of course, that all street repair work and bridge and sewer maintenance, as far as is practicable, will be done by municipal labor, and all original construction and repaving by contract.

The organization, it will be observed, is divided into five main divisions, which in turn are subdivided in accordance with the requirements of the functions of the respective divisions. A chief clerk is in charge of the clerical force, which embraces auditing and accounting, permits and license division, stenographers and clerks purchasing supplies, etc. The maintenance of bridges and sewers is under the direction of an assistant engineer, and is subdivided into two divisions, maintenance of bridges and maintenance of sewers. All minor repairs to bridges and sewers are made by municipal labor, more extensive repairs by contract. Sewer cleaning, of course, is done by municipal labor.

The supervision of all regulating and grading of streets, construction and maintenance of pavements and street cleaning is divided into two main divisions, each under the direction of an assistant engineer. Both of these divisions are subdivided into three districts, each under the direction of a district engineer. Each district has nine patrol inspectors, whose duty it is to report and measure all defects in pavements, plumbers' cuts, corporation cuts, and report encumbrances, answer complaints, etc., and supervise the street cleaning and collection of garbage, which have been assumed to be under contract in the organization under discussion. It is strongly recommended, however, that this work be performed by the municipality itself, as it is the only logical way to properly control it. It will also be observed that each district engineer has under his jurisdiction seven foremen, laborers, vehicles, carts, etc., assistant engineer, stenographer, storekeeper and corporation yard.

The number of patrol inspectors, assistant engineers, foremen, laborers, etc., may vary somewhat, depending upon the requirements of the respective districts, but the total number is approximately correct for the municipality at large.

Construction inspectors are assigned to each district as occasion requires by the assistant engineers of construction and maintenance. The other main division comprises the office force in charge of plans, specifications and contracts, the asphalt plant, and the division of subsurface structures, and is under the direction of an assistant engineer. The division of subsurface structures is a most important division, and the rules and regulations governing the placing of subsurface structures in the street, after a pavement has been laid, cannot be too strict. This is one of the most serious problems confronting the municipal engineer, and indications point to its not being under proper control in any municipality in this country. The only real solution of the problem would seem to be underground pipe galleries. The evil, however, can be minimized by exercising a more thorough control over the corporations by insisting on a strict compliance with rules and regulations designed to permit of as little disturbance as possible to pavements after being laid.

A testing laboratory has not been mentioned, as it is assumed that the municipality would have a laboratory equipped to handle the work of all the city departments.

The primary considerations in making up the accompanying chart were to illustrate a practical scheme for carrying on the work of an organization, such as referred to in this paper, by subdividing the responsibility for the work in such a manner that the chief engineer will not be swamped with detail, but at the same time will be in such close touch with all the work under his jurisdiction that he can intelligently direct and thoroughly control the operations of the bureau.

The organization under discussion has been used as an illustration in this paper, as it is one with which the writer is familiar, but is not presented as an ideal municipal highway organization—the object simply being to illustrate the essential features that must necessarily be considered in order to successfully control a municipal highway organization. The fundamental principles under discussion, however, would apply to any like organization; any deviations would simply be of minor detail.

A copy of the Queen's Engineering Works Magazine, published by W. H. Allen, Son & Company, of Bedford, England, has been received by The Canadian Engineer. This magazine is published primarily to keep their old pupils and apprentices in touch with this firm. and contains many articles of interest to them. We have been requested to call the attention of those interested through these columns.

ENGINEERS' LIBRARY

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

BOOK REVIEWS:

BOOK REVIEWS.

Design and Construction of Steam Turbines.—By H. M. Martin, London. 372 pages; cloth; 7½ x 11 in. Longmans, Green & Co. Price, $6.00 net.

Reviewed by R. W. Angus, B.A.Sc.*

This addition to a fairly long list of books on this very important subject is written especially for engineers who have had sufficient training in thermodynamics and mathematics to understand moderately difficult theory. As it contains a good deal of descriptive matter, however, and a large number of dimensioned drawings, it should prove helpful to the less skilled reader. The author states that the theory contained in the book is based on articles contributed by him to "Engineering" (London), the illustrations and descriptive matter being also largely from the same periodical.

The first chapter is brief, and is designed to give an idea of the action of a turbine, and to explain in a very elementary way the different types of wheels in use, these types being illustrated by water turbines. The chapter is too short to be of much help to anyone not having a pretty general knowledge of the subject, and the author might, with advantage, have elaborated his explanation somewhat.

The next chapter deals with the flow of steam through blades and nozzles, and proceeds at once to compute the velocity of steam from nozzles and the work done during various forms of expansion. The Mollier diagram is introduced and used as far as possible in the calculations, the author assuming that the reader understands the theory of the diagram, although this is explained in a later chapter. This important diagram deserves a place in any such treatise, and the value of the book is enhanced by explaining the use of Mollier's diagram and giving a copy of it for use.

