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SASKATCHEWAN RIVER IN MANITOBA

ITS TRIBUTE TO THE AVAILABLE POWER RESOURCES OF THE PROVINCE, AS REPORTED BY THE WATER POWER BRANCH, DEPARTMENT OF THE INTERIOR, TO THE PUBLIC UTILITIES COMMISSION.

THE Saskatchewan River enters Manitoba from the west, crossing the boundary between Saskatchewan and Manitoba almost directly opposite the north end of Lake Winnipeg. It enters the lake some 50 miles south of the lake's northerly end.

The area drained by the Saskatchewan River is in extent approximately 155,000 square miles, comprising a great portion of the western plains. The headwaters lie in the Rocky Mountains, and the drainage, though collected by many tributaries, is carried across the prairies by two large rivers known as the North and South Saskatchewan. The north branch heads in the Rockies west of Edmonton, while the southern branch heads in the same mountain range approximately on a line west of Medicine Hat. Intermediate between these two branches is situated the Red Deer River, a stream of almost as great an extent as the southern branch which it joins. The distance between the two rivers gradually diminishes with a consequent contraction of the drainage until about 30 miles below Prince Albert the junction of the north and south branches occurs. From the junction to Lake Winnipeg the flow is mostly confined to a single bed although in places it is divided into main and secondary channels, as at the Sepannock Channel, due to the generally flat and low-lying nature of the country, and to the consequent ease with which the river can and does at times change its bed. In Manitoba the river flows through a low-lying region in which occurs innumerable lakes and swamps. Great portions of the surrounding land are subject to floods during periods of high water. In the vicinity of Lake Winnipeg the river enters Cedar Lake and discharges from this lake into Crodd Lake, the Demi Charge Rapids occurring in this

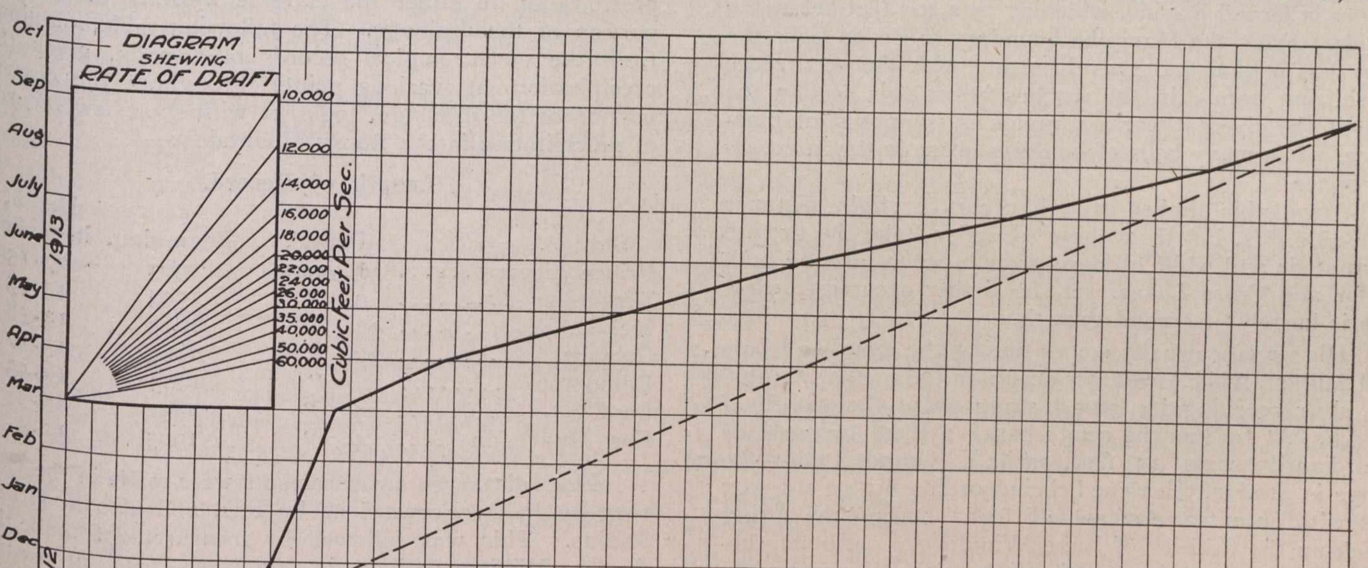

Fig. 1.—Mass Curve of Estimated Run-off, Saskatchewan River.

portion of the river. From Cross Lake to Lake Winnipeg a series of rapids occur comprising the Cross Lake rapids, Bed Rock Rapids and Grand Rapids.

Nature of the River and Banks.—In the vicinity of Le Pas, the banks range from 15 to 25 feet in height, but they become gradually lower as Cedar Lake is approached. The shores of this latter lake, as also the banks in the stretch of river to Cross Lake are rocky. From Cross Lake to the mouth of the river outcroppings of limestone occur at the water's edge. At Cross Lake Rapids this outcrop reaches a height of from 2 to 6 feet. In the vicinity of Red Rock Rapids the right bank is composed of limestone of some 6 feet in height, while the left shows no rock outcrops, being composed of clay and of some 12 feet in height. From Red Rock Rapids to Grand Rapids the banks, which are of clay, gradually become higher. At the latter rapids limestone is again encountered, rising in some places 30 feet above river level. A high ridge of lightly colored boulder clay overlying limestone rises to a height of some 60 feet about the mid point of Grand Rapids. This ridge which forms the barrier between Cedar Lake and Lake Winnipegosis crosses the Saskatchewan about three miles above the mouth. Near the foot of Grand Rapids a gully, which was probably as one time an overflow channel, sweeps inland from the left bank and returns to the main river a mile further down.

The river in Manitoba has an average width of about 1,000 feet; a minimum width of approximately 500 feet occurs in Grand Rapids, widening to 2,400 feet below the rapids. From the Manitoba boundary to Cedar Lake the river has a mud and gravel bottom with the occurrence of shifting bars. In the reaches below this section the bed of the river at various rapids is composed of limestone, while many beds of boulders occur in the intervening space.

A valuable timber growth occurs a slight distance above Le Pas, but from there to Cedar Lake the growth is stunted; and while a dense growth occurs around both Cedar and Cross Lakes, yet the timber occurring below this is largely of second growth.

High water usually comes during the months of July and August, while low water occurs in the winter months, the river reaching its lowest stage about the month of March. At Le Pas the range between these two periods is ordinarily some 15 feet, while at Grand Rapids the range is gradually lessened, being ordinarily from 4 to 5 feet with an extreme of some 6 feet. During the spring break-up the field ice of Lake Winnipeg occasionally becomes jammed at the mouth of the river, damming the outlet and causing a rise at the lake of from 12 to 15 feet.

The Saskatchewan is navigable above Grand Rapids, the Hudson's Bay Co. having at one period run steamers as far upstream as Edmonton. The river at present is navigated by gasoline launches from Le Pas to Cedar Lake. It is accessible by railroad at Le Pas and also by steamer at the mouth.

With the exception of Le Pas, no settlements of any size occur in the lower reaches of the river. A Hudson's Bay post is situated at Cedar Lake and a small settlement occurs at Grand Rapids.

Surveys of the River.—In 1884, Dr. Otto Klotz made a traverse of the river. The late R. E. Young made a survey of the settlement in the year 1903 and continued his traverse to the head of Grand Rapids, obtaining at the same time a profile of the portage. In 1909 a reconnaissance survey of the river was made from Le Pas to Lake Winnipeg by E. A. Forward, of the Public Works Department. The investigations made by the Water Power Branch of the Department of the Interior comprise a reconnaissance power survey by the late William Ogilvie in the year 1911, and in the following year a detailed survey of Grand Rapids and vicinity from Lake Winnipeg to Cross Lake. This latter survey was carried out by E. B. Patterson in charge of a field party of the Manitoba Power Survey. At the same time, a gauging station was established at Grand Rapids and discharge measurements were then and have since been obtained at this station.

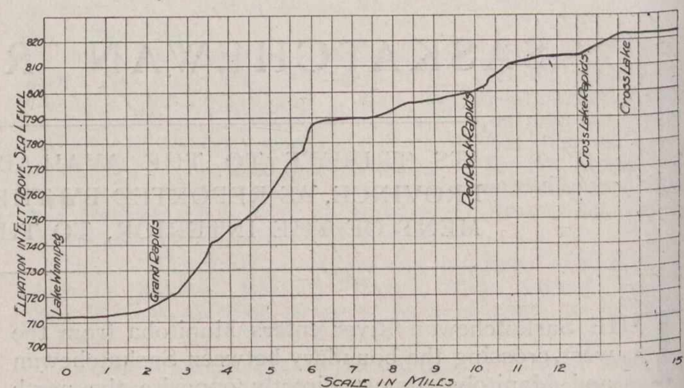

Fig. 2.—Profile of Saskatchewan River from Lake Winnipeg to Cross Lake.

Run-off.—No complete records are available for the precipitation in either the extreme western or eastern portion of the drainage. The following table, obtained from the meteorological records of Canada, gives the precipitation at various points throughout the central portion of the drainage, together with some few records of precipitation in the Rocky Mountains:—

Length of Record.

Station.	Period.	Beginning.	Depth, in inches.
Prince Albert	9 years	1903	17.13
Saskatoon	9 "	1904	14.45
McLeod	22 "	1884	12.58
Calgary	27 "	1885	15.17
Edmonton	28 "	1883	16.43
Banff	19 "	1891	20.3
Fort Dunvegan	4 "	1905	11.5

Float discharge measurements were made in the year 1909 by E. A. Forward at Le Pas, and also at Grand Rapids. This was followed by measurement made by the late William Ogilvie in the year 1911 at Grand Rapids. On August 8th, 1912, a gauging station was established at Grand Rapids by the Manitoba Hydrographic Survey, and on October 21st of the same year, a second station was established at Le Pas. It is estimated that for the year 1913, a low flow of 5,000 second-feet occurred during the month of February at Le Pas, and while several lakes and a great area of low-lying, swampy land occurs between this point and Grand Rapids which should give some regulation of the flow at the latter point, yet it has been assumed that a minimum flow of 5,000 second-feet also occurred at Grand Rapids. During July of 1913 a flood discharge of approximately 64,000 second-feet was recorded at Le Pas.

Storage Possibilities.—Three lakes are situated in the lower portion of the river system immediately above Grand Rapids; through two of these lakes—Ceder and Cross Lakes—the river flows, while Moose Lake is a tributary to the north. The combined area of these three lakes is estimated to be 970 square miles, being made up as follows: Cross Lake, 39; Cedar Lake, 425, and Moose Lake, 513 square miles. While there might be a possibility of storage on these lakes, investigations are at present being made as to the reclamation of low lands in the vicinity of Cedar Lake through the lowering of the latter, which if carried out would forestall storage possibilities. Investigation is also being made as to the storage possibilities in the headwaters of the Saskatchewan River.

Making the assumption that the flow of the winter months from October 1st, 1913, to April 1st, 1914, would be similar to the same period during 1912-1913, mean curve studies (See Fig. 1) show that a storage of 305 billions of cubic feet would be necessary for a uniform flow of 32,000 second-feet. A 1-foot storage on Cross, Cedar and Moose Lakes would give approximately 27 billion cubic feet, indicating that a storage slightly over 10 feet would be necessary to create a uniform flow for a period similar to that found year ending September 30th, 1913.

Water Power.—An estimate of the power available at the three rapids, as indicated in Fig. 2, is given below. The power available has been based on a 80% efficiency and is also computed, 1st, for an estimated minimum flow of 5,000 second-feet, and 2nd, for a flow of 34,000 second-feet, this being the lowest monthly mean flow for the 6 highest months of the year ending September 30th, 1913, and extending from April to September, and the power as indicated refers only to this period.

No estimate has been made as to the additional power available during periods of low flow through any storage system:—

Estimated Horse-power on 80% Efficiency.

Possible power site.	Head in ft.	Minimum flow 5,000 sec.-ft.	Period 6 mos., April-Sept. 34,000 sec.-ft.
Demi Charge ..	15	6,808 h.p.	46,289 h.p.
Red Rock	15	6,808 h.p.	46,289 h.p.
Grand Rapids ..	80	36,305 h.p.	246,877 h.p.

Mayor Curley of Boston is advocating the consideration of the erection of a municipal asphalt and bitulithic paving plant, pointing out the significance of the fact that the Central Construction Company, which recently installed a plant for paving work, was the lowest bidder on work recently advertised by 10 per cent., bidding against one of the largest firms in the world.

In co-operation with Connecticut's plan for developing New London as an ocean port the United States War Department on January 19th recommended to Congress a channel 33 feet deep at mean low water and 600 feet wide, at an estimated cost of $330,000. The department recommended a first appropriation of $170,000 and a second of $160,000 to complete the work in two years, conditioned upon assurances that the State will carry out its terminal plans, for which it has already appropriated $1,000,000.

It has been reported at Buffalo that the Legislature proposes making an appropriation of $30,000 to cover the expense of a commission of 15 citizens who shall be known as the Peace Centenary Commission. The idea of the commission is to get up a plan for proper celebration of the 100 years' peace between the United States and other countries, barring Mexico. The project contemplated is the erection of a bridge which will connect Fort Erie and the Canadian border that shall be sufficiently large to accommodate the great traffic certain to use it.

THE DETERMINATION OF THE MAGNETIC DECLINATION, DIP AND TOTAL FORCE IN WESTERN CANADA.

Although the compass is not used in running lines on Dominion land surveys, it is a valuable accessory, especially in unexplored parts of the country. Where no line of definite bearing is available, it may be used advantageously as a finder of Polaris in daylight observations for azimuth. To accomplish this, however, a knowledge of the local magnetic declination is necessary; in other words, one must know within a reasonable degree of accuracy the angular interval between magnetic north and astronomic north.

The Topographical Surveys Branch, Department of the Interior published, in conjunction with the latest report of the Surveyor-General of Dominion Lands, a description of the determination of the magnetic declination, dip and total force in Western Canada, written by D. E. Chartrand, B.Sc., and reproduced in part as follows:—

The accurate determination of the magnetic elements in western Canada dates as far back as the year 1842, when Lieut. J. H. Lefroy, under the direction of the Royal Society, made a magnetic survey of that portion of the country. Magnetic observations were taken in the year 1887 by the Topographical Surveys Branch, but nothing further to any extent was done by it until 1908, when its Dominion land surveyors were instructed to observe the magnetic declination during the course of their surveys.

An isogonic map, on a very small scale, was published in 1904, chiefly from data obtained from Lefroy's survey and the 1887 observations of this Branch. Some information along the international boundary and around the Great Lakes was obtained from the United States Coast and Geodetic Survey.

In 1911 an isogonic map, on a very small scale, of that portion of Canada south of the 54th parallel of latitude was prepared and published in two sections, one for eastern Canada and the other for the western provinces. The declinations used for the western section were derived from the observations of this Branch. The sources of information for the compilation of the eastern section were: the Director of the Meteorological Service at Toronto, the British Admiralty charts, and the United States Coast and Geodetic Survey.

Area Covered.—As the survey operations under this Branch are confined entirely to the lands under the control of the Dominion government, the stations occupied since 1908 are limited to the provinces of Manitoba, Saskatchewan, Alberta and British Columbia. The districts where meridian, base line and subdivision surveys have been in operation since that date have been dotted with stations for the magnetic declination. A special effort has been made to gather magnetic data from the settled districts by means of travelling parties employed on miscellaneous surveys. These surveys generally cover a wide stretch of country and provide the only means now at our disposal of observing the magnetic elements in the settled parts of western Canada.

Compass Used for Declination.—The determination of the magnetic declination is made by means of a trough compass attached to the standards of the transit theodolite used on the Dominion land surveys. The needle is made as light as possible in order to reduce friction on the pivot to a minimum. The graduation of the end blocks consists of a single fine line, and readings are made on both ends of the needle. The range of readings of a first-class needle, well balanced, and in the hands of a competent observer, can be expected not to exceed two minutes. The original method of attaching the compass to the standards consisted of a hook at one end and a thumb-screw at the other, but as this was not always found to be satisfactory, the hook was discarded, and the compass attached by thumb-screws at both ends.

Method of Observing.—The method adopted for the determination of the magnetic meridian is given in Appendix C of the Manual of Instructions for the Survey of Dominion Lands. The observer is instructed to proceed as follows and to note the following remarks:—

1. Place the instrument on a section line and after adjustment set the vernier to read the astronomical bearing of the line.

2. Release the lower clamp, direct the telescope on the line and fasten the lower clamp.

3. Release the vernier clamp and turn the vernier plate until the north end of the magnetic needle, observed with a magnifying glass, is seen exactly opposite the zero mark. Tap the trough lightly with the pencil or hit the milled parts of the foot-screws with the finger nail to be sure that the needle has taken the position of rest. Note the reading of the horizontal circle. Take several readings by repeating the operation.

4. Repeat operation No. 3 for the south end of the needle.

5. Enter in the notes the place of observation, date, hour of the day, weather and other remarks, if any. It is important to record auroras occurring within 24 hours of the time of observation.

The observations should be taken only when the needle is nearly stationary, say, in the afternoon after 5 p.m. if possible.

In taking the needle out of the trough, whether to rebalance it or to clean the agate, care should be taken to see that it is put back in its proper position. If replaced in the reverse position the index correction would be altered. For this reason, to safeguard against error, the position of the compass, whether "compass west" or "compass east," should be entered in the remarks after each observation when observing.

The returns should also state whether the observations are recorded in the mean time of the place or standard time.

The direction of the magnetic needle is subject to a daily fluctuation called the diurnal variation. During the greater part of the night the direction is not far from normal. In the early morning the north end of the needle in Canada moves towards the east, reaching its maximum deflection about 7 or 8 a.m. The motion is then reversed, the north end travelling westward and crossing the normal direction about 10 or 11 a.m. The extreme western position is reached in the afternoon, and then the needle comes back to its normal position at some time after 5 or 6 p.m. This march is subject to wide variations during magnetic storms. The magnitude of the diurnal variation is not constant. Observations at both eastern and western elongations of the needle on the same day, that is, between 7 and 8 a.m. and between 1 and 2 p.m., give the best results, and it is desirable that when convenient they may be taken then. This gives not only the best value for the declination, but also the diurnal variation, which it is very useful to know. Failing this, however, the best time to observe is after 5 p.m., when the needle is about in its normal position. It is true that the normal position is crossed generally between 10 and 11 a.m., but, the motion being very rapid and the time of crossing uncertain, the afternoon observation is preferable.

The place of observation must be at least three or four hundred yards away from wires carrying direct electric current. There must be no iron near the instrument. The observer must make sure that he has no iron or nickel on his person. If any magnetic object is not brought closer to the needle than fifteen or twenty times the distance at which an appreciable deflection is first produced, the effect on the needle is negligible in observations of this kind. Avoid transportation of the instrument on electric cars, as there are instances of the polarity of the needle being reversed in such an intense magnetic field.

If the needle is sluggish the observation cannot be accurate. The sluggishness is generally due to a dull pivot or a scratched cap. To keep both in proper condition the needle must always be lowered gently on its pivot and never be allowed to play except when actually in use.

Instrument Constant.—Through the courtesy of the Director of the Meteorological Service at Toronto, the index correction of every instrument used for observing was determined both at the beginning and at the close of the survey season, whenever possible. If a serious discrepancy was found between the two determinations, it was investigated and the observations taken with the instrument rejected unless the cause of the discrepancy could be satisfactorily explained.

Reduction of Observations.—In order to give a character of homogeneity to the declination observations, a reduction to a common epoch had to be applied to the observed data. To accomplish this a knowledge of the diurnal and secular variation is necessary. Again, as the diurnal variation is subject to extreme fluctuations, magnetic storms must be detected. The only method at our disposal for reduction was making use of the daily records of the declinometer at Agincourt, but the observatory being far away from where our observations had been taken, it was thought advisable to compare by actual experiments the fluctuations of the compass in western Canada and those at Agincourt. An observer was instructed to observe the magnetic declination at Rosthern, Sask., during the whole of November, 1910. Rosthern was chosen on account of being advantageously situated as a base station. The observations were taken from 7 a.m. to 4 p.m. at periods ranging from half an hour to one hour, care being taken to observe the needle at its two elongations. The work was carried out in a small silk tent in order to shelter the instrument from the influence of the wind and storms.

A comparison of the results of these observations with a diurnal variation observation taken at Jasmin, Sask., on July 10th, 1910, disclosed a diurnal range of the compass in July almost double of that at Rosthern in November.

Later, in the office, copies of the photographic traces of the declinometer at Agincourt were made for the days on which diurnal variation observations had been taken in the western provinces. On these copies were plotted the diurnal variation observations taken in the West so as to correspond in mean local time to the traces of the declinometer, and the points were joined by straight lines. From this investigation useful information was derived for the reduction of our magnetic declinations. According to our expectations, mostly all magnetic disturbances shown on the traces of the declinometer were recorded on the diurnal variation curve, and both occurred at practically the same instant.

In applying reductions the observations have been reduced to the mean of the month of the year in which they were taken. This was done in the following way:

A tabulation of the mean monthly declinations of each year was obtained from the magnetic observatory at Agincourt. The declination, for the corresponding date and mean local time at which the observation to be reduced was taken, was scaled from the trace of the declinometer at Agincourt. If the trace showed the declination then fairly steady, the difference between the mean declination of the month and the actual declination scaled from the trace was applied as a correction to the observation.

To reduce an observation to January of the same year, the difference between the mean declination of the month in which the observation was taken and the mean declination of January was applied to the observation reduced to the mean of the month.

In the absence of any definite knowledge of the secular variation a plus correction of three minutes per year, which agrees closely with the mean secular variation of the corresponding western portion of the United States as shown on the isogonic map of the United States Coast and Geodetic Survey, published in 1905, was adopted for the reduction of our declination observations to January 1st, 1912. From the few stations in the West which have been reoccupied this would appear to be a close approximation, and the maximum error from this general assumption cannot be large, as the period for reduction covers only three years.

Dip and Total Force.—During the season 1908 dip and total force observations were taken by Mr. J. E. Morrier, D.L.S., at Norway House, Oxford House, Fort Churchill and York Factory.

In 1910 similar observations were taken by Mr. C. Engler, D.L.S., during his trip from Athabaska Landing to Fort Smith, and subsequently by Mr. J. A. Cote at different points between Edmonton and Calgary. Unfortunately the results of these observations were lost during a fire at Carstairs, Alberta.

During the miscellaneous surveys made by Mr. P. A. Carson, D.L.S., in 1910, about 24 stations were occupied for dip and total intensity, between Swan River, Man., and Lashburn, Sask. Every complete observation consisted of a dip, a total force and a dip, the mean dip being used in working out the total force. This complete observation was generally duplicated at every station. In some instances the same station was reoccupied during the season and the results compared with those already obtained.

The instruments used for the determination of these magnetic elements were Dover dip circles, the constants of which were determined both before and after every season's work. The total force constant was the mean of at least six observations.

The following are the directions for the use of the dip circle and attachments in observing for magnetic declination, dip and total force.

The conditions to be satisfied in choosing a magnetic station are freedom from present and probable future local disturbance, combined with convenience of access. Proximity of electric railways, masses of iron or steel, gas or water pipes, buildings of stone or brick, should be avoided. A quarter of a mile from the first, 500 feet from the second, 200 feet from the third and fourth may be considered safe distances. The station should be at least 50 feet from any kind of building. If any doubt arises in the selection of a station on account of the possible existence of local disturbances, two intervisible points a hundred yards or more apart should be selected and the magnetic bearing of the line joining them observed at both. A lack of agreement between the two results is evidence of local disturbance.

When taking the observations, the instrument box, especially the bar magnets, should be 40 or 50 feet away for the declination observation and 25 or 30 feet for the dip and total force observations. All knives, etc., should be removed from the person. It should be noted also that iron is frequently present in buttons, hats, neckties, etc.

Care should be taken to keep the instrument in good adjustment, clean and free from dust. A camel hair brush, pith, chamois and tissue paper are supplied for that purpose.

The dipping needles should be carefully guarded against moisture, and after use should always be wiped dry with chamois or tissue paper. They should be put back in the box with poles of opposite polarity at the same end and should be magnetized afresh for each station.

The bar magnets should be touched with the hands as little as possible and should always be wiped with chamois or tissue paper after the observation to prevent rusting. They should not be allowed to touch each other except at their opposite poles and, when placed in the box, the ends of opposite polarity should be connected by a soft iron armature.

The instrument is levelled in the ordinary way with the plate level.

The trough compass should be attached to the upper horizontal plate by means of the two thumb-screws and the telescope to the vernier arms of the vertical circle. The observation for magnetic declination is then taken and recorded in accordance with the instruments given for magnetic declination observations with the D.L.S. pattern transit.

The magnetic meridian may also be determined by means of the dipping needle. Set the vertical circle verniers to read 90° and revolve the instrument in azimuth until the needle is bisected by the microscopes and read the horizontal circle. As the dipping needle points vertically when in the magnetic prime vertical, in this way the magnetic prime vertical is found and by applying 90° the magnetic meridian.

The magnetic meridian found in this manner is sufficiently accurate, however, only for the dip and total force observations. The former method is preferable and should always be adopted when possible.

The needles for the dip observations are carried on the lid of the instrument box. Taking out one of these needles carefully wipe with tissue paper and clean the pivots with pith and having also carefully cleaned the agate planes in the box with pith, place the needle on the brass v's with the face of the needle to the face of the instrument. (The face of the needle is that side which is lettered, the face of the instrument that side which is graduated.) Turn the instrument in azimuth until it lies in the magnetic meridian (previously determined in the declination observation) and with its face to the east, and lower the needle gently on the agate planes. It will now swing in the approximate position of the dip. When it settles it ought to be slightly raised and lowered once or twice by means of the screw, so as to ensure its being exactly in the centre of the instrument. The vernier of the vertical circle is now turned until the north, that is the lower end, is seen to be bisected by the cross hair of the microscope; the lower vernier is then read. Similarly, the upper end is bisected by the upper microscope and the upper vernier read; the needle is then slightly disturbed by the screw and the readings repeated until there are three readings for each end. The instrument is now turned 180° in azimuth so that the face of the instrument is now west and the same number of readings taken for this position. The needle is then taken out of the glass box and reversed end for end of its axis, so that it faces the other way. The six readings are again taken as before for both ends of the needle.

The needle is then taken out of the box, and its polarity reversed in the following manner: Put the needle on the reversing block, face up and secure by the brass centre piece which is intended to protect the axis. Place the reversing block so that the north end of the needle will be on the right hand and the south end on the left. Now take the bar magnets one in each hand, the north pole of the magnet in the right hand lowermost and south pole of the magnet in the left hand, and bring the opposite poles of the two magnets down on the needle, near its centre and one on each side of the brass centre piece. Draw them slowly and steadily outwards over the needle, carrying them over its ends and lifting them some inches above the level of the needle, bring them back to the middle position again and repeat. This should be done five times. Care should be taken to have the motion as nearly parallel to the axis of the needle as possible; the ledge on each side of the reversing block is intended to act as a guide for the magnets to ensure this. The needle is then put face down in the reversing block and the operation repeated in the same way. The polarity of the needle will then be completely reversed.

The observations taken before reversal are now repeated. The mean of the observed inclinations in the eight positions is the dip.

It will be noticed that the mean resulting dip will, by the reversal of the dip circle, be free from any small error in the verticality of vertical axis and also eliminate index error of vertical circle; that the reversal of the face of the needle on the agates will eliminate the error caused by any want of perpendicularity of the axis of the needle to the needle; that the reversal of the polarity will correct for any want of balance of the two ends of the needle.

Total Force.—The total intensity may be determined with a dip circle by Lloyd's method when suitable standardization observations have been made at a station where the dip and intensity are known. This method involves first the determination of the angle of dip with a loaded needle, and second, a determination of the angle through which another needle is deflected by the loaded needle when the latter is placed at right angles to it in the place provided between the reading microscopes and protected by the brass shield. As the determination of total intensity by this method is relative, it is necessary to guard, as far as possible, against any change in the magnetism of the two needles and to use the same weight in the field as during the standardization observations. Their polarities must never be reversed, therefore, and they must not be allowed in close proximity to the bar magnets when these are being used to reverse the polarity of the regular dip needles. The needle which is weighted with the small wire is the loaded needle and is called the statical needle; the other is called the dipping needle. Neither of these needles must ever be touched with the bar magnets. Turn the instrument into the magnetic meridian with its face to the east. Revolve the vertical verniers until the tangent screw points to the north. By means of the small brass clips, attach the statical needle to the vernier plate with its face to the east and its north end next to the tangent screw and put the brass protecting shield in position over it. Place the dipping needle in the usual way on the agate planes, now, moving the vernier arms, read the inclination of the swinging needle as before, both north and south ends, then reverse the vertical vernier plate so that the tangent screw is south of the centre and read the inclination again. It should be noted here that the vertical circle is graduated into quadrants, from 0 to 90 degrees, and that these inclinations should always be read from the north zero, so that if in the former part of the observation, the north end of the dipping needle should be deflected by the statical needle past the vertical line, the reading to be entered is 180 degrees less the actual vernier reading, and, if in the latter part of the observation, the north end of the dipping needle be deflected above the horizontal, the vernier must be entered with a minus sign. The algebraic difference of the two readings is twice the deflection.

Frequency and Time of Observations.—The observations should be taken at least twice at each station whenever possible. Should the two observations not agree within 5 or 6 minutes a third observation should be taken. The most desirable time of day to observe is about the time of eastern and western extremes of declination, say, at 8 a.m. and 1 p.m., and it is suggested that when convenient these times be adopted.

Suitable forms for the observations are provided. The constant "A" used in the form is a constant for the two total force needles. That and the index correction to the compass have to be determined at the magnetic observatory at Agincourt.

Coal is produced commercially in only three of the numerous coal fields of British Columbia—namely, on Vancouver Island, in Nicola, and in the neighboring Similkameen district, and in the Crow's Nest section of southeast Kootenay. Production was adversely affected in 1913 by a strike of miners and other employees in Vancouver Island coal mines, so that the output of those mines was less by 596,000 long tons than in 1912. However, there was an increase at the other fields, so that the net gross production of coal—that is, of the quantity including coal made into coke—was about 450,000 tons less than the total for the previous year, the respective totals having been, for 1913, 2,576,071 tons of 2,240 lbs., and for 1912, 3,025,709 tons. The quantity of coal made into coke was 440,091 tons in 1913, as compared with 396,905 in 1912. The net production of coal disposed of as such was, in 1913, 2,125,980 tons, and in 1912 2,628,804. A summary of the production of coal in the several districts follows:

	Tons of 2,240 lbs.
Vancouver Island mines	962,620
Nicola and Similkameen mines	202,708
Southeast Kootenay	1,350,683
Total production (gross)	2,576,671

According to Consul Felix S. S. Johnson, Kingston, Ont. (United States Consular Report), the success of experimental work conducted by the Canadian Government in the manufacture of peat, has resulted in the fact that there are now two private concerns producing peat, one at Alfred, Ontario, and the other at Farnham, Quebec. The product is said to be satisfactory for use in grates and for cooking purposes. In connection with the new industry the Canadian Government will experiment with the production of gas and electrical energy from peat. At the fuel testing plant in Toronto a 60 horsepower gas producer engine is operated on gas from peat. If these experiments are successful, sections of the central peat-producing districts of Canada where water power is not available will be able to obtain power from a series of these gas-producer engines.

PAVEMENT WORK IN ST. JOHN, N.B.

DETAILS OF SPECIAL DESIGN AND CONSTRUCTION—ADAPTED RAIL SECTIONS, TRACK BASINS, ETC.—NOTES ON EQUIPMENT AND METHODS EMPLOYED.

THE following is a general description of pavements laid and paving methods employed in the City of St. John, N.B., during 1913.