Chapter III. describes a number of experiments made on nozzles and blades, showing somewhat the effect of the shape of the nozzle. The book then deals in the following chapter with the impulse turbine, illustrating with the turbine of Dr. Laval. The velocity triangles are drawn, and a method explained of finding the "indicated work done" on the turbine shaft by which the author means the turbine output plus the mechanical friction. This is then used to determine the efficiency of the wheel itself, and the whole is illustrated by a numerical example.

A table is given of a series of tests on impulse wheels to determine the wheel efficiency. The chapter concludes with a discussion on shock and proper velocities in the bucket.

In Chapter V. there is a discussion of the term efficiency ratio, or the ratio of the theoretical to the actual steam consumption, and the reasons for adopting multi-stage expansion, together with the resulting losses. The method of proportioning the turbine is merely suggested. In the following chapter a very interesting set of curves is given, which enable the designer to infer the results which he will obtain on a given turbine from the results of tests made on a similar turbine under different conditions, these curves enabling one to reduce any set of observations to corresponding results under a different set of conditions.

The actual design of the impulse turbine is dealt with by the author in two steps, the first dealing with the general proportioning of the parts and the determination of the probable steam consumption, etc., while the second step deals with the dimensions of the blading. The method of procedure is altogether too complicated to be discussed in this review. In general it may be stated that the limitations of the work have forced the author to assume formulas without proof, to which, however, fair exception could scarcely be taken. A chapter has been devoted to velocity compounded impulse wheels.

A number of chapters have next been devoted to reaction turbines and their design, which have been treated with a fair degree of completeness, and some difficult problems in this part of the subject are dealt with. Numerical examples have been given in certain places, and there are many useful tables and practical coefficients.

Following a chapter on the radial flow turbine, the author has given a considerable amount of theory and explanation of the thermodynamic principles involved in the turbine design, dealing also with the Mollier diagram, which has been used in earlier parts of the work.

Having treated the design from the thermodynamic standpoint, the author devotes a number of chapters to the mechanical details, there being a chapter on each of the following: Balancing, Dummy and Gland Packings, High-speed Bearings, the Strength of Rotating Discs, Geared Turbines, and the Condenser, this part occupying a fair proportion of the whole work. One could not expect the most complete treatment of these matters in a book of the size under discussion, and yet the treatment is fairly complete. For example, in the part dealing with dummy and gland packings various designs have been sketched and the method of calculating the probable leakage discussed in detail. Some dimensioned drawings have also been given.

The latter third of the book is almost entirely descriptive, and gives details of all the principal turbines, such as the A. E. G., Curtis, Rateau, Zoelly, Parsons, etc., most of the descriptions being accompanied by detail drawings

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with many dimensions, thus making them of considerable value as guides to the designer.

The book, on the whole, is well gotten up, its make-up being much better than is found in general in engineering books, but it is rather unfortunate that it has not been made into a more portable form. The large pages, heavy paper, well-spaced lines and good margins are attractive, but tend to make a book rather heavy and unwieldy, as in the present case.

The engineer who is well versed in his theory should find the book a real addition to the literature on this subject; other readers will have to confine their attention largely to the descriptive parts.

American Civil Engineers' Pocket Book. Published by John Wiley and Sons, New York. Canadian agents, Renouf Publishing Company, Montreal. Second edition, enlarged. Morocco, 1,483 pages, 500 tables, 1,200 cuts, 16 mo. Price, $5 net.

This pocket book, which has now appeared in the second edition, and of which Mr. Mansfield Merriman is editor-in-chief, has been very well received by the engineering profession.

Two new sections have been added to this second edition: Section 14, setting forth those fundamental principles and facts of Steam and Electrical Engineering, which are of especial importance to civil engineers, and Section 15, giving the most recent practice in the construction and maintenance of highways and streets. Eight new pages have been added to the chapter on Earthwork Computations. Section 3, which formerly treated of roads and railroads, has been revised, and is now entirely devoted to Steam and Electric Railroads, seven new pages being added. Many other changes throughout the book are noted, to correct ambiguities, supply deficiencies, and bring the subjects up-to-date.

The index has been revised and entirely reset, and the preface states that all known errors, typographic and otherwise, have been corrected, and that alterations and corrections have been on more than one-fourth of the pages of the first edition. Necessarily, in the first edition, this book, which is the compilation of so many different authors, contained a number of errors. A list of these errors has been prepared, and a copy will be sent to any purchaser of the first edition who forwards his address for that purpose.

This issue contains 23 articles, 43 tables and 18 cuts more than the former edition. The volume in its enlarged form will certainly be most useful to the members of the profession and everyone who is at all interested in engineering should possess a copy.

A Manual of Cement Testing. By Richards and North. Published by D. Van Nostrand Company, New York. Cloth, 137 pages. Price, $1.50 net.

Reviewed by P. Gillespie, B.A.Sc.*

This little volume is intended for the guidance of analysts and inspecting engineers, and gives in small compass, the methods in general use of making physical and chemical examinations of Portland and other cements. No attempt to elaborate any special theory or to leave the beaten path has been made. An examination of the text gives one the impression that precision of statement and literary accuracy have not received the attention that they should receive in the preparation of a text book. Clay for example, is defined as a "more or less plastic substance composed chiefly of aluminium silicate formed by the decomposition of minerals"; limestone is said to be "a substance formed where clay has been deposited with a calcareous matter." Elsewhere we are told that "samples should be taken more often," and that "tests often do not check closer than 10 per cent." On page 41, one observes that "compression tests are not used as standard tests for the reception of a cement," and that "the form and size of the specimen most generally used are two inch cubes. . . ."