At the outset of the season the Public Works Department had mapped out a programme of about 30,000 sq. yds. of pavement to be laid under the Local Improvement Act. When the time had arrived to call for tenders, however, the yardage was reduced to about 5,000 yds. This is accounted for by the fact that the owners of one-third of the total abutting frontage had the necessary power to petition and stop the laying of any pavement under the Act which provided that the abutters should pay one-half and the city the other half of the total cost of the pavement. It may here be stated that the present Commissioner of Public Works has had framed a new Act in which it is provided that sixty per cent. of the abutting frontage shall be necessary to stop the laying of any pavement. Even this Act does not give the city the necessary authority to force a single yard of pavement where it might be absolutely needed.

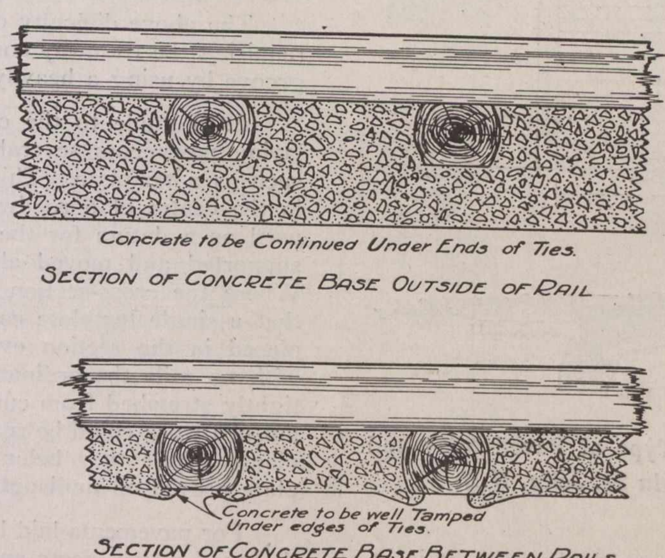

Fig. 1.—Sections of Concrete Base Adjacent to Rails.

With the small yardage above noted as being left it was decided that it would be useless to call for bids on sheet asphalt as recommended for these streets. So, a split was made and tenders asked for the concrete base, brick and granite track sections, there being local contractors in this line of work. It was decided the asphalt surface could be laid by city forces by day labor. Contracts were accordingly let for concrete and setts. Shortly afterwards some other streets asked for pavements, which brought the quantity up to approximately 12,000 yds. As these streets were all suitable for a smooth pavement, a 2-inch bitulithic surface was contracted for, and in one case both surface and base was laid by the contractors for this material.

The general design of pavement laid during the past year is about the same as that adopted in most places where bitulithic pavement has been laid. It will, therefore, not be necessary to elaborate upon the design with the exception of the few following points. In the specifications, Mr. G. N. Hatfield, the City Road Engineer, has defined the results to be obtained leaving as far as possible to the contractor the methods to be employed. At the present time there is no local contractor equipped with any modern street paving machinery except a concrete mixer. The only road rollers available are the property of the city, which are necessarily hired out to enable the local contractors to bid upon the work.

Perhaps the only real departure from the general line of construction has been performed in the track section of some of the streets paved. To this work the accompanying illustrations chiefly allude. The concrete, as shown in Fig. 1, is not carried continuously under the ties between the rails, the specifications calling for the ties to be thoroughly tamped with concrete. But from

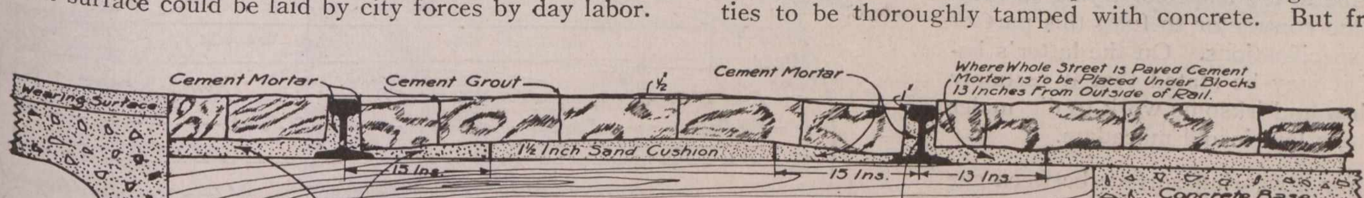

Fig. 2.—Detail of Rail Section for Granite Block Pavement.

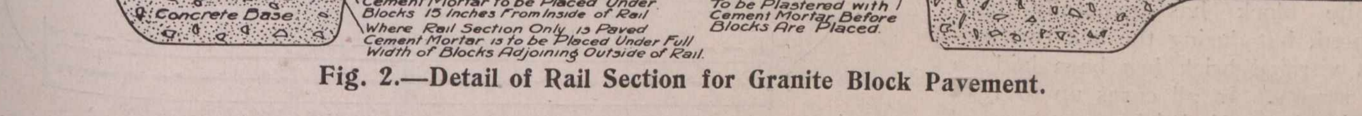

Fig. 3.—Detail of Rail Section for Vitrified Brick or Scoria Block Pavements.

the centre of rail to the outside end of ties the concrete is so placed that it is continuous under this section. In the opinion of the City Road Engineer the extra work and material is unnecessary between the rails if the ties are well supported under the rails and outside ends. Experience in railroading has shown that if all ties are well

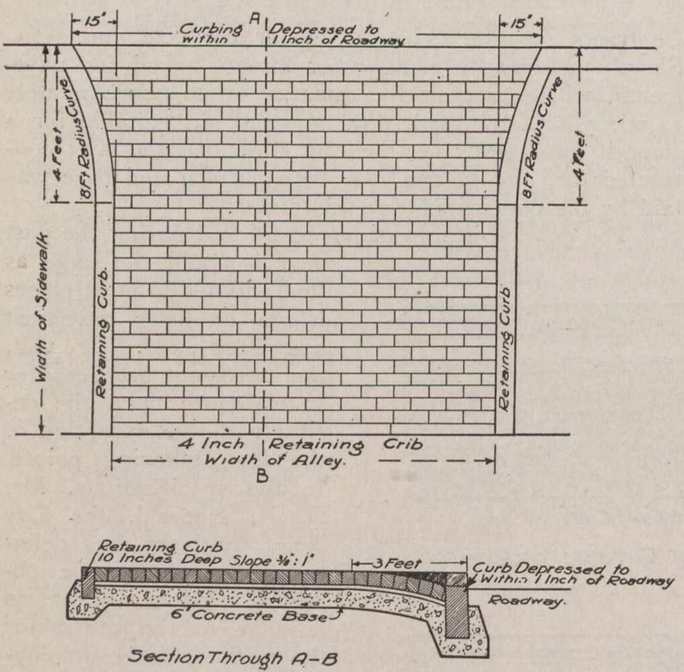

Fig. 4.—Plan and Section of Type of Paved Alley and Street Intersection Used in St. John, N.B.

tamped on the outside end and under the rails, it is inadvisable that they be extensively tamped between the rails. It has been noted on numerous occasions that railroad ties have snapped in the centre because too much attention had been given to the tamping of the section between rails. Moreover, it has been found that calling for continuous concrete under the ties has added twenty-five to thirty cents per sq. yd. to granite pavement. Again, it proves a continuous round of trouble to the inspector trying to compel the contractor to fulfil this part of the specifications. On the latter's behalf it may be stated that it certainly is slow and irksome work to dig under the ties laid in old macadam.

For a wearing surface between car rails and eighteen inches outside granite block has generally been adopted, but during the last two seasons vitrified brick has been laid on two streets. In all cases up to 1913 the blocks and bricks were paved flush with the top of rails, leaving a rectangular groove for the flange of car wheels. In both cases this method has proved rather unsatisfactory as the cement grout which was filled up to the ball of the rail has become badly rutted in places, and the vitrified bricks were soon badly spalled or broken, being unable to stand the blows of traffic in this exposed condition.

To overcome the difficulty where granite blocks were used the groove was formed as narrow as possible, which was found to be 1¼ in. This method is evidently an improvement, but from all indications will not prove entirely satisfactory. During last season's work in laying granite block the rectangular groove was abolished, and the blocks set in under the ball of the rail and crowned up at the centre to ½ in. above the top of rail, as shown in Fig. 2. The camber was made as acute as possible adjoining the rails, so that on the flat grades the track section would not have the appearance of being entirely flooded during wet weather. The water would be confined to a comparatively narrow section adjoining the rails. Where bricks have been employed specially grooved scoria blocks have been used adjoining the rails, as shown in Fig. 3. To date both of these methods have proven very satisfactory.

The above difficulty could otherwise be overcome by requiring the tramway companies to supply the necessary groove by using a heavily grooved rail.

As a guide to the contractors in excavating and laying pavements several methods have been employed, such as a template. This is used where track is placed in the centre of a roadway which was first graded and used as a datum for the template, the other end being supported and moved along the top of the curbing. Where the cross-section of the street was so irregular that a single template could not be used iron pins were placed in the section every twenty feet and in streets with no rails the ordinates were computed from a cord tightly stretched from curb to curb. By this method the finished work could be readily checked and errors, if any, placed where they belong. In the same way the template proved an undisputed judge.

For pavements laid by the city forces a template was designed which meets any case to which the formula for an eccentric crown is applicable. This is shown in Fig. 5. The section formed by this template is two straight slopes joined with a short vertical curve which might be much shorter. Such a section will tend to distribute traffic as the very centre will be the least pleasant to

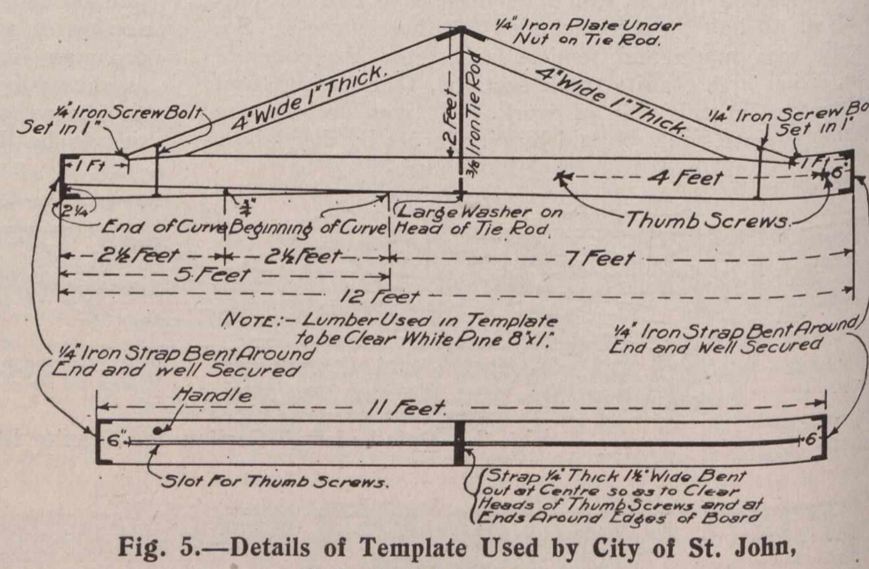

Fig. 5.—Details of Template Used by City of St. John, N.B., in Pavement Laying.

horses. On this template there is attached a small level which is set to a crown of one-fiftieth of the total width of the roadway, and also graduated to different crowns as far as possible. No doubt a metal frame could be employed to hold the bubble with an adjustable thumb screw for changing the height of crown. By means of this template the foreman can crown the street by working from the opposite curbs or gutters, and if either of these does not properly exist all that he requires are a few pegs along the centre line of crown. The template was changed, as noted above, it presented no handicap to the successful use of the basin.

From a study of the diagrammatical illustrations. it may appear to some that there is a greater surface of cover than conditions, considered with respect to expense, warrant. It is quite desirable, nevertheless, to

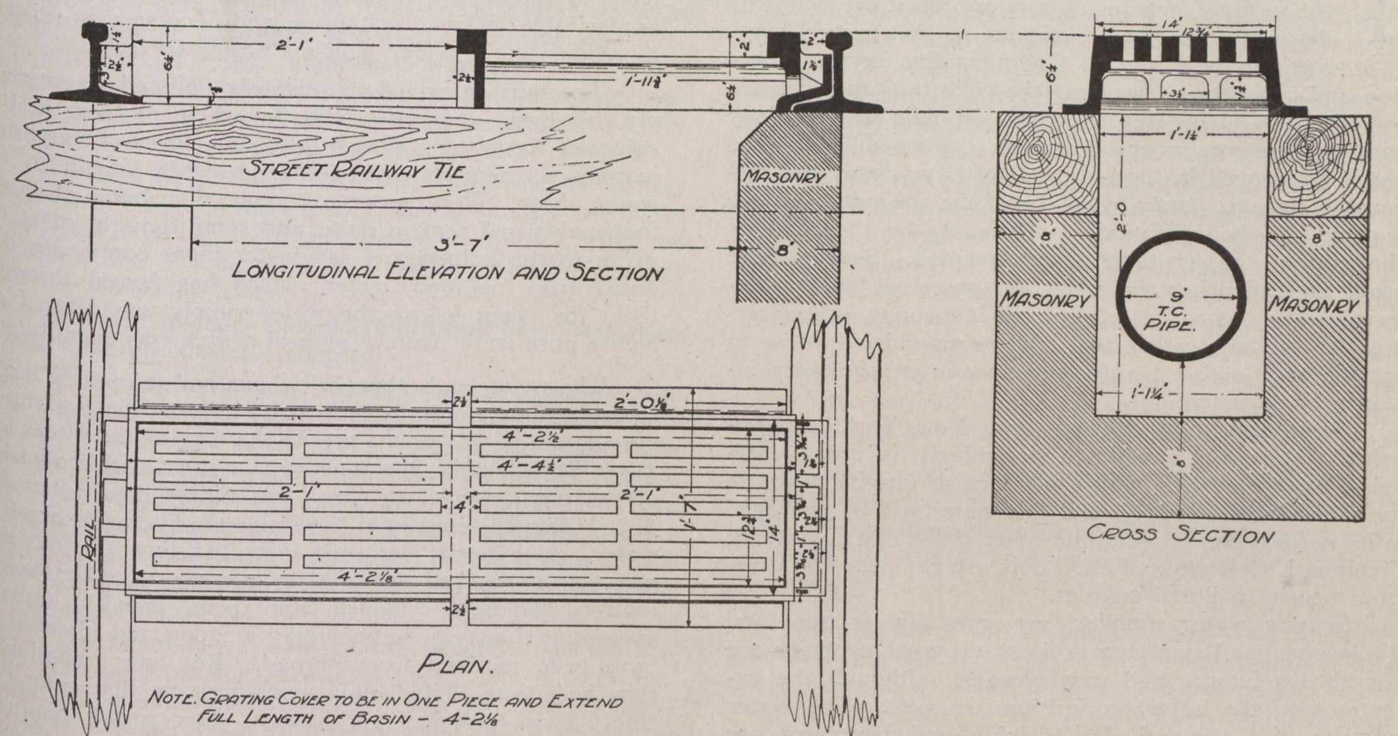

Fig. 6.—Plan and Sections of Track Basin, St. John, N.B.

is designed to meet the conditions of a medium crown, and when changed to suit others it is not absolutely correct from a theoretical standpoint. No appreciable error is involved, however, when so used in practice.