Within the covers of the little book, notwithstanding, is found much information on the appliances for and methods of cement examination. The appendix consists of a reprint of the standard specifications for Portland cement of the American Society for Testing Materials, 1909, and the methods of analysis of raw materials, cements, etc., suggested by the Society for Chemical Industry. The book, as a handy and compact guide to routine work, possesses some value.

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Manufacture of Iron and Steel.—By H. R. Pearson, M. I. Mech. E., Kiangnan Arsenal, Shanghai, China. Published by E. & F. N. Spon, Limited, 57 Haymarket, London. Cloth; size, 6 x 9 in.; 104 pages; 21 illustrations. Price, $1.15.

This book seems to have for its object the giving of an outline of the principal operations connected with the manufacture of iron and steel. It is put in an interesting way for all, and is designated a hand-book for engineering students, merchants and users of iron and steel. This about correctly infers what one would expect to find in the book. It is not highly technical, but where technical expressions are used and necessary, they are often not explained till several pages further on in this book. For an untechnical man to properly read and understand the book it ought to be read through twice, the first time to obtain a general idea of contents, and then more carefully. It contains thirteen comparatively short chapters, with numerous little cuts and tables, as follows:—

Chapter.		Page.
I.	Chemical Elements in Iron and Steel	1
II.	Iron Ores	6
III.	The Blast Furnace	9
IV.	The Manufacture of Wrought Iron	22
V.	The Manufacture of Steel	27
VI.	The Siemens-Martin or Open-hearth Process	38
VII.	The Basic Open-hearth Process	50
VIII.	The Acid Bessemer Process	58
IX.	The Basic Bessemer Process	66
X.	The Treatment of Steel Ingots	76
XI.	Effects of Adding Other Metals to Steel	85
XII.	Mechanical Testing of Steel	88
XIII.	Heat Treatment of Steel	97
	Index	102

This book ought to be of interest to all who, in a general way, are interested in the manufacture of iron and steel, and of value to students or others starting work in steel plants and desiring to quickly understand the practical work going on around them.

The New Building Estimator. By William Arthur. Published by the David Williams Company, 231-241 West 39th Street, New York. Flexible leather. Size, 4½ x 7 inches, 712 pages. Price, $3 net.

This book on estimating, first published in 1904, has now reached the eleventh edition. It is, without question, the best book of its kind to be obtained to-day covering the necessary data for the calculation of the cost of building construction. The subject matter is taken up both in detail and approximately. The value of this double arrangement lies in its giving the appraiser or estimator—who has to give quick and approximate figures—the information desired, while the detail section provides figures covering quantity of material and the labor required, in carefully checked and prepared form.

In this present edition, all prices have been corrected, and about 250 pages of new matter covering reinforced concrete, measurement of building work, comparative costs, sprinkler systems, valuations, railroad figures, grain elevators, square foot costs, cost of wood trusses, equipment of buildings, apartment houses, etc. The style of binding has been much improved by the use of gilt-edged flexible leather in place of the previous stained edges and cloth covers.

In every way this book on estimating can be recommended both to the engineer and the architect. Certainly no engineer should be without a copy for ready reference.

Book of Standards. Published by the National Tube Company, Pittsburg, Pa.; 1913 edition. Pages. 559. Size, 4 x 6½ ins. Price, $2.

The 1913 edition of the Book of Standards has just been received from the press. The present edition, which is the first since the 1902 edition, is much larger and more complete than the older one. It is printed on Canterbury Bible paper, the book, including the binding being not quite five-eighths of an inch thick and will fit the pocket readily.

The information incorporated has made it strictly a pipe handbook, and as such, it is believed, will find an immense use with the trade. The index of the book will be found to be very complete, all headings being thoroughly cross indexed. There are approximately 4,000 references found in the index. Several pages are devoted to a descriptive article covering the main process of manufacturing both welded and seamless tubes, also giving information in regard to the threading, durability and physical properties, etc., of both "National" pipe and Shelby seamless steel tubes. There are a number of pages which give weights, dimensions, threads per inch, test pressure, sections of joints, specifications, ets., of the various kinds of pipe and tubing made.

An article on Protective Coating, Matheson Joint Pipe, and Converse Joint Pipe contains desirable information on these subjects. Tubular electric line poles receive considerable attention, the information given will help an engineer in understanding more about tubular poles which are being used by many of the larger cities as a medium for better service, better appearance, etc. Various types of joints are described and illustrated. Full tabular information is given for poles from 22 to 40 feet, showing lengths of sections, size of butt, weight, thickness, greatest load pole will carry, etc. Several pages describe, illustrate and contain tables in regard to lapweld and seamless tubes, upset and expanded, wrought pipe bends, butted and strapped joints, bump joints, valves and fittings, including various kinds of nipples and flanges, band railings and ladders, working barrels, cylinders, Shelby seamless specialties, Shelby seamless cold drawn trolley poles, tables of various physical properties of Shelby seamless steel tubes, physical properties of carbonic acid gas, Briggs' Standard, holding power of boiler tubes, thermal expansion of iron and steel tubes.

Considerable prominence is given to articles on strength of tubes and cylinders under internal fluid pressure and collapsing pressures. Both of these papers are very complete and have been extracted from papers by Prof. R. T. Stewart, Dean of Mech. Engr. Dept., University of Pittsburg, and read by him before the A.S.M.E. Several of the formulae are compared and results of actual tests are given. Tables are given which show the probable collapsing and bursting strengths of standard tubes. These articles and tables will prove of immense benefit to the mechanical engineer, especially in the connection with boiler engineering problems. An article covering pipe used as columns is given, tables are supplied showing the use of standard, extra strong, and double extra strong pipe based on the New York Building Code as well as the Chicago Building Ordinances.

Considerable attention is given to the mechanical properties of solid and tubular beams, of usual and unusual shapes. As tubing is finding considerable usage in the mechanical field, notably in automobile construction, this data is particularly useful. This article is accompanied by tables giving the mechanical properties of solid and tubular beams of uniform cross section, various conditions of loading are illustrated and formulas are shown to secure their physical properties values. Unusual shapes are illustrated and formulae given to secure their properties as beams or columns.

An article on safety factors and safe working stresses is given which shows through what ranges values should be used for safe operation. Chapters are supplied giving information in regard to water, gas, steam and air. It has not been the intention to go very deeply into these various subjects, only in so far as they concern tubular products. Perhaps the scope of these articles is best shown by giving a list of some of the headings, information in regard to which is given in detail:

Water.—Properties, Boiler Incrustation and Corrosion, Flow in Pipes, Measurement of Flowing Water, Water Power, Tables.

Gas.—Physical Properties of Cases, Flow of Gas in Pipes at both High and Low Pressure.

Steam.—Properties, Superheated Steam, Flow of Steam, Loss of Heat from Steam Pipes.

Air.—Properties, Expansion, Compression, Flow of Air.

A large collection of tables in conjunction with explanatory articles is given; an idea of the extent of which can be secured from the following list:—Fifth roots and fifth power; decimals of a foot for each 1-64 of an inch; decimals of an inch for each 1-64; wire and sheet metal gauges in approximate decimals of an inch.

Proportions of screw threads, nuts and bolt heads, illustrated explanatory article accompanied by tables showing dimensions of screw threads, nuts and bolts. Several pages are devoted to area and weight factors for tubes and pipes by means of which it is readily possible to figure the area and weight of various kinds of tubing. A special table is shown by means of which it is possible to find directly the weights of nearly all sizes and thickness of steel tubing up to 36 inches in diameter. By means of factors weights of various other metallic tubing can be found. A table showing properties of tubes and round bars is given with an explanatory article. This table gives various physical properties, including circumference, area, weight, surface in square feet, volume, moment of inertia, radius of gyration, etc., for tubes and round bars up to and including 36 inches. This data is given in increments of .01 inches up to 16 inches and increases from there by ⅛ inch increments to 36 inches.

The metric system is included with conversion methods for most of the more commonly used measures, including temperatures. A glossary of terms used in the pipe and fittings trade will be found in the back of the book, and in many instances the meanings of many of the more or less well-known words used in this trade are defined.

Practical Mathematics for the Engineer and Electrician.—By Elmer E. Burns and J. G. Branch, B.S., M.E., Member of the Board of Engineers for the city of St. Louis, Member of the American Society of Mechanical Engineers. 8 x 5½ in.; cloth; 143 pages. Price, $1.00. The J. G. Branch Publishing Co., Chicago.

The authors assume that the reader knows little of mathematics, and the book is chiefly intended for the operating engineer and electrician. Those engineers and electricians who have never had the advantage of a college education will not find it written above their heads. It is also of value to those who have had a mathematical training on account of the practical way in which the subjects are treated. Apparently, it has been the aim of the authors to write it in simple, elementary and clear language, and to confine it to subjects of especial value to all practical workmen. The subjects treated cover a wide scope, but no subject treated requires knowledge of any preceding subject or any previous knowledge of mathematics. A person fully understanding all the subjects treated will pretty well have all the mathematics that is required to make him a first-class operating engineer or electrical worker. Practical questions with answers worked out are given. There is no list of contents to the book, merely an alphabetical index of the subjects treated.

PUBLICATIONS RECEIVED.

Bureau of Mines.—Twenty-first annual report for the year 1912. Printed by the Legislative Assembly of Ontario. 300 pages; five sheet maps accompanying the report; 17 sketch maps and plans; 130 illustrations. Contents: Statistical Review; Mining Accidents; Gold Fields of Lake-of-the-Woods, Manitou and Dryden; Porcupine Gold Area; Water Powers in the Porcupine Gold Area; Swastika Gold Area; Cripple Creek Gold Area; West Shining Tree Gold Area; Notes on McArthur Township; Geology of the Detroit River.