Fig. 6 illustrates a form of track basin designed last season. Several basins of this pattern have been placed

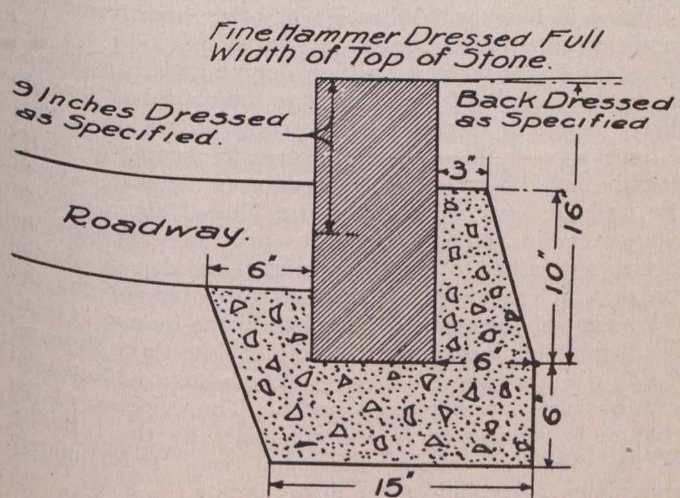

Fig. 7.—Details of Curb Setting.

and are proving very satisfactory. With little attention necessary, they take care of all water which runs along the groove provided for the car wheel flanges, as shown in Figs. 2 and 3. Although the style of track section

have a comparatively large pit to accommodate the silt and refuse which reaches it. Provision must also be made for easy cleaning. With these points in view it was decided to specify a cover of perforated iron. It can be readily lifted, and when winter thaws occasion

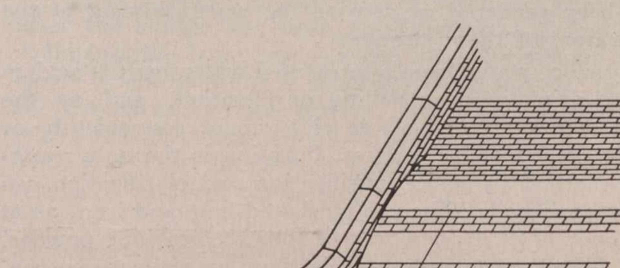

Fig. 8.—View Showing Setting of Bridge Stones at Street Corners.

excess of water with the trackway somewhat banked up with snow, these large gratings will readily take care of it.

The designs are those of Mr. G. N. Hatfield, City Road Engineer, to whom we are indebted for the above information and drawings.

THE PRESENT STATUS OF SANITARY ENGINEERING.*

By John W. Hill, C.E.,
President of the Ohio State Board of Health.

THE sanitation of cities is fast becoming an art, and the various features of sanitary work are being by degrees reduced to a science, so that certain steps can now be taken by a municipality for the collection and reduction of wastes—the collection and disposal of sewage—and for improvement of public water supply with positive assurance of success. Some difficulty has been experienced in the reduction of city wastes and disposal of sewage, partly by reason of the attempt to realize a profit on the operations and partly by the complex character of the substances to be handled. Setting aside profit and adopting the reduction processes to the materials to be destroyed or rendered innocuous, and allowing the sanitary rather than the commercial interest to prevail, satisfactory results can now in nearly every instance be expected.

Some cities, like Boston and New York, can impound water from unpolluted watersheds, in great reservoirs, at an elevation which will furnish gravity pressure for a low service supply, and this water will be purveyed in its natural condition, while other cities like Cleveland, Cincinnati, Chicago and St. Louis are compelled to draw from nearby polluted sources.

Gravity water supplies are not always pure and wholesome, and pumping sources of great capacity are not always impure and unwholesome, although the exceptions to the latter proposition are rare. The water supplies of Cincinnati, Philadelphia and Hamburg are obtained from seriously polluted sources, but by filtration the water is made safe for domestic use.

The Ohio River at Cincinnati, the Schuylkill and Delaware Rivers at Philadelphia and the Elbe River at Hamburg are badly sewage polluted streams at the intakes of these several waterworks. But by resorting to methods of purification which long time and broad experience have shown to be reliable, these polluted waters have been rendered as safe as the water flowing at the headwaters of these streams.

Surface water from unprotected watersheds is seldom safe to drink without boiling or filtration, and as the water supply of a whole city cannot conveniently or cheaply be boiled before use, filtration is the only recognized method by which purification and clarification can be accomplished. The use of slaked lime and iron, as at St. Louis, or of hypochlorite of soda or bleaching powder, as at Cleveland, cannot at this time lay claim to be considered as substitutes for filtration, although both are at times and under some conditions useful and valuable adjuncts of filtration. Free chlorine as applied at the Cincinnati filtration works, or chlorine gas as used at Wilmington and Delaware, and ozone as used at St. Petersburg, Russia, and on a small scale in some of the waterworks of Holland, are safeguards to doubtfully filtered waters, and are to be commended as aids to the broader and older methods of water purification.

The removal of all, or even of the pathogenic forms of bacteria from a polluted water by ozone or chlorine or by an electric current does not satisfy the requirements of modern sanitation. People will not drink dirty water, even if is certified as pure and safe, and filtration is the only recognized method capable of broad application, which will render a turbid water clear, safe and attractive. Filters of the slow sand or of the rapid type are capable when skilfully managed, of converting a polluted water into a safe drinking water, but the skilful management is not always forthcoming, so that some additional treatment to supplement filtration has come to be considered as desirable in some instances, and necessary in others, to render public water supplies absolutely safe.

The purification of a previously polluted water supply, however, does not solve the whole problem of the safety of the water as regards typhoid fever at least, nor perhaps as regards some other diseases known to be water borne. Pure water cannot be distributed through foul mains and remain pure, and some thought must be given to the influence of old water pipes containing deposits from polluted water which has flowed through them for years before the water supply was filtered or before pure water from a natural source was substituted.

The writer and others who have had to operate large city filtration works have sought information and have speculated on this point, and in the case of the filters for West Philadelphia, the typhoid statistics of that district of the city, seemed to show that ninety days after the distribution system began to receive the filtered Schuylkill water, all external evidence indicated that the old deposits were washed out of the pipes or that all noxious matters had been removed from them. Similar experience at various places, including London and Hamburg, have been received from abroad. But later experience elsewhere than Philadelphia, convinces me that complete safety from typhoid fever from a water source requires that the old deposits from a polluted water supply should be wholly and certainly removed from the mains, before they can be regarded as safe carriers of a purified or pure water. Recent experience seems to show that even seven years is not enough to eliminate the danger which may arise upon sending pure water through previously foul distribution pipes.

Water mains can be cleaned and deposits removed by several mechanical methods which have stood the test of time, and where the quality of a public water supply is about to be improved this cleaning of the mains should go hand in hand with filtration or other improvement in in the quality of the water. What boots it to advance the standard of water to a high degree and then destroy its sanitary quality by sending it to the consumer through dirty pipes? Experience has come to me in a very serious way, both in filtering the water supply of Philadelphia and otherwise, which convinces me that some of the typhoid fever vagaries from a filtered water are not chargeable in some instances to poor operation of the filters, but rather to the stirring up of old deposits in the mains which contain the necessary matter for the development of the typhoid organism in the human system. A considerable increase in the rate of flow through water mains will start these old deposits and destroy the wholesomeness of a well filtered water. The evidence of the change is manifested to the consumer by the turbidity of the previously clear water and very unfortunately sometimes by typhoid fever in his family.

The prompt removal of sewage from premises is necessary to health but in effecting this removal we should have some regard for the health of others who may become victims of our carelessness or indifference. Aside from the desire to keep our streams free from pollution they should not be used to carry sewage pollution from

*Extracts from address read before Conference of State Board of Health with Municipal Health Officials January 22-23, 1914.

one town to the water supply of another, and some remedy must be sought to guard against this evil.

It might not be out of place to here remark that some twenty years ago I entertained the thought that if all water supplies for domestic and dairy use, and any other use in connection with food or drink, were free from typhoid fever organisms that typhoid fever would soon be stricken from the list of diseases, and that water in some form or condition was responsible for our continued typhoid rates, and that with pure or purified water, universally used for dietetic purposes and in connection with articles of diet ingested even uncooked, we might hope for practically the elimination of typhoid.

It may be recalled that Prof. Dr. Von Pettenkofer leaned strongly to this theory, based largely no doubt upon his experience with the disease in Munich, after the introduction of a new public water supply from springs in the Mangfall Valley.

Various methods of sewage disposal have been tried and some permanently adopted.

Screening the coarser floating particles from sewage is a part of every system of disposal. Grit chambers to remove by limited sedimentation the heavier solids held in mechanical suspension is also a part of every system, where combined sewers are in use. But after these two steps have been taken, the further treatment takes a wide range from simple and limited sedimentation, to the most refined methods of filtration adapted to the treatment of sewage.

The treatment of sewage will depend upon the disposition of the final effluent. If the effluent is to be discharged into a rapid flowing stream of large relative volume, the degree of purification need not be so high as it should be when the dilution and opportunity for oxidation of the decomposable matters in the sewage will be less. If the sewage outfall is into a stream not drawn upon for public water supply, nor used for watering stock, and where nuisance only is to be considered, the purification need be only sufficient to avoid putrescibility. But if the stream is used below the point of sewage outfall for public water supply, or for watering stock, and the effluent must be no worse, and possibly better than the water naturally flowing in such stream, then the most advanced and comprehensive methods of purification will be necessary to meet the present sanitary requirements.

In the case of a public water supply, the standards of quality whether the water be naturally wholesome, or made so by filtration, will be about the same everywhere, so that the analytical conditions which determine wholesome water are not difficult to establish, and will not vary materially the world over. But standards for sewage effluents are not so easily established. Thus sewage discharged into New York harbor where the fresh and salt water dilution will be very large and the water nowhere used for domestic purposes, nor for the watering of stock, may be much inferior to the sewage effluent which can safely be discharged into Lake Erie at Cleveland, or of the sewage effluent which can safely be discharged into the Ohio River at Pittsburgh.

Each place may require a standard of sewage effluent different from the other places, and as a consequence the systems of sewage purification will take a wide range of design and efficiency, depending upon the place and condition of final discharge.

In Europe almost every known method of sewage disposal has been tried. Some of these methods have survived the experimental stage and have become standards under proper conditions, others have been tried and finally abandoned. At Glasgow, for example, the sewage is simply screened, the grit intercepted, a few hours of continuous sedimentation allowed, when the effluent is run into the Clyde, on the ebbtide, and the sludge pumped from the sedimentation tanks and carried out to deep water in the sea, in sludge boats constructed for the purpose. Some of the heavier sludge, however, is loaded on railway trains and then used for filling lowlands along the river below Glasgow, and some of it is pressed in order to extract part of the water, and is then dried and sold as a fertilizer. The fertilizing value of the average sewage sludge is low, and the thought once entertained by Victor Hugo and others of less romantic mind, that the elements of a complete fertilizer were to be found in domestic sewage has long since been disproved. Sewage has been successfully applied to certain kinds of crops, but it has no broad application as a general fertilizer, and when so used the crop must be adapted to the sewage. Of course, something else must be grown on the land besides "alfalfa" and "cabbage" if we are to live, and to the great crops of corn and wheat upon which the farming life of the nation depends, it is doubtful if a raw sewage can be of material benefit.

The disposal of sewage should be conducted upon strictly sanitary lines, and if processes can be worked out which will enable some portion of the sewage to yield a profit, these must have in view the sanitary end as the first object.

In this state the proper treatment and disposal of sewage is generally required to prevent pollution of our streams, and to avoid nuisance. Some of our streams, like the Cuyahoga River at Cleveland, and Millcreek in and north of Cincinnati, are now so vile from untreated sewage effluents that at times it seems that it only requires a match to set fire to them. But these conditions will soon be remedied in both places, and we may expect to see the waters of these streams flow into Lake Erie and the Ohio River respectively, as clear and sanitary as the natural waters of the Lake and River, and perhaps safer for ordinary uses.

It is a theory in one part of Germany to-day, that after the sludge has been precipitated by a few hours' sedimentation from raw sewage, that the effluent can be safely discharged into a relatively small stream, provided the stream has a good current, and no places occur in it where the unsedimented solids in the sewage can strand. That is to say, the sewage must be kept moving until it reaches a body of water large enough to furnish proper dilution. The dilution in the small streams may be low provided the current is maintained, and to this end brooks have been improved and artificial channels created, for the carriage of the sewage effluents at constant safe velocities.

The Imhoff septic tank has come into vogue in the Emscher district of Westphalia, as an adjunct of this system. In this district all the smaller streams and constructed channels flow into the Emscher River, and the river finally empties into the Rhine, where the volume of flow is relatively large.

If we pursued our plans for sewage disposal as persistently and cheerfully as do our neighbors in Europe, much better results would probably be accomplished, and less complaint would be heard from those to whom the sewage effluent of our cities is a nuisance and sometimes a menace to the public health.

The collection and proper disposal of garbage and other city wastes is another branch of sanitation that must not be neglected. Because we cannot readily trace disease to city dumps, there is no reason why these eyesores should remain as blots on the landscape. All these dumps are more or less a nuisance, and in decency should be abated. It may cost something to collect and properly dispose of wastes and rubbish, but very little that is desirable is obtained without cost, and no expense that we indulge in will yield so large a return in the beautifying of our small streams in the unimproved outskirts of our cities as the complete abolition of our waste and rubbish dumps. No one wants a garbage or waste dump on or near his premises, but he is not so particular about someone else's premises, and that which is unsightly and an offence to his finer sensibilities will likely be a nuisance and offence to others who from locality are compelled to endure it.

In cities of less than 100,000 population it is thought that garbage and other wastes and rubbish are best disposed of by combustion in high temperature destructor furnaces, if sanitation is the object in view.

In large cities, however, the garbage can be separately collected and reduced to inoffensive and saleable products with reasonable profit and the other wastes and rubbish from domestic, commercial and municipal sources can be collected, sorted and some material of value obtained from them before the useless matters are destroyed. The picking over of garbage wastes and rubbish to obtain revenue is a doubtful procedure. Great risk is run by the "pickers" in handling cast-off clothing, bed linen and some other household articles. The picking of inorganic matter may be attended with no great risk, but all material which by chance can transmit disease should not be picked and preserved, but be promptly put through the combustion furnace and rendered harmless.

In some cities the garbage is collected and delivered to the reduction works at cost, the reduction being performed under contract by private parties, while in others the reduction as well as collection is conducted by the municipality. The net profit from the handling of the garbage in Cleveland, for the year 1909, was $85,715, and by the adoption of the same energetic and efficient methods in some of our other cities corresponding results can be expected.

Garbage when reduced will yield grease and fertilizer, but the value of the fertilizer will be low. The grease is a valuable product and this together with the articles of value "picked" from the garbage constitute the source of profit.

Small cities cannot successfully conduct garbage reduction works owing to the lack of sufficient raw materials to work upon from day to day, and in these, with sanitation as the object, the garbage and all other wastes and rubbish should be reduced to clinker, ash and gases, in high temperature "destructor" furnaces. "Picking" the garbage and wastes may furnish some material that is saleable but after this has been done, the remainder of the material should be quickly destroyed.

In suburbs of cities and in villages the rubbish and wastes from the household can often be destroyed on the premises, and when this is done the burden on the municipality will be correspondingly lessened. Organic wastes and rubbish of whatever kind should not be alowed to accumulate, and the same desire for cleanliness of person and clothing which we are all supposed to have should apply to the household, the factory and the store.

How often are we shocked at sight of dump heaps and rubbish piles along our trunk line railways in the outskirts of cities; useless in themselves, eyesores, nuisances and sometimes the cause of ill health?

The City of Cincinnati collects and reduces its garbage, but ashes, street sweepings, domestic, commercial and building wastes and rubbish are collected as daily tributes to our waste heaps or so-called "city dumps." Things that cannot be used should be destroyed, and not left to encumber the premises or the landscape, to offend good taste and obscure the face of nature.

No one should be offended by an order to clean up his premises and keep it clean, to collect and reduce, pick over or destroy what he cannot use, with the best means at his disposal, and when the individual has done all that can reasonably be expected of him then the municipality must do the rest.

PERMEABILITY OF CONCRETE.

Results of great importance to contractors, engineers and farmers who have to do with concrete construction are being obtained in a series of tests to determine the rate and the amount of flow of water through concrete. The College of Engineering of the University of Wisconsin is making these tests with the object of finding a simpler means of making concrete watertight. A large cement company in the middle west is co-operating with the college by offering the facilities of its plant.

Already some interesting results have been gotten in the effect of the length of time of mixing in a machine mixer of the batch type; the effect of the percentage of mixing upon the imperviousness of the concrete; the effect of having sand in dry condition before mixing; and the effect of having the sand wet.

The experimenters have found that good results are obtained if the concrete remains in the mixer from two to three minutes when dry materials are employed. For cases where the sand and gravel or stone are damp a considerably longer time is required. Therefore the use of wet sand should be avoided if possible. The experiments showed that mixtures consisting of 1 part of cement, 1½ parts of Janesville sand of the Torpedo grade, and 3 parts of Janesville gravel, when mixed to a wet consistency, are impervious to water when subjected to a pressure of 40 pounds per square inch. Mixtures as lean as 1 part of cement to 6 parts of gravel (a graded mixture) have been made impervious at high pressures by using care in proportioning the amount of water and in mixing the batch. The specimens used in making these tests are cylindrical in form and so made that the faces of the cylinders, which are 13½ inches in diameter, are exposed to the predetermined water pressure. The thickness of the concrete through which the water must pass can be varied from 4 to 18 inches. Ample provision is made for cleaning both faces of the cylinder before placing it upon the testing apparatus. The apparatus itself is so arranged that very accurate tests can be made.

The importance of these experiments will be more sufficiently appreciated when it is understood that a large proportion of the trouble arising from poor concrete is due to the use of defective sand or gravel.

The department is also studying the effect of varying the percentages of cement and water, the gradation of the sand and gravel (by this is meant the size of the rocks and the fineness of the sand), the proportioning of the mixture, the thoroughness of mixing, and the effects of different conditions on the hardening of the specimens.

LOSS OF HEAD DUE TO BENDS IN WATER PIPES.

THERE has been much argument as to the loss of head due to bends or curves in pipe lines. Many theories have been advanced and many attempts to determine the laws which govern it have been made, but after great care, different experimenters have arrived at quite different conclusions. The result is an abundance of experimental data on the subject with small means of determining what are most feasible and most reliable.

A good deal of accurate information, derived from the data already at hand, is contained in a paper on the subject by Mr. W. E. Fuller, read by him before the New England Waterworks Association last September. It is in such a form as to admit of ready determination of the probable loss of head in bends and curves under the conditions that are ordinarily met with in waterworks practice.

It is known that water passing around curves and bends loses a greater amount of head than when passing through an equal length of straight pipe. When the direction of the flow of water is changed, the distribution of velocity and pressures in the pipe is also changed, eddies are set up, and probably other actions take place which cause this excess loss.

It is more convenient, in comparing different bends, to divide the total loss of head due to the bend into two parts: (1) that which occurs in an equal length of straight pipe; (2) the excess loss due to the curve. If this is done it is necessary to assume that the effect of roughness of pipe, condition of joints, and other matters which affect the flow in straight pipe have the same effect on the flow in curved pipes. Quite probably this is not exactly true, in which case bends of the same dimensions with different hydraulic conditions would give different excess losses of head. The experimental data are insufficient to decide this matter, but they indicate that the effect of roughness, etc., is not greatly different in the two cases. Loss of head due to bends will be considered as that portion of the total loss in excess of the loss which would occur in an equal length of straight pipe.

It is known that the disturbance caused by the bend is continued for some distance in the straight pipe beyond the bend and that the loss due to the bend continues in this straight pipe. It is also probable that the pipe preceding the bend, causing more or less eddies, according to its condition, may affect the loss due to the bend. The fact that some of the loss due to the bend takes place in the straight pipe makes it necessary in experimental work to measure the head at some distance beyond the bend itself. The loss due to pipe friction must then be eliminated before the loss due to the bend can be obtained. This pipe friction represents a large proportion of the total loss, so that errors in obtaining it materially affect the loss due to the curve. With all these difficulties to overcome it is not surprising that the different experiments should not agree closely.

Main Points at Issue.—For practical purposes it is essential to know the effect of both the radius of the bend and the velocity upon the loss of head for pipes of different sizes.

Until recent years Weisbach's formula, based upon experiments made on small pipes, was generally accepted. This formula is:

h_b (additional loss of head due to 90° bend) = 0.13

$$+ 1.85 \left(\frac{D}{2r}\right)^{\frac{3}{2}} \frac{v^2}{2g},$$

in which D is diameter of pipe, r the radius of the centre line of the bend, and v the average velocity in the pipe. On this basis the greatest loss of head would be from a bend of the smallest radius, and the longer the radius the less the loss would be.

Experiments made at Detroit on pipes of 12, 16, and 30 in. in diameter, indicated losses quite different from those given by the Weisbach formula. From these experiments it was concluded that the loss of head was a minimum for bends with radii of about two and one-half times the diameter of the pipe. These experiments also indicated that the loss did not in all cases vary as the square of the velocity.

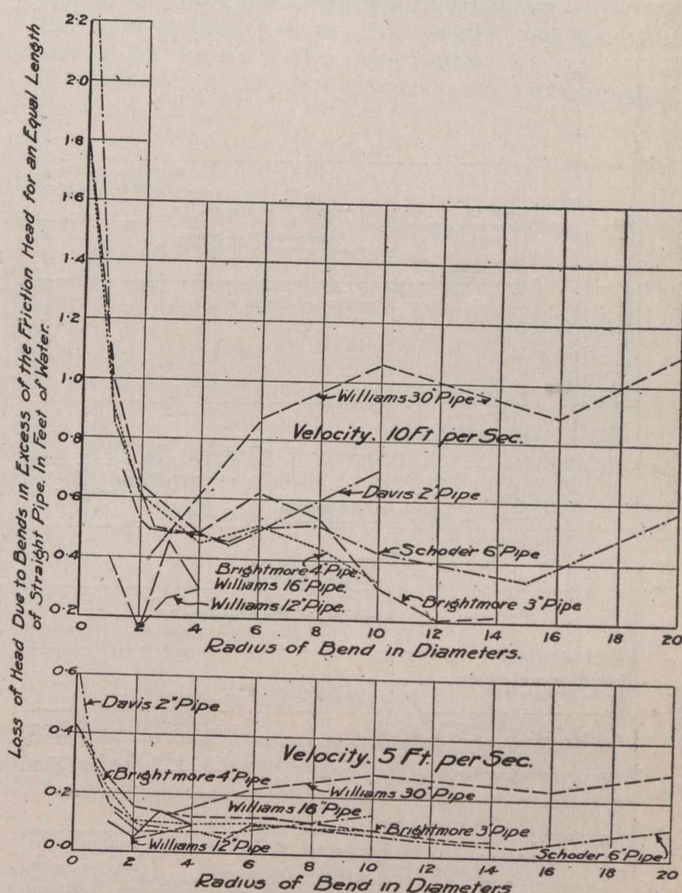

Fig. 1.—Loss of Head Due to 90° Bends. Radius in Diameters.

Further experiments made on 2, 3, 4 and 6-in. pipe showed that the Weisbach formula did not hold for larger pipes under ordinary conditions of service. These later experiments, however, did not confirm the Detroit experiments as to the minimum loss occurring with bends of a radius of 2½ pipe diameters. These different experiments indicated quite different variations of loss in relation to the velocity. Some of the experiments showed this relation as high as $v^{2.75}$, while others showed it as low as $v^{1.5}$.

These experiments give the best basis that we have of obtaining the loss of head in bends.

The experiments were all carefully made, every effort being made to eliminate errors. The conditions existing for the different experiments were nea enough alike to justify the expectation of at least an approximate agreement.

In the discussion of the question resulting from these experiments it seems to have been assumed that the loss of head in bends on different sizes of pipe should be the same when the radius of the bend in terms of the diameter of the pipe were alike. The writer sees no valid reason why this should be so. With so many different factors contributing to the loss there seems no reason to assume such a relation. If this assumption is abandoned, a much closer agreement between the data can be obtained and it seems better to accept the experiments as they stand, adjusting the conclusions to the data rather than to assume that some of the data are in error simply because they do not satisfy the above assumption.

Effect of the Radius.—A study of the data shows that the loss is more nearly the same for different sizes of pipes with bends of the same actual radius in feet than for bends of the same radius in pipe diameters. This is shown by a comparison of Figs. 1 and 2.

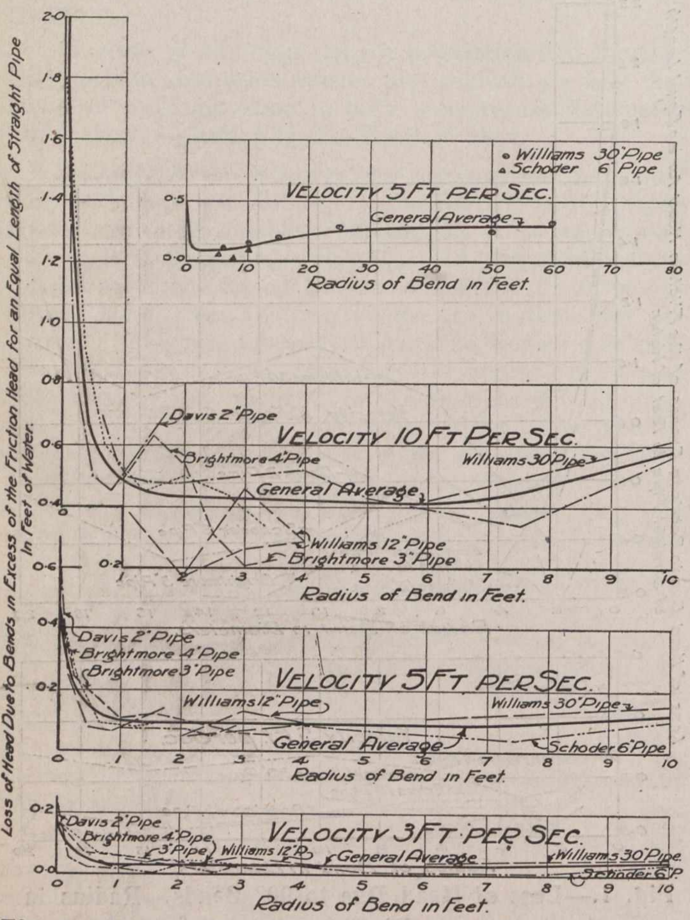

Fig. 2.—Loss of Head Due to 90° Bends. Radius in Feet.

Fig. 1 shows a plotting of the data on the basis of the radius in pipe diameters, while Fig. 2 shows a similar plotting on the basis of the radius in feet. On Fig. 1, while the curves representing the losses in bends of diameters from 2 in. to 6 in. agree fairly closely, those for the larger pipes are very different. On Fig. 2 a much closer agreement between the small and large pipe curves is obtained.

It is probable that neither of these diagrams is on the correct basis, and that the actual relation between the loss of head and the radius is a more involved one. Possibly the inner radius or the outer radius of the bend should be used for the comparison instead of the radius of the centre line; or it may be that both r and D are involved in some more complicated form.

On Fig. 2 the average curves drawn fit the data approximately and may be used for obtaining the probable loss of head in bends.

Relation of Loss of Head to Velocity.—Values of the loss of head for different velocities due to bends of the same radius, taken from the average curves on Fig. 2, were plotted on logarithmic paper in relation to velocity. From these plottings the relation was established that the loss of head is proportional to $v^{2.25}$. On this that the loss of head is proportional to $v^{2.25}$. On this basis a formula for loss of head may be stated as $h_b = kv^{2.25}$, in which k is a coefficient different for bends of different radii, and h_b is the loss of head in excess of the loss in a straight pipe of a length equal to the length of the curve. On Fig. 3 is given the values of k for bends of radii up to 60 ft. This relation between h_b and v is an average relation, as indicated by the experiments used. Further experiments may change it materially.

Practical Use of the Data.—Fig. 2 gives the loss of head due to 90 degree bends in excess of the loss due to friction in straight pipe of a length equal to the length of the curve. To compare the total loss of head which would actually occur in pipe lines containing these curves, it is necessary to take into account the relative length of the different curves. The use of long curves makes the total length of pipe less than the use of short curves giving a corresponding smaller loss in pipe friction.

The introduction of this matter brings in a difficulty in that the friction will vary as the roughness of the pipe, so that the curve giving the least total resistance for one pipe will not do so for another pipe with different

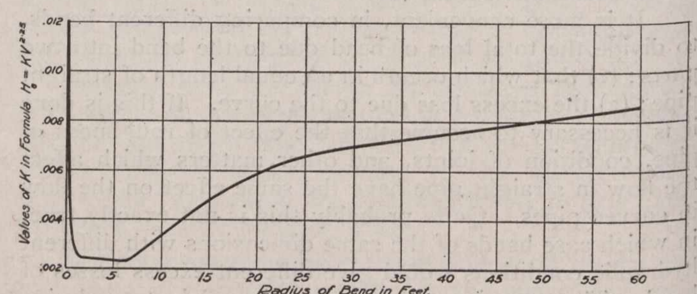

Fig. 3.—Values of "K."

hydraulic conditions. It is most convenient to compute the loss of head in pipe lines by taking the actual lengths of the tangents as straight pipe, finding the frictional resistance in it, and then adding the excess resistance due to curves and other specials.

To meet this requirement Fig. 4 has been drawn, on which is shown the excess loss of head in bends over what would occur in straight pipe of a length equal to the tangents of the curve under average conditions. The data for plotting this diagram were obtained as follows: The loss due to the curve is taken from the average curve in Fig. 2. The friction in straight pipe of a length equal to the difference between the length of the tangents and the length of the curve is then deduced. The frictional resistance in straight pipe is taken according to the Hazen-Williams formula with $c = 100$. The coefficient represents the average pipe after it has been in use for some years. As the loss of head in bends becomes of most importance at the time when the pipe is being used at its maximum capacity, which usually comes aften some years of use, this value of c will probably meet the usual requirements. For new pipe well laid this excess loss in head would be somewhat greater, while for pipe in very bad condition it would be less.

Fig. 4 shows the following interesting points:

1. The excess loss of head in bends is greater for large pipes than for small ones.

2. For large pipes a six-foot radius bend gives the least resistance, unless very long radii are used.

3. If the radius can be made very long, the least resistance will evidently be from the bend of greatest radius.

4. For small pipes, at least, with long radii the loss of head will be less than it would be in straight pipe of a length equal to the tangents of the curve. This occurs when the saving in friction head due to shorter line becomes greater than the excess loss due to the bend.

In order to show the loss of head for bends in ordinary use, Table I. has been prepared on the same basis as Fig. 4, giving the excess loss for bends made according to the New England Waterworks Association standard.

Table I.—Loss of Head Due to Ninety Degree Bends of the New England Waterworks Association Standard.

Size of pipe. Inches.	Radius bend. Feet.	Excess loss over loss in straight pipe of length equal to tangents.		
		$v = 3$ ft.	$v = 5$ ft.	$v = 10$ ft.
4	1.33	0.021	0.073	0.37
6	1.33	0.025	0.082	0.40
8	1.33	0.026	0.086	0.41
10	1.33	0.027	0.089	0.42
12	1.33	0.028	0.090	0.43
16	2.0	0.026	0.085	0.41
20	2.0	0.027	0.086	0.41
24	2.5	0.026	0.085	0.41
30	3.0	0.026	0.083	0.41
36	4.0	0.026	0.083	0.40

Necessity for Considering Loss in Bends.—For most lines of small pipe, consideration of economy or convenience in laying will govern the selection of the bend or curve to use. Generally, of course, the use of very sharp bends should be avoided. In designing pipe systems about pumping stations, filter plants, and elsewhere, where many specials are necessary, a thorough understanding of the loss is important to avoid unnecessary loss of head.

For large pipes the losses in bends assume a far greater importance. The loss is more important for several reasons. First, the actual loss is greater for the larger pipes than for small pipes. Second, for the same velocity the frictional loss is less for large pipe than for small pipe, so that the loss in bends is a greater proportion of the total loss. Third, the amount of money involved is greater in the case of large pipe, and a greater expenditure is justified to avoid losses of head.