Barge Canal Bulletin.—January, 1913. Published by the Department of the State Engineer of State of New York. 40 pages. Contents: Progress of Contract Work; Progress of Plans being Prepared; Plans before Canal Board; Contracts Advertised; Bids Opened; Award of Contracts; Annual Report of State Engineer and Surveyor, first part.

Report of the Department of Trade and Commerce. For the year ending March 31st, 1912. Contains miscellaneous information on bounties, lumber, and staple products, revenue and expenditure of Department of Trade and Commerce, statistical record of the progress of Canada, tonnage table, etc. Department of Trade and Commerce, Ottawa.

Application for the Revision of the Toronto Building By-law.—A memorial presented to the Mayor, Board of Control, and City Architect of Toronto by a general committee of citizens representing various technical and business organizations of the city of Toronto. C. R. Young, 318 Continental Life Building, Toronto.

Bulletin of the Imperial Institute.—A Quarterly Record of Progress in Tropical Agriculture and Industries and the Commercial Utilization of the Natural Resources of the Colonies and India. Edited by the Director and prepared by the Scientific and Technical Staff of the Imperial Institute and by other contributors.

Engineering Problems Connected with Biological Sewage Disposal.—By T. Aird Murray. Part of a Symposium on Biological Sewage Disposal, Canadian Public Health Association, Annual Meeting, November 21st to 23rd, 1911. The Canadian Engineer, 62 Church Street, Toronto.

Roofs and Their Coverings. By Clough Williams-Ellis. Being the paper on Welsh slates. Re-printed by permission from "The Architect and Contract Reporter." Published by Spottiswoode and Co., Ltd., London, Colchester and Eton. Price, six cents.

Public Service Commission. Report of the Commissioners, Vol. 1, 1912. Comprises report on government dredging, report on the Department of Public Printing of Stationery, and special report on Temiskaming dam contract, Sorel shipyard and dismissal of R. E. Cook.

Weekly Report, Department of Trade and Commerce, Ottawa.—Bulletin No. 473, February 17th, 1913. Pages 183 to 205. Contents: Australia, Trinidad, Great Britain, Panama Canal, Canadian Produce Prices in England, British Agricultural Produce Imports, Grain Statistics, Trade Inquiries.

Methods of To-day on (1) Swimming Bath Water Purification, (2) "Overground" Conveniences, (3) "Vacuum" Exhausters, (4) Dry Closets, (5) Fly-proof Privies.—By James S. Dunn, Sanitary Department, Town Hall, Kimberley, S.A.

Water Supply of San Francisco. Report by H. M. Chittenden. A well illustrated cloth-bound book, 11½ x 9 in.; 44 pages. Secretary, Department of the Interior, Washington, D.C. This is a very beautifully gotten up report.

Hydro-Electric Power Commission. Third and Fourth Annual Report of the Province of Ontario for the year ended October 31st, 1911. The Hydro-Electric Power Commission of Ontario, Continental Life Building, Toronto.

Coal Mine Accidents in the United States. Monthly statement, January to August, 1912, and Statistics for 1910-11. Compiled by Fredk. W. Horton. Bureau of Mines, Department of the Interior, Washington, D.C.

Influence of Icebergs on Land on the Temperature of the Sea. By H. T. Barnes, B.Sc. Being supplement of the 45th Annual Report of the Department of Marine and Fisheries for the year 1911-12, Ottawa.

Cement Process of Excluding Water from Wells, as practised in California.—By Ralph Arnold and V. R. Garfias. Bureau of Mines, Department of the Interior, Technical Paper No. 32, Washington, D.C.

Engineering Experiment Station.—Bulletin No. 29, the Iowa State College of Agriculture and Mechanic Arts, on Cost of Producing Power in Iowa with Iowa Coals. By H. W. Wagner, Ames, Iowa.

Practical Kinks, Recipes and Tables. Collected by Joseph G. Branch. Published by the Joseph G. Branch Publishing Co., 608 Dearborn St., Chicago, Ill. Cloth; 5½ x 7½ in.; 143 pages. Price, $1.

Railway Statistics of the Dominion of Canada for the year ending June 30th, 1912. (From sworn returns furnished by the several railroad companies.) Department of Railways and Canals, Ottawa.

Questions With Answers on Pumps and Pumping Machinery. By W. H. Wakeman. Published by the Joseph G. Branch Publishing Co., Chicago, Ill. Cloth; 5½ x 7½ in.; 190 pages. Price, $1.50.

Alternating Currents Simplified. By E. E. Burns. Published by The Joseph G. Branch Publishing Co., 608 South Dearborn St., Chicago, Ill. Cloth; 5½ x 7 in.; 199 pages. Price, $1.50.

Treatise on Scientific Methods of Concrete Construction, Using Lock Steel Form.—By the Hotchkiss Lock Metal Form Company. Sixteen pages, with an attached sheet of about twenty cuts.