The importance of losses of head which occur on large pipe lines at bends and at other specials and at entrances and outlets of the pipe to structures is not as generally realized as it should be. It is not uncommon to find losses from such causes, in large and comparatively short pipe lines, a large percentage of the total loss. In many cases much greater capacity of the line could have been obtained by proper consideration of the losses in the design of these works, and in some cases the capacity could have been nearly if not quite doubled. Instances of this may be found in intake and suction pipes. The importance of these losses may be understood when it is realized that in 1,000 ft. of 72-in. pipe a single 90° bend poorly designed may readily reduce the capacity of the line by 5 per cent., and a poorly designed inlet or outlet of the pipe to a structure may reduce the capacity by fully 10 per cent. It is not uncommon to find structures on pipe lines in which the velocity is suddenly reduced to a small amount, after which it is again increased. Such structures are extremely wasteful in head. A careful design to secure gradual changes in velocity and to prevent eddies at specials is very essential in order to secure the proper capacity of large lines and to prevent the waste of capital in building larger pipe lines than are needed.

Loss of Head in Other Than 90° Bends.—There are but little data on losses in curves of radii other than 90° curves. Even with bends of small curvature the flow is disturbed, eddies are started, and considerable loss of head may result. It seems certain that the loss in 45° bends is greater than one-half that in 90° bends. Until more information is obtained, the writer suggests the use of the following values for losses of head:

For loss of head due to 45° bends, use three-fourths that due to 90° bends of the same radius.

For loss of head due to 22.5° bends, use one-half that due to 90° bends of the same radius.

For loss of head due to a Y-branch, use three-fourths that due to a tee.

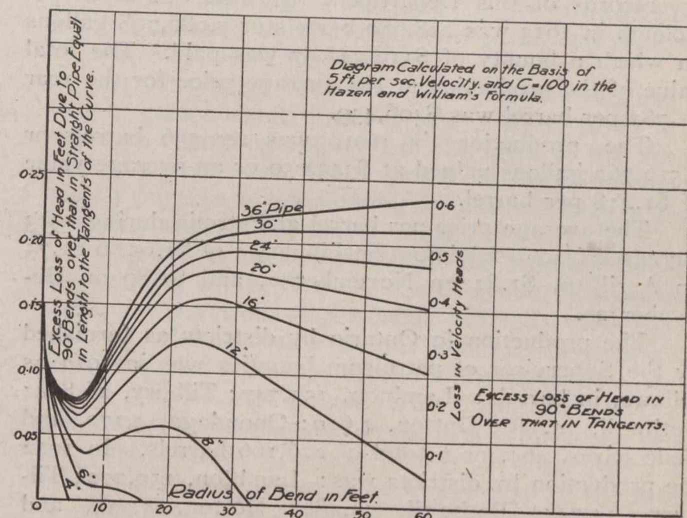

Fig. 4.

Approximate Rules for Losses of Head.—The loss of head in bends, for ordinary velocities, that is, from 3 to 6 ft., is approximately proportional to the velocity head, $\frac{v^2}{2g}$. It is convenient to express the loss in this way, and for rough approximations the following rules will serve:

For 90° bends of a radius in excess of 1.5 ft. and less than 10 ft., $h_b = \frac{1}{4}\frac{v^2}{2g}$.

For tees (bends of zero radii), $h_b = 1\frac{1}{4}\frac{v^2}{2g}$.

For sharp 90° bends of 6-in. radii, $h_b = \frac{1}{2}\frac{v^2}{2g}$.

Only further experimental work can satisfactorily settle some points involved in the loss of head in bends. Experiments which would add to the data on the loss of head in bends of large diameter would prove of the greatest service. It is for such bends that the matter is of the greater importance and the data more limited.

Messrs. Cammell, Laird and Company, of Birkenhead, England, have supplied the turbines for the Canadian Pacific steamer St. George, the installation being made at the Robins drydock at New York under the superintendence of engineers from Birkenhead.

CANADIAN PRODUCTION OF PETROLEUM AND NATURAL GAS, 1913.

THE Division of Mineral Resources and Statistics of the Department of Mines, Canada, reports that the production of crude petroleum in Canada was confined during 1913 to the old established fields in Ontario with a few barrels pumped from gas wells in New Brunswick.

The annual output has been steadily declining during the past six years and shows a further falling off in quantity produced in 1913 although owing to the higher price obtained for oil a larger total value is shown than for 1912.

A bounty of one and a half cents per Imperial gallon is paid upon the production of crude petroleum, the Bounty Act being administered and payments made by the Department of Trade and Commerce. According to the records of this Department the total output of petroleum in 1913 was 228,080 barrels or 7,982,798 gallons on which a bounty of $119,741.97 was paid. The total value of the production at the average price for the year $1.782 per barrel was $406,439.

The production in 1912 was 243,336 barrels or 8,516,762 gallons valued at $345,050 or an average value of $1.418 per barrel.

The average price per barrel at Petrolia during 1913 increased from a minimum on January 1 of $1.65 to $1.75 on April 16, $1.84 on November 6, and $1.89 on December 22.

The production in Ontario by districts as furnished by the Supervisor of petroleum bounties was in 1913 as follows, in barrels: Lambton, 155,747; Tilbury, 26,824; Bothwell, 34,349; Dutton, 4,610; Onondaga, 4,172, and Belle River, 464, or a total of 226,166 barrels. In 1912 the production by districts was: Lambton, 150,272; Tilbury, 44,727; Bothwell, 34,486; Dutton, 4,335, and Onondaga, 7,115, or a total of 240,935 barrels.

The production in New Brunswick in 1913 was 2,111 barrels as against 2,679 barrels in 1912 and 2,461 barrels in 1911.

Exports entered as crude mineral oil in 1913 were 3,650 gallons valued at $379 and refined oil 24,273 gallons valued at $3,188. There was also an export of naphtha and gasoline of 17,875 gallons valued at $4,284.

The total value of the imports of petroleum and petroleum products in 1913 was $13,339,326 as against a value of $11,978,053 in 1912. The imports have been increasing rapidly during the past few years.

Crude oil is being extensively used as a fuel on the Pacific Coast in both steamships and locomotives and the wide use of the gasoline motor has created a big demand for gasoline. The total imports of petroleum oils, crude and refined in 1913 were 222,779,293 gallons valued at $13,230,429 in addition to 1,628,837 pounds of wax and candles valued at $108,897. The oil imports included crude oil 162,062,201 gallons, valued at $5,250,835; refined and illuminating oils 19,393,627 gallons, valued at $1,386,440; gasoline 29,525,170 gallons, valued at $4,822,941; lubricating oils 6,789,451 gallons, valued at $1,172,986, and other petroleum products 5,008,844 gallons, valued at $597,227.

The total imports in 1912 were 186,787,484 gallons of petroleum oils, crude and refined, valued at $11,858,533, in addition to 2,144,006 pounds of paraffin wax and candles valued at $119,520. The oil imports included: Crude oil, 120,082,405 gallons, valued at $3,996,842; refined and illuminating oils, 14,748,218 gallons, valued at $1,012,735; gasoline, 40,904,598 gallons, valued at $5,347,767; lubricating oils, 6,763,800 gallons, valued at $1,077,712, and other petroleum products, 4,288,463 gallons, valued at $423,477.

There was an increased importation in 1913 of all classes of oil with the exception of gasoline, the increases being most pronounced in crude oil and refined illuminating oil.

Natural Gas.—There was comparatively little change in the production of natural gas in Ontario but a large increase in the production in New Brunswick and in Alberta. The total production in 1913 was approximately 20,345 million feet valued at $3,338,314, of which 828 million feet valued at $174,006 was from New Brunswick; 12,487 million feet valued at $2,092,400 from Ontario, and 7,030 million feet valued at $1,071,908 from Alberta.

The production in 1912 was reported as 15,287 million feet, valued at $2,362,700, and included 174 million feet from New Brunswick, valued at $36,549; 12,529 million feet from Ontario, valued at $2,036,245, and 2,584 million feet from Alberta, valued at $289,906.

These values represent as closely as can be ascertained the value received by the owners or operators of the wells for gas produced and sold or used. The values do not represent what consumers have to pay since in cases where transmission is by separately operated pipe line companies such cost is not included.

It has been finally decided by the State of New York to request the foreign relations committee of the House of Representatives to recommend that New York State be vested with power to permit the diversion of water from Niagara River for power purposes or to establish a State power plant at Niagara Falls.

The Wheeler Condenser and Engineering Company, of Carteret, N.J., have opened an office at 122 Board of Trade Building, Montreal, under the management of Jos. McKay, Jr., formerly New York manager of the company. The company make surface and jet steam condensers water-cooling towers, feed-water heaters, evaporating apparatus, etc.

One of the most interesting railway structures in the world is the bridge over the Faux Namti gorge in Indo-China, where, owing to the peculiar difficulties in the way of building a bridge of any type, it was necessary to adopt a special design suited to the only method of erection that seemed possible. The sides of the gorge are practically vertical; and there is no approach to the bridge from either side except through tunnels. The track grade is 335 feet above the river, so that no system of falsework could be used in building the bridge, while cantilevers were out of the question owing to the lack of "elbow-room." The design finally adopted consisted of two steel trusses, each hinged at the cliff side, which were erected in a vertical position and then lowered so that the ends met, forming a structure of inverted V-shape. The ends of the two trusses were firmly connected; steel towers were erected on the humps of the trusses; and, on this support, the steel deck truss, carrying the track, was placed. At the beginning of the work it was necessary to let the workmen down by ropes from the tunnel mouth to prepare the foundations of the supporting trusses. The track trusses were built in the tunnels and were then moved into position on rollers. From end to end this bridge measures 220 feet 4 inches, while the distance between the heels of the supporting trusses is 180½ feet.

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ESTABLISHED 1893.

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CONTENTS OF THIS ISSUE.

SPECIAL BOARD FOR LAKE OF THE WOODS QUESTION.

One of the Privy Council committee reports approved on March 2nd by the Governor-General, deals with the organization of a Board, representative of different departments of the Government, for the special consideration of various questions that are being referred from time to time to the International Joint Commission. Questions frequently arise in which more than one department of the Government is interested and in regard to which several departments have special knowledge. In order that such questions may be fully and effectively dealt with, it has been deemed desirable that there should be some method by which advantage may be taken of the information possessed by the different departments, and thus greater co-operation secured in dealing with the problems involved.

It is interesting to note that in the United States such matters are within the jurisdiction of, and dealt with by, the War Department alone.

At the present time the question which requires the most urgent consideration is the one involved in the reference regarding the level of the Lake of the Woods, and it is suggested that a Board be organized for the special purpose of considering it, and outlining a policy for submission to the Government.

The report recommends that the working members of the Lake of the Woods Board should be representatives of the various departments affected. The Department of Marine and Fisheries and the Department of Public Works are responsible for the navigation on the lakes; the Fisheries Branch of the Department of Marine and Fisheries is interested in the propagation and care of fish and, therefore, in any change of level which may affect the spawning beds; the Department of the Interior is much interested in the water powers connected with the watershed of the Lake of the Woods, particularly those in the Province of Manitoba; the Hydro-Electric Power Commission of Ontario is interested in the water powers in the Ontario section of the watershed; and the Department of the Naval Service is charged with the work of preparing charts for navigable waters.

In view of difficulties that may be encountered in getting representatives from these various departments to act together, and in order to facilitate direct communication with the Government, it is suggested that a member of the Cabinet should be the chairman of the Board. The report accordingly recommends the constitution and appointment of such a Board under the chairmanship of the Minister of Marine and Fisheries, to consist of the following members as representing their respective departments: B. H. Fraser, assistant chief engineer, Department of Marine and Fisheries; S. J. Chapleau, district engineer, Department of Public Works; J. B. Challies, superintendent, Water Power Branch, Department of the Interior; W. J. Stewart, chief hydrographer, Department of the Naval Service and External Affairs; and H. G. Acres, hydraulic engineer, Hydro-Electric Power Commission of Ontario.

The committee also recommend that the Board be instructed to examine the various departmental interests involved, bring them into harmony as far as possible, and present to the International Joint Commission the views of the Government of Canada on this question.

Authority should be given to the Board to appoint the requisite number of clerks, or junior engineers to collect and tabulate such data as may be collected; and further (with the concurrence of the Prime Minister), that the necessary expenses in connection with the carrying out of these proposals be defrayed from the contingencies of the Department of External Affairs.

MUNICIPAL ENGINEERS AND PRIVATE PRACTICE.

An Association of Consulting Engineers was recently formed in Great Britain. At the inaugural dinner it was strongly pointed out that there was a necessity for the new departure. In order to maintain a profession at its highest level it was essential that it should have an external conscience, in addition to the individual conscience of its members, and the new society was due to have a conscience of this kind. It would draw a distinct line between the municipal engineer as he should be, and the municipal engineer when he becomes commercialized and competes with private enterprise.

One of the strong advocates for the association, Mr. J. H. Balfour-Browne, K.C., felt very keenly against the State and municipal engineers being permitted to compete with consulting engineers. They should devote all their time and attention to the work of the municipality, and be adequately paid for doing this duty. If they did devote their time and attention adequately to the woik of the municipality, they ought to have no time for engaging in private practice. Apart from this, there was the danger in a municipal engineer acting in a consulting capacity, that he was liable to have a narrow outlook. The variety of the work engaged in by the consulting engineer was his strength, and was apt to give a judicious breath to his decisions, which was invaluable to his client. The Association of Consulting Engineers was doing good work, both for itself and for the public, in keeping up the standard of the profession.

These grounds for the preclusion of State and municipal engineers from acting privately in a consulting capacity are, according to the London *Times*, thin and unconvincing. "For," says the *Times*, "if variety of experience is a source of strength to the everyday consulting engineer it is reasonable to suppose that the municipal engineer would also acquire strength and develop the judicial attitude of mind from occasional indulgence in that class of work. The truth is that the most weighty objections to the acceptance by qualified engineers of private consulting work are based not upon their lack of knowledge, experience, of powers of judgment, but upon ordinary considerations of what is expedient for public servants. In this respect members of the engineering profession holding State or municipal appointments are even more restricted than members of the legal profession in like circumstances. The essential requirement in private consulting work is that when advice is sought upon an engineering matter the engineer selected should be a qualified specialist upon the subject in question; and what the public have to avoid is the employment of a person who poses as a consulting engineer upon every engineering subject that presents itself. In cases of doubt regarding qualifications, an appeal can always be made to the councils of the great engineering societies and institutions."

Some difficulty was encountered during the formation of the new association in discovering exactly what the term "consulting engineer" constituted, as applied in England. The definition proved hard to deduce, although of considerable import, as the association rules are to be applicable only to consulting engineers—professional men to work along professional lines and to advise clients to the best of their ability irrespective of their own pockets.

SURFACE INSULATION OF PIPES.

An investigation of the subject of surface insulation of pipes as a means of preventing damage to underground metallic structures by stray currents from electric railways has recently been completed by the U.S. Bureau of Standards, by Burton McCollum and O. S. Peters. Tests were made of the various substances available for the purpose of insulation of underground structures, including paints, pitch and asphalt dips, pitch and paper and asphalt and felt wrappings, and so forth. Test specimens were made by lining shallow sheet-iron cones with the material to be tested. Before being subjected to the final test each cone was filled nearly full of ten per cent. salt (NaCl) solution and an alternating difference of potential of 80 volts (effective) applied across the coating for 30 seconds, in order to be sure that it was continuous and without flaws. A milliammeter in series with the specimen indicated a defective coating by a kick of the needle. The electrical resistances of the perfect specimens were then approximately determined with a Wheatstone bridge. In the case of the paints these resistances were found to be of the orders of from 10^8 to 10^{11} ohms per square centimetre, while for the wrappings they were much higher.

The final test of the specimens which survived the preliminary test consisted in allowing water and air alternately to come in contact with the coating while a direct potential difference of either four or fifteen volts was applied across the coating. The value of the voltage applied depended on the thickness and other characteristics of the coating. In some of the specimens made up from each material the iron of the cone was made negative and in others positive, while in the case of the paints some of the specimens were subjected to the alternate action of air and water with no potential difference applied, in order to check up the effect of the electric stress.

The alternating contact with the coating of air and water was obtained by filling the cone and allowing the water to evaporate, which took about a week. Readings of the current flow were made at suitable intervals. The first appearance of current flow was taken as indicating the end of the useful life of the specimen as an insulating coating.

The average life of the paints was about 116 days, the maximum life obtained from any specimen being but little more than a year. No conclusive evidence was obtained that the low potential differences applied had any effect in hastening the initial failure of the coatings. The wrappings lasted longer than the paints and dips, but none of them much more than 400 days. It seems from the results that the failure of the coatings must be caused by absorption by them of water, which in time penetrates to the iron, allowing current to flow and destroy the coating by electrolysis. After the first appearance of current flow the destruction of the coating was observed to proceed very rapidly.

The conclusion drawn from the results of the laboratory tests, as recently published in Technologic Paper No. 15, of the Bureau, to the effect that the protection against electrolysis which is obtained by wrapping or painting pipes or other metallic bodies for use underground is only temporary, is borne out by tests on insulated pipes buried in the ground under practical conditions, and also by correspondence with gas and water companies whose experiences lead to the same conclusion.

LETTER TO THE EDITOR.

Cost of the National Transcontinental Railway.

Sir,—I notice in the daily press, under the heading of "Bonded Indebtedness and Annual Interest Charges of Canadian Roads," an item for the National Transcontinental Railway as follows:—

"Line, Moncton to Winnipeg, being constructed by Dominion Government

"Estimated cost guaranteed by Dominion Government, $234,000,000."

The cost of the National Transcontinental Railway for constructing and equipping the road, outside of rolling stock, from Moncton to Winnipeg, will not far exceed $150,000,000. Major R. W. Leonard, Commissioner, and Mr. Gordon Grant, Chief Engineer, estimate this cost to be somewhere around $150,000,000. An item appeared in another Montreal paper as follows:—

"Ottawa, February 19.—The National Transcontinental Railway and its cost is dealt with in an interim report of the Commissioner, Major Leonard, for the nine months of the fiscal year ended December 31. It was tabled in the House last night.

"The total outlay in the nine months was $10,314,994, and up to the end of the calendar year the aggregate was $140,567,147. This is exclusive of interest on capital.

"Track-laying was completed on the eastern section on November 17. There are 1,803 miles of main line, 20 of double track, and 407 of sidings. Steel bridges are 95 per cent. completed.

"The rest of the report deals with contracts awarded during the year for buildings, equipment and supplies."

This proves that my statement is correct, as any competent railway engineer knows that it should not take more than $10,000,000 to $20,000,000 to complete the road, ready to operate in an efficient manner. Any engineer connected with the Headquarters Staff of the National Transcontinental Railway at Ottawa, will affirm that the cost of construction of this road will not be over $160,000,000, and that according to the National Transcontinental Act, the Grand Trunk Pacific will only have to pay interest on the actual cost of the road, which will not exceed $160,000,000.

My reason for drawing your attention to this matter is that I don't think it fair to the credit of Canada and the engineers who were connected with the National Transcontinental Railway, to advertise, not only in Canada but in Europe, that the Grand Trunk Pacific will have to pay interest on the amount of $234,000,000 when the cost of the road will not exceed $160,000,000. The cost is divided approximately as follows:—

Grading	$105,000,000
Bridges	10,000,000
Shops and terminals	10,000,000
Engine houses, stations and other buildings	10,000,000
Salaries, wages and administration expenses	10,000,000
Other items	10,000,000
	$155,000,000

Yours truly,

H. Victor Brayley, A.M.Can.Soc.C.E.

Montreal, Que., March 5th, 1914.

A METHOD OF DETERMINING THE AREA OF CROSS-SECTIONS.

By C. D. Norton,

In the computation of earthwork quantities, the most troublesome detail is the finding of the area of the various cross-sections. On railway construction a 3-level section is generally used, the area of which is found by the following well-known rule:—

Multiply the extreme horizontal width by ½ the centre height, also multiply ¼ the width of the roadway by the sum of the 2 side depths; the sum of the two products is the area required.

If, however, the cross-section contains 4 or more readings, the figure cannot always be divided into soluble triangles, and its area is best found by the following method, which has the advantage that the only figures used, are those recorded in the field book, reducing thereby the chances of error to a minimum. It is also simple and easily checked.

Cross-sections are almost invariably obtained by measuring horizontal distances and vertical elevations, each angular change being noted by a fraction, in which the numerator is a vertical elevation, and the denominator a horizontal distance. As these measurements refer to a base line and a datum at right angles to it, they can be correctly termed *rectangular co-ordinates.*

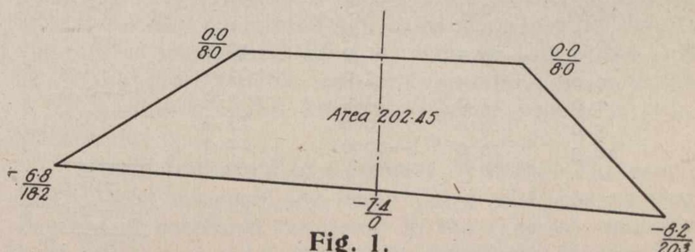


Fig. 1.

A rule to find the area of a figure platted by rectangular co-ordinates can be formulated as follows:—Designate the vertical ordinates as numerators, those above the point of origin being plus, and those below being minus; designate the horizontal ordinates as denominators, those to the right being plus and those to the left, minus. Multiply each numerator by the algebraic difference of alternate denominators. One-half the del. sum of the products will be the area required. If the measurements are taken in feet the result will be in square feet, if in metres the result will be in square metres. The terms may be taken clockwise or not, as may be desired, but in either case a regular order must be observed from start to finish, and strict attention given to the algebraic signs.

To apply the foregoing to earth cross-sections the rule can be worded as follows: Designate cuts and distances to the right as plus, fills and distances to the left as minus. Multiply each numerator by the algebraic difference of alternate denominators, one-half the del. sum of the products will be the area of the figure.

As it is often necessary that calculations be made by men whose knowledge of mathematics is limited the rule can be best understood by following a series of examples.

Example I. (Fig. 1).

Fills.	Alternate Distances.		Differences.	Products.
—6.8	— 8.0	0.0	— 8.0	54.4
—7.4	—18.2	20.3	—38.5	284.9
—8.2	0.0	8.0	— 8.0	65.6
				404.9

One-half of 404.9 = 202.45 = Area.

Distances.	Alternate Fills.		Differences.	Products.
— 8.0	0.0	—6.8	6.8	— 54.4
—18.2	0.0	—7.4	7.4	—134.68
0.0	—6.8	—8.2	1.4	
20.3	—7.4	0.0	—7.4	—150.22
8.0	—8.2	0.0	—8.2	— 65.6
				—404.90

One-half of 404.90 = 202.45 = Area.

It will be noticed that there are two solutions to each figure, one in which the numerators are multiplied by alternate denominators, and one in which the denominators are multiplied by alternate numerators, the result in each case being the same, although the figures in the products are dissimilar. In example No. I. it will be noticed also that the figures resolve themselves into the rule for 3-level sections.

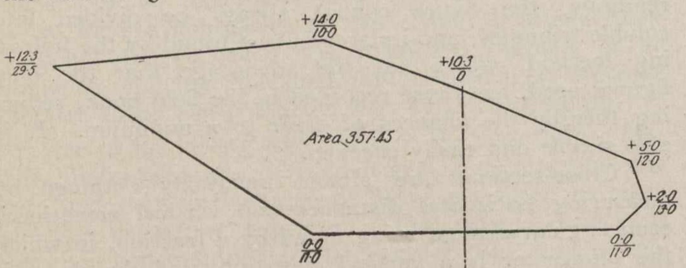


Fig. 2.

Example II. (Fig. 2).

Cuts.	Alternate Distances.		Differences.	Products.
14.0	0.0	—29.5	29.5	413.0
12.3	—10.0	—11.0	1.0	12.3
0.0	—29.5	11.0	—40.5	
0.0	—11.0	13.0	—24.0	
2.0	11.0	12.0	— 1.0	—2.0
5.0	13.0	0.0	13.0	65.0
10.3	12.0	—10.0	22.0	226.6
				716.9
				—2.0
				714.9

One-half of 714.9 = 357.45 = Area.

Distances.	Alternate Fills.		Differences.	Products
—10.0	10.3	12 3	—2.0	20.0
—29.5	14.0	0.0	14.0	—413.0
—11.0	12.3	0.0	12.3	—135.3
11.0	0.0	2.0	—2.0	—22.0
13.0	0.0	5.0	—5.0	—65.0
12.0	2.0	10.3	—8.3	—99.6
				—734.9
				20.0
				714.9

Hence area = 357.45.

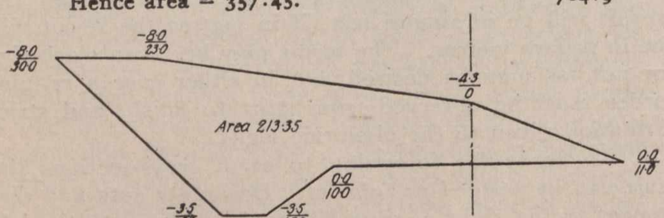


Fig. 3.

Example III. (Fig. 3).

Elevations.	Alternate Distances.		Algb. Diff.	Products.
8.0	0.0	—30.0	30.0	240.0
8.0	—23.0	—18.0	— 5.0	—40.0
—3.5	—30.0	—15.0	—15.0	52.5
—3.5	—18.0	—10.0	— 8.0	28.0
0.0	—15.0	11.0	—26.0	
0.0	—10.0	0.0	—10.0	
4.3	11.0	—23.0	34.0	146.2
				466.7
				40.0
				426.7

∴ Area = 213.35.

Distances.	Alternate Elevations.		Algb. Diff.	Products.
—23.0	4.3	+8.0	—3.7	85.1
—30.0	8.0	—3.5	11.5	—345.0
—18.0	8.0	—3.5	11.5	—207.0
—15.0	—3.5	0.0	—3.5	52.5
—10.0	—3.5	0.0	—3.5	35.0
11.0	0.0	4.3	—4.3	—47.3
0.0	0.0	+8.0		
				—599.3
				172.6
				—426.7

∴ Area = 213.35.

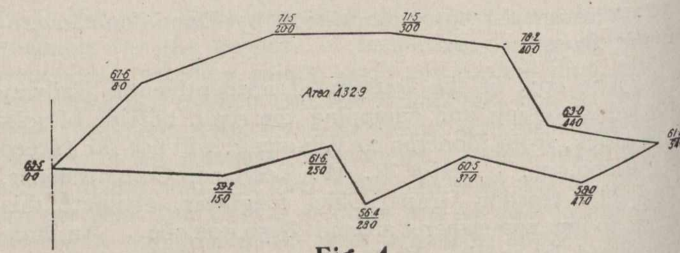


Fig. 4.

Example IV. (Fig. 4).

Numerators.	Alternate Denominators.		Algb. Diff.	Products.
13.5	15.0	8.0	7.0	94.5
17.6	0.0	20.0	—20.0	—352.0
21.5	8.0	30.0	—22.0	—473.0
21.5	20.0	40.0	—20.0	—430.0
20.2	30.0	44.0	—14.0	—282.8
13.0	40.0	54.0	—14.0	—182.0
11.2	44.0	47.0	— 3.0	— 33.6
8.0	54.0	37.0	17.0	136.0
10.5	47.0	28.0	19.0	199.5
6.4	37.0	25.0	12.0	76.8
11.6	28.0	15.0	13.0	150.8
9.2	25.0	0.0	25.0	230.0
				—1753.4
				887.6
				865.8

∴ Area = 432.9.

Denominators.	Alternate Numerators.		Algb. Diff.	Products.
0.0	59.2	67.6	—8.4	
8.0	63.5	71.5	—8.0	—64.0
20.0	67.6	71.5	—3.9	—78.0
30.0	71.5	70.2	1.3	39.0
40.0	71.5	63.0	8.5	340.0
44.0	70.2	61.2	9.0	396.0
54.0	63.0	58.0	5.0	270.0
47.0	61.2	60.5	.7	32.9
37.0	58.0	56.4	1.6	59.2
28.0	60.5	61.6	—1.1	—30.8
25.0	56.4	59.2	—2.8	—70.0
15.0	61.6	63.5	—1.9	—28.5
				1137.1
				271.3
				865.8

∴ Area = 432.9.

This method is noted in some text books, but is not in general use, mainly because the procedure is at first a little difficult, but with the aid of the above examples it can be easily understood.

A full mathematical discussion will be found in a book entitled "Traverse Tables," by Messrs. Louis and Gaunt, where the method is applied to the finding of areas of figures platted by Latitudes and Departures.

No less than 40,000 horsepower will be available from the new power site reserve in Boulder Canon, two miles east of Las Vegas, Nev., which the United States Federal Government **has approved.**

DECAY OF IRON AND STEEL IN ENGINEERING WORKS.*

By W. H. Maxwell, Assoc.M.Inst.C.E.

DURING recent years, the writer has been called upon to give close attention to the question of the relative durability of various metals subjected to corrosive influences, as met with in structural engineering, more particularly in connection with deep-well work for public water supply purposes, in steel bridge work, and in boilers and steam engineering generally.

The remarks which follow are in no sense intended to be a complete survey of the subject of corrosion of iron and steel, but simply to outline a few of the more practical points as met with in practice.

At the outset, it may be observed that, however simple the usual text-book theory may appear in regard to the common phenomenon of the corrosion of metals, such as the rusting of common iron or steel, those who are responsible for the prevention of corrosion in important engineering structures will soon realize that the problem is one of much greater complexity than a case of simple oxidation, as commonly supposed. The underlying causes and remedies for such deterioration are still somewhat imperfectly understood, and, even in the simplest cases, there remains room for fuller investigation.

Complications Affecting Corrosion.—In most cases met with in practice, it is not a question of investigating the action of water and air upon *pure* iron, but the deterioration to be arrested is invariably found to be the product of these substances mixed with numerous impurities, thus giving rise to an almost endless variety of conditions and results. The impurities of water and air vary with the locality, and the precise composition of metal is often a varying and elusive contingency of manufacture, somewhat difficult to trace and control.

Commercial Iron and Steel.—In view of the fact that commercial iron and steel are not uniform in composition, and that water and air are invariably contaminated in numerous ways, it is not surprising that the growth of knowledge on the subject has been slow, and that many of the opinions formed have since proved erroneous.

Want of Uniformity in Composition of Metals.—In the case of ordinary commercial irons and steels, the more soluble constituents dissolve out first, according to the nature of the liquids or other deteriorating influences with which the metals are brought into contact. Different batches of steel cannot be depended upon for uniformity of composition and equal durability under like circumstances.

Great care should be taken to prevent irregularity of composition in iron if corrosion is to be retarded. The greater uniformity of wrought iron, as compared with steel, also renders the former metal more resistant to galvanic activity.

Segregation in Metals.—Steels usually show great tendency to segregate, owing to the different temperatures of solidification of their constituents, and the smaller the proportion of iron present the greater is the want of uniformity due to segregation. Under these conditions, differences of potential exist, galvanic activity is set up, and the steel becomes highly corrodible.

*Extract of paper presented in the Journal of the Institution of Municipal and County Engineers (Great Britain).

Uniformity of Coatings Necessary.—Provided the metal can be completely covered with an efficient protective coating in order to insulate it from other metals or from the electrolyte in which it may be immersed, resistance to corrosion will be increased, but it is essential such coatings should be entirely continuous, otherwise, galvanic currents may be concentrated at points or pinholes, and thus cause greater damage than if uniformly distributed over the entire surface of the metal.

Local Conditions Affect Rate of Corrosion.—The behavior of metal is very largely dependent upon the precise local conditions to which it is subjected; for example, a strong industrial atmosphere may give rise, in the presence of moisture, to a powerful corrosive action. The writer has often experienced the highly damaging effect of fumes from passing locomotives upon mild steel bridge work exposed to such fumes in the presence of moisture.

Practical Observations.—Also, he has found that steam boilers and condenser tubes sometimes become pitted and grooved in a very unaccountable manner. Two or more boilers installed at the same date, made of similar material, fed with the same class of feed water, and worked under like conditions have oftentimes been observed to give widely divergent results—one being in good condition after 15 years' use, whilst another may become seriously pitted within one-fifth of that time. The repair of an old boiler with new boiler plate sometimes hastens the destruction of one or other of the metals, but it is impossible to foretell which metal will be the first to fail. The best classes of iron, such as Low Moor, are invariably more reliable than modern mild steel, which is a composite material involving many uncertain complications.