The Resources of Tennessee.—Magazine devoted to the description, conservation and development of the resources of Tennessee. Published by the State Geological Survey. Nashville, Tenn.

The Production of Copper, Gold, Lead, Nickel, Silver, Zinc and other Metals in Canada During the Year 1911. By C. T. Cartwright, B.Sc. Mines Branch, Department of Mines, Ottawa.

Obligations of the United States as to Panama Canal Toll.—By Hon. E. Root, of New York, in the Senate of the United States. Address The Congressional Record, Washington, D.C.

Proceedings of Ontario Association of Architects.—Being transactions of the Special General Meeting and twenty-third Annual Convention. 96 King Street West, Toronto.

Facts About Treating Railroad Ties.—By W. F. Goltra. Twenty-four pages on the Essentials for Effective Work in Timber Treating. W. F. Goltra Tie Company, Cleveland, Ohio.

Report of the Minister of Public Works for the Province of Manitoba, for the year ending December 31st, 1911. Department of Public Works, Parliament Buildings, Winnipeg, Man.

Index to the Weekly Report.—Published by the Department of Trade and Commerce, Ottawa, for the year ending December 31st, 1912. Weekly reports number 414 to 466.

Report of the Minister of Public Works for the Province of Ontario, for the year ending October 31st, 1911. Department of Public Works, Parliament Buildings, Toronto, Ont.

The Iowa Engineer.—Published by Students of Engineering, Iowa State College; $1.00 per year. Published monthly. Forty pages. Iowa State College, Ames, Iowa.

Report of the Sixth Annual Convention of the Western Irrigation Society, held at Kelowna, B.C., August, 1912. Forestry Branch, Department of the Interior, Ottawa.

Annual Report of the Board of Regents of the Smithsonian Institute, for the year ending June 30th, 1912. The Secretary, Smithsonian Institute, Washington, D.C.

Report of the Director of Forestry, for the Year 1912. Being Part 6, Annual Report, Department of the Interior. Issued by the Department of the Interior, Ottawa.

Preliminary Review and Estimate of the Mineral Productions of British Columbia, for the year 1912. Bureau of Mines, Parliament Buildings, Victoria, B.C.

Ice Cold Storage (on the Farm).—Bulletin No. 207. The Ontario Department of Agriculture, Parliament Buildings, Toronto. Fifty pages, with illustrations.

Castings.—Published monthly. A reference for buyers of foundry equipment and supplies. The Gardner Printing Co., Caxton Building, Cleveland, Ohio.

Journal of the American Peat Society.—Devoted to the development of American peat resources. Secretary, Julius Bordollo, Kingsbridge, New York City.

Report with Reference to Civic Administration and City Development, of the City of Prince Albert, Sask.—By E. A. James, B.A.Sc., and T. Aird Murray.

Telegraph Statistics, Dominion of Canada.—For the year ending June 30th, 1912. A. W. Campbell, Department of Railways and Canals, Ottawa.

Queen's Engineering Works Magazine.—Published by W. H. Allen, Son & Co., Limited, at the Queen's Engineering Works, Bedford, England.

Commercial Review Showing the Export Trade from Port of Montreal of Canadian Products in 1912.—The Gazette, Montreal, Canada.

Annual Report of the Directory of Forestry, for the year 1912. 270 pages. Department of the Interior, Parliament Buildings, Ottawa.

Training with Mine-Rescue Breathing Apparatus. By J. W. Paul. Bureau of Mines, Department of the Interior, Washington, D.C.

Chemical Properties of Western Larch.—By W. A. Ross, Department of Agriculture, Forest Service, Washington, D.C.

Board of Governors' Report of the University of Toronto, for the year ending June, 1912. Parliament Buildings, Toronto.

Mine Fires and How to Fight Them. By James W. Paul. Bureau of Mines, Department of the Interior, Washington, D.C.

Accidents from Falls of Roof and Coal. By G. S. Rice. Bureau of Mines, Department of the Interior, Washington, D.C.

Annual Report of the City Engineer of Port Arthur for the year 1912. Twenty pages. L. M. Jones, City Engineer.

Estimates for the Fiscal Year ending March 31st, 1913. Department of Finance, Parliament Buildings, Ottawa.

Chemical Properties of Western Hemlock.—Department of Agriculture, Forest Service, Washington, D.C.

Bulletin No. 62, of the University of Illinois, on the Electron Theory of Magnetism, Urbana, Illinois.

Mine Rescue Work in Canada.—By W. Dick, M.Sc., Commission of Conservation, Ottawa.

CATALOGUES RECEIVED.

D. VanNostrand Company, 23 Murray Street, New York, forward the following four catalogues and books: Catalogue of scientific books, recently issued and in preparation; catalogue list of books on Producer Gas and Gas, Gasoline and Oil Engines; catalogue of a list of books on Scientific Management, Efficiency and Allied Subjects; catalogue of scientific books published between December, 1909, and October, 1911.

Induction Motors.—Engineering Works of Canada, Limited, New Birks Building, Montreal, P.Q., operating under the patents of "Société Alsacienne Des Constructions Mécaniques," forward Catalogue No. 1, of 15 pages, on two and three-phase induction motors.

Dynamos.—From 200 to 15,000 horse-power, under construction in the shops of Belfort, by the Société Alsacienne de Constructions Mécaniques. Representatives in Canada, Engineering Works of Canada, Limited, New Birks Building, Montreal.

Switchboard Indicating Instruments. — The Northern Electric and Manufacturing Company, Montreal and Toronto, forward a catalogue announcement re Weston Alternating Current Switchboard Instruments. Write for Catalogue 16.

Catalogue of central stations installed by the Société Alsacienne de Constructions Mécaniques, Belfort, for mines and metallurgical plants. Canadian Rrepresentatives, Engineering Works of Canada, Limited, New Birks Building, Montreal.

Catalogue of book.—Title, Internal Combustion Engine, a handbook for designers and builders of gas and oil engines. By Hugo Güldner. 700 pages; 728 illustrations. D. VanNostrand Company, publishers, New York.

"Bitumastic" Enamel.—Wailes, Dove & Co., Limited, 5 St. Nicholas' Buildings, Newcastle-on-Tyne, agents, Montreal, Toronto and Vancouver, forward an 18-page little catalogue.

Portmadoc Slates.—Festiniog Slate Quarries Association, Portmadoc, North Wales, forward a 15-page catalogue and pamphlet on slates.

Lentz Engine.—Catalogue from the Erie City Iron Works, Erie, Pa. A Poppet valve engine under patent.

Blacksmithing and Drop-forging.—Tait, Jones & Co., Pittsburg, Pa., forward a 16-page catalogue.

COAST TO COAST.

Regina, Sask.—The Emerson-Brantarghain Implement Company, of Minneapolis, who are represented here by Tudhope-Anderson Co., recently shipped forty-five car loads of tractors here. This is claimed to be a record for the shipment of a single commodity, as the value may be seen from the fact that the freightage cost $7,145.

Ottawa, Ont.—The Canada Cement Company, the Canadian merger, threatens that the fullest advantage of conditions will be taken to obtain the highest prices possible for cement during periods of restricted supply, so that later it will be able to accumulate reserve to meet the importations from the United States at slaughter prices if the government re-enact the duty remission of fifty per cent. enforced from July 1st to October 31st, last year.

Winnipeg, Man.—The Grain Growers' Grain Company have purchased timber limits near Fort George, British Columbia, comprising about 300,000,000 feet of lumber, at a price of about $1.50 per 1,000 feet. It is said to be the intention of the Grain Growers to hold this as a reserve supply with the idea of establishing lumber yards at different points in the province for the purpose of supplying farmers and settlers with lumber at reasonable prices.

Ottawa, Ont.—Sustained growth and stability in Canadian trade are indicated by the figures recently published. The customs returns approximated $106,000,000, against $83,906,706 during 1911. Adding to this excise duties for the year amounting to about $31,000,000, the grand total is $137,000,000. The statistics for the year show that the total trade of Canada with other countries from January 1 to December 31, 1912, amounted approximately to a billion dollars, the imports being $650,000,000 and the exports $350,000,000. The total trade during the previous twelve months amounted to $828,614,120, the imports being $524,850,792 and the exports $303,763,328.

Toronto, Ont.—The new provincial boiler regulations have received their final approval, so that after July 1st every boiler manufactured in Ontario, apart from railway and steamer boilers, which are covered by separate legislation, must be made along standard lines and stand a thorough inspection, not only on completion, but during construction.

Ottawa, Ont.—Jas. Stewart & Company, one of the oldest contracting firms in the country, has been incorporated under the same name with a total capitalization of $3,750,000. It was formed in Ottawa in 1845 by Jas. Stewart, a native of Aberdeenshire, Scotland, and in 1865 moved its headquarters to St. Louis. It has district offices in Montreal, Chicago, Pittsburg, Salt Lake City and New Orleans. The new company's principal offices will be in New York, where they have $20,000,000 worth of business booked at present.

Before the conference committee of the Board of Trade of the city of Toronto last Thursday Mr. Lionel H. Clarke and Mr. E. A. James, chairman of and consulting engineer, respectively, to the York County Board of Highway Commissioners, presented some interesting phases of the work the commission has already done and is still doing. Mr. Clarke treated the subject of good roads from a general viewpoint, while Mr. James went more particularly into details, and outlined what had been accomplished, and spoke of some of the plans for the future. Following the address the meeting was thrown open, and Messrs. Gundy, Hewitt, Ellis and several others took part. Before the meeting adjourned a resolution was moved and carried unanimously, as a result of which the Board of Trade will continue its efforts to have legislation brought about which will result in the continuance of the good work already begun.

The old-established firm of Hyde & Webster, builders' and foundry supplies, of Montreal, which firm has gone out of existence, have acquired the still older established business of Messrs. F. Hyde & Company, 31 Wellington Street, Montreal, and under the name of Webster & Sons propose to continue same business in all its branches.

PERSONAL.

MR. A. W. ROGER WILKY, C.E., for the past eight years on the engineering staff of the Island branch of the Canadian Pacific Railway, has been appointed engineer-in-charge of all construction work of the Department of Marine and Fisheries for the province of British Columbia.

MR. MORRIS L. COOKE, director, Department of Public Works, Philadelphia, Pa., on February 18th, delivered a lecture on "Scientific Management as Applied to Highway Engineering," before the graduate students in Highway Engineering at Columbia University.

MR. VIRGIL G. BOGUE, M.Am.Soc.C.E., former chief engineer of the Western Pacific Railway, has recently been engaged in an economic study of line improvement and double-tracking of the Canadian Pacific Railway through the Selkirk and Rocky Mountains in British Columbia.

WILLIAM McGIE YOUNG, B.Sc., Associate Member Canadian Society of Civil Engineers, graduate in mechanical engineering of McGill University in 1899, is leaving Ottawa to accept the position of comptroller of water rights in the Department of Lands of the province of British Columbia. Mr. Young was formerly chief engineer of the International Marine Signal Company, and has been recently practising as a consulting engineer, giving special attention to efficiency engineering, factory management and production.

HARRY WEBB has resigned his position with the city of Winnipeg to take up a position with the Canadian Mineral Rubber Company, Limited, as local manager, to succeed Mr. F. G. Pusey, resigned. Mr. Webb was in charge of the several paving plants operated by the city for five years, and during the last three years has been superintendent of all paving work in Winnipeg.

MR. W. W. COLPITTS, M.Am.Soc.C.E., a graduate in civil engineering of McGill University, class of 1899, and for three years associated with the Canadian Pacific Railway, has resigned his position of chief engineer of the Kansas City, Mexico and Orient City Railway to become associated with W. H. Coverdale & Co., of New York City. He is being retained by his former company as consulting engineer.

OBITUARY.

SIR WILLIAM ARROL, the most noted of British bridge builders, died on February 20 in London, Eng. He received his Knighthood in 1896, and was born in Ayrshire in 1839. He constructed the present Tay bridge and the Forth bridge. From 1895 to 1906 he represented Ayrshire in the Commons. He was a Unionist.

The Ontario Good Roads Association is holding its eleventh annual meeting at the Exhibition Buildings, Toronto, on February 26th, 27th and 28th of this month. Further notes of this meeting and the papers read will appear in next week's issue.

ONTARIO LAND SURVEYORS.

The following gentlemen received certification to practice as Ontario land surveyors at the recent examinations,—J. R. Gill, F. J. K. Benner, E. Cavell, R. F. Dynes, D. S. Ellis, S. E. Flood, C. W. G. Gibson, J. B. Hellferth, E. G. MacKay, D. A. Niven, G. L. Ramsey, W. R. White.

The following gentlemen have passed the preliminary examination:—K. Campbell, F. L. Moore, J. R. Scott, W. M. Stone, C. R. Yates.

COMING MEETINGS.

THE CLAY PRODUCTS EXPOSITION.—To be held in the Coliseum Chicago, Feb. 26th to Mar. 8th.

AMERICAN INSTITUTE OF CONSULTING ENGINEERS.—A meeting for the purpose of further discussing "Professional Relations," will be held at the Engineers' Club, 32 West 40th St., New York City, Tuesday evening, 8 p.m., March 11, 1913. Secretary, Eugene W. Stern, 103 Park Ave., New York City.

THE CLEVELAND ENGINEERING SOCIETY.—Regular meeting, Chamber of Commerce Bldg., March 11th, 1913, Illustrated Paper on "Storage Batteries," by H. H. Smith, Chief of Research Dept., Edison Storage Battery Co., Orange, N. J. Secretary, David Gaehr.

ILLINOIS WATER SUPPLY ASSOCIATION.—The Fifth Annual Meeting of the Association will be held at the University of Illinois, Campaign-Urbana, Ill., March 11th and 12th, 1913. Secretary, Edward Bartow.

NATIONAL PAVING BRICK MANUFACTURERS' ASSOCIATION.—Annual Meeting will be held March, 3, 4 and 5, 1913, in the Green Room, Congress Hotel and Annex, Chicago, Ill. Secretary, Will P. Blair.

CANADIAN MINING INSTITUTE.—Annual Meeting will be held at Chateau Laurier, Ottawa, March 5th, 6th and 7th. H. Mortimer Lamb, Windsor Hotel, Montreal, Secretary.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, T. S. Young, 220 King Street W., Toronto.

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

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

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

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

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

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

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson, Address: 422 Pacific Building, Vancouver, B.C.

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

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

MUNICIPAL ASSOCIATIONS

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

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

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

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

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

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

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

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

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

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

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

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

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

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

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

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

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

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

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

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

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

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor, Secretary-Treasurer, Hamilton, Ont.

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

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

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

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

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

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

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

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

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

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

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

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

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

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

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

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

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

MANITOBA ASSOCIATION OF ARCHITECTS.—P ident, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

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

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

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

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

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

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

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

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

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

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

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

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

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.