Metals Immersed in Corrosive Waters.—The writer has closely observed, for many years past, the varying degrees of corrosion occurring in the case of wrought iron, mild steel, and cast iron immersed in corrosive waters in structural works, particularly when these metals are used in juxta-position with gunmetal and other alloys. In the latter case a very marked and rapid deterioration of iron and steel has been observed to take place in certain natural waters, and under conditions such as these, the author has been engaged upon investigations into the question of the most suitable method of lining bore-wells 336 ft. deep by 3 ft. 6 in. diameter, for water supply purposes.

Deep-well Linings.—The usual mild steel linings were found to be inadmissible, owing to their very limited life under the conditions to be dealt with, and cast iron tubes with specially machined points were finally decided upon—a double lining being used through the first 165 feet of impermeable clay with the annular space between the inner and outer tubes grouted up with Portland cement grout. Great care was taken that no machined parts of the metal were exposed to the action of the water—these being protected by bituminous composition, and by closely fitted metal sleeves.

Foundry Skin.—Except where fully protected in this way, the foundry skin of the metal was not allowed to be broken, as this skin was found to have a strongly resistant action to the corrosive tendencies of the water. Should any machined face of the metal be exposed, deterioration will proceed rapidly at that part.

Uniformity and Insulation of Metals.—In all such works where metal must be fixed in contact with corrosive waters, the metals used should be as uniform in composition as possible, and if the employment of different metals is unavoidable, they should be insulated from each other as perfectly as possible.

Cast Iron More Resistive Than Steel.—Under many circumstances cast iron is much superior to either wrought iron or steel, and the closer the grain of the cast metal the more perfectly will it resist corrosive influences.

Action of Pure Iron, Air and Water.—Absolutely pure iron, if it could be obtained, would be unusually resistant to corrosion, unless placed in metallic contact with dissimilar metals. It is interesting to note that the action of pure water and pure air upon pure iron is but slight, and for all practical purposes negligible, but inasmuch as all these commodities are scientific curiosities of the laboratory rather than matters of ordinary experience, the point is not of direct practical importance, except in so far as it indicates the direction in which causes of corrosion may be expected to lie.

Moisture Hastens Corrosion.—Whilst there are many points still the subject of controversy, investigators appear to be agreed that, unless water is present, iron will not rust in air or oxygen. Natural rain-water and mist show great activity in the oxidation of metals, and water, when saturated with air is strongly corrosive to iron and steel. Corrosion proceeds most rapidly when the metal is alternately subjected to wet and dry conditions, such as at the water-line of iron columns, ships, boilers, water tanks, and the like. Deterioration of the metal at the water-line in boilers is a very generally noticeable condition.

Effect of Deeply Immersing and Burying Metals.—Water surfaces in contact with the atmosphere become more or less saturated with oxygen and the corrosive action of the water is consequently increased. Ironwork is much less corroded when immersed to a considerable depth in water than when placed near the surface, where air gains access.

Acids in Soils.—Deeply burying of metal in the soil has also been observed to have a preservative effect, as free oxygen cannot readily reach it. Should the soil, however, contain acids or acid salts these will soon have a destructive effect on the metal, as also will stray electric currents by the setting up of "electrolysis," resulting in rapid corrosion. It has also been observed that exposure to the action of diffused sunlight stimulates the rate of corrosion of iron.

"Busy" Iron.—Railway metals in active service corrode less rapidly than do similar rails laid in sidings which are little used. It may also be taken generally that "busy" iron, and iron subjected to vibration, has been observed to rust much less rapidly than idle metal subjected to similar corrosive influences. A thick scale of rust on the surface of metal retains moisture and hastens further corrosion.

Painting of Metals to Prevent Corrosion.—In regard to the question of painting or "coating" of metals with a view of preventing corrosion much consideration is needed, or more harm than good may result. A form of specification commonly seen requires "all ironwork to receive one (or two) coats of paint before leaving the manufacturer's works." The wisdom of this is very doubtful, inasmuch as the "mill-scale" on the new ironwork is certain to come away sooner or later as oxidation sets in under the paint, and the latter coating will thus be brought away with the scale. In the use of some proprietary "coatings" it is, in fact, recommended that a first coat be applied and allowed to peel away, should it prove disposed to do so, in order that all scale may be removed therewith, and the subsequent coatings will then permanently adhere and protect the metal.

In the galvanizing and other similar trades the mill-scale is removed by dipping the steel and iron goods in hydrochloric acid solution before coating the metal.

Removal of "Mill-scale."—Before painting iron and steel work, as in bridges, etc., the black oxide scale, or "mill-scale," may advantageously be permitted first to turn to red oxide or rust, and the metal then be thoroughly well cleaned with wire brushes or sand blast. This having been well done, the paint will then find its way direct to the metal and form a much more permanent coating. It is often a difficult matter to remove every trace of mill-scale, but the improved results obtained justify this precaution.

Many engineers now frequently allow iron and steel structures to stand for a while and rust, in order that the mill-scale may be loosened and so come away more freely by scraping and wire-brushing, before any coat of paint is applied.

Rust is capable of setting up galvanic activity, but to a less degree than is the case with magnetic or black oxide.

Necessity of Continuous Coatings.—Numerous "coatings" of varying composition have been largely used on all classes of work in which metals are extensively employed. In the case of steel pipe-line in wet soils or situations, the conditions are severe, and no permanently effective coating is at present available. The application of the coating is also of first importance. It should be absolutely uniform and continuous, otherwise, should there be imperfections, such as small holes, galvanic currents leave the metal plates at these points, and the iron or steel work becomes more quickly corroded than would be the case if the same action took place uniformly over the whole surface.

"Coatings" May Prove Detrimental.—Artificial coatings, intended for protection, may thus not infrequently become sources of danger, and, in the case of some paints, the coarser particles of pigment may induce galvanic activity under the paint. It will be advantageous, therefore, to use a pigment which is a bad conductor of electricity, finely ground, and well incorporated with oil.

R. H. Gaine's General Comment.—The whole subject of the corrosion of iron and steel abounds in curious anomalies, and apparently similar materials do not always behave alike under what may be believed to be identical conditions. The general comment on this subject of Mr. R. H. Gaines, the eminent chemist to the New York Board of Water Supply, is of special interest. In a report on the corrosion of a 38-in. diameter steel conduit at Rochester, New York, it is observed that:—

"The corrosive influences of nature can never be precisely imitated, and, moreover, the time during which laboratory experiments extend is relatively so short that they are of little value compared to actual experience. Besides, practical experience on such subjects is always more reliable than mere laboratory experiments. . . . There is a wide divergence of opinion among metallurgists on the corrodibility of the various forms of iron. Experience at Rochester, Portland, and elsewhere, seems to show that cast iron resists corrosion better than any other form of iron, and wrought iron is less easily corroded than mild steel. As between steel and wrought iron, some metallurgists claim that the difference is slight, but their reported experiments have not been carried far enough to base a final opinion."

Failures of Steel Pipe-lines.—A number of very costly failures, due to corrosion, are on record in regard to mild steel pipe-lines. The use of this material for water conduits was adopted some 25 years ago, and, so far as durability is concerned, may almost be said to be still in the experimental stage. But, apart from the probability of early deterioration, mild steel mains have many advantages from a structural engineering point of view, such as greatly reduced weight, as compared with cast iron, for a given carrying capacity, greater reliability under heavy pressures, and generally increased adaptability to meet the conditions of route of any particular pipe-line.

38-in. Main, Rochester, New York.—The steel pipe-line in connection with the Rochester water undertaking, New York, already referred to above, is 38-in. in diameter and 26 miles long, and, within 6 years of being brought into use in the year 1894, rust-hole leakage, due to external corrosion, took place.

Causes of Failure.—The cause of this failure was attributed to "electrolysis," and occurred in parts of the main laid in wet soils. Corrosion is found to be much retarded in dry, sandy or well-drained soils. Subsoil water in contact with steel in such cases is found to produce electromotive force from electro-chemical action, and the electrolytic damage is proportional to the time during which the current acts.

The three leading conditions which brought about serious corrosion in the Rochester main were: The wet soils through which the main was laid, ineffective protective coatings, and want of uniformity in the composition of the steel.

Even in the best and most uniform qualities of steel there exist contiguous areas of different electrical potential, and if the steel tubes lie in contact with an ionized solution, like soil water, corrosion will occur by electrolysis, as in this case.

Failure of 30-in. Main in Australia.—Another case of serious corrosion occurred during recent years in connection with a large and costly steel main 350 miles long by 30 in. diameter, in Australia—the corrosion being first observed about 3 years after completion. The official reports in such cases form an instructive study to those interested in such matters.

Relative Durability of Cast Iron, Wrought Iron, and Mild Steel.—The relative durability of cast iron, wrought iron, and mild steel is a matter of considerable commercial importance. In the case of cast iron, it would appear, in some instances, that no practical limit can be put upon this material when used under suitable conditions. The cast iron flanged pipes supplying water to the great fountains at Versailles were laid in 1685, or 229 years ago, and are stated to be still in use. Evidence is also available of cast iron bridges having been in use over a century and a quarter without visible deterioration from corrosion. Some wrought iron bridges are said to have shown over 60 years' service, but as regards mild steel bridges the life is usually much less, some such structures having become unsafe from corrosion after 25 years' use. In the author's experience, when mild steel bridges arrive at about this age, much annual attention is necessary to cope with deterioration due to corrosion.

Influence of Electrolytic Activity, Strain, etc.—In the decay of metals by corrosion, electrolytic activity is a much more serious factor than was formerly thought, and its action is of a subtle and elusive nature and difficult to stop. Many intricate complications arise, e.g., iron subjected to strain or uneven treatment, generally speaking, corrodes more rapidly than that treated uniformly. A difference of electrical potential exists between strained and unstrained pieces of similar metal, also between tempered and untempered portions. Galvanic activity can therefore be induced by immersing metals under these conditions in electrolytic solutions, and corrosion of the anodic metal results.

In some experiments strained portions of metal were found to be cathodic to the unstrained, and the latter specimen was therefore attacked the more vigorously.

No Rules Generally Applicable.—No general rules appear to be universally applicable, but the important point for engineers to bear in mind is that a difference of electrical potential does exist, and that strain of any kind will induce such change of potential, resulting, when immersed in an electrolytic solution, in corrosion due to galvanic activity. Beforehand, it is difficult to say whether the strained or the unstrained portion will act as the cathode, and so be preserved at the expense of the other, as the difference of potential is small and dependent on the actual local conditions of the case in point.

Differences of Potential.—Differences of potential between two metals placed in the same electrolyte under different conditions do not always remain constant. The potential difference may change in degree, and in some cases even the polarity may undergo reversal. The metal which is at the higher potential corrodes and constitutes the "anode," whilst the cathodic metal will remain unaffected.

Reversals of Polarity.—In cases where reversals of polarity occur, owing to the initial difference in potential being slight, both metals will corrode proportional to the time each has served as the anode.

Potential Difference.—Potential difference depends upon the chemical nature of the electrolyte, on its degree of concentration, temperature, rate of motion and other factors.

Means of Retarding Corrosion.—Corrosion due to galvanic activity can be retarded by securing greater uniformity of composition in the metal, a minimum of segregation as occurring in steel, uniformity of physical condition in the metal, and protection from moisture, which will act as an electrolyte.

Theories of Corrosion.—Although the foregoing observations on the corrosion of metals are intended to bear primarily upon the practical side of the question, a brief reference to the principal theories of corrosion which have been suggested to explain the cause of this great waste and decay which takes place may be of interest in the present connection.

Many theories have been proposed, but two only merit serious consideration, viz.: the acid and the electrolytic theories respectively.

Acid Theory.—According to the acid theory, oxygen, *pure* water and iron may remain in contact indefinitely without producing rust, the presence of a trace, at least, of some acid being essential to the oxidation of the metal. Carbonic acid, being naturally prevalent in air and water, is generally understood to be the primary cause of attack in ordinary cases of rusting.

Electrolytic Theory.—The electrolytic theory, on the contrary, depends upon the solubility of iron in pure water, and maintains that the presence of even traces of an acid is not necessary to its oxidation, but that water and oxygen alone are essential. This theory depends upon the presence of free hydrogen ions in the purest water, and the experimental work done shows rusting to be principally due to attack from this source.

Differences of Opinion.—As indicating the unsettled state of scientific opinion on the theoretical side of this question, it may be observed that one authority, whose views on the subject command the greatest respect, considers the balance of evidence decidedly in favor of the acid theory, whilst another, of equal eminence, strongly urges the electrolytic doctrine.

Use of Theories.—Whilst the ordinary user of metals may look upon these different theories as of little moment, and regard the fundamental distinctions between them as theoretical rather than practical, it should not be overlooked that a reasonable tentative conjecture respecting the cause of any phenomenon may have its uses as a working hypothesis.

Commercial Importance of Inhibition of Corrosion.—The present may be looked upon as the age of iron and steel, and the commercial importance of the subject of the corrosion of metals can scarcely be over-estimated, inasmuch as in almost every department of constructive work these materials are increasingly used, and, in view of the universally heavy costs of maintenance and renewals due to corrosive deterioration, no problem, perhaps, holds out greater prospects of reward, both to the scientific investigator and to the manufacturer alike, who shall commercially produce more resistant metals than those now available for the general structural requirements of the engineer.

A Swedish engineer has patented a process for the manufacture of cement in electric furnaces, which has been found practicable. Hitherto, the manufacture has been made difficult by the formation of calcium carbide that ruins the cement. The method of overcoming the difficulty consists in adding a metallic oxide to reduce the carbide. Iron oxide has proved a suitable material, and, instead of including this in the charge of the furnace, it has been found sufficient to add the powdered oxide to the cement product taken from the furnace.

In a report by United States Deputy Consul-General Loop of London, to the Treasury Department, it is said that pneumatic grain elevators are used in England by practically all of the large grain handling and milling concerns located at the various ports, and are regarded as being very successful. The average quantity of grain dealt with in an hour by such elevators, may be taken as 100 tons, (ton equals 2,240 lbs.), though the largest plants are capable of dealing with 150 to 200 tons of grain per hour, while smaller ones are in use dealing with as little as 5 tons per hour.

It has been announced in London, England, that work on the tunnelling for the underground railway to be constructed to facilitate the handling of mail matter in England, is to be commenced immediately. Comprehensive plans have been prepared for the project, which show an underground narrow-gauge automatic railway which will link up all the principal railway terminals with the district post offices. Interesting tests were shown recently at Chelmsford with automatic electrical trains working on an experimental railway. The track has an 18-inch gauge, and is half a mile long. It contains curves of very sharp radius, and runs part of the way through a tunnel, such as the Government has decided to construct. The tunnel is just high enough to enable a mechanic to walk upright through it, with a track on each side for trains. Pneumatic tubes are suspended from the roof, and there is provision for telegraph and telephone wires, to the right and left underneath. The cars, which are 2 feet wide, 2 feet high, and 6 feet long, are constructed to permit the carrying of large parcels and mail bags. They carry no operators, but are controlled automatically until they arrive at a station, travelling at an average speed of 30 miles an hour and being despatched at one minute intervals.

REINFORCED-CONCRETE HIGHWAY BRIDGES AND CULVERTS.

At the annual convention of the American Concrete Institute, held in Chicago February 16-20, 1914, the Committee on Reinforced Concrete Highway Bridges submitted the following tentative recommendations and suggestions. The report was intended to be a preliminary one, to deduce discussion from the members of the Institute. Mr. Willis Whited is chairman of the committee. The other members are Messrs. A. N. Johnson, H. H. Quimby, A. M. Loves and Lemuel Holmes.

Dead Loads.—The following are given as average weights per cubic foot of the materials mentioned, but if the weights of the materials to be actually used are definitely known to be different from those given, the correct weights should be used.

Materials.	Lb. per cu. ft.
Earth filling	110
Plain concrete	150
Reinforced concrete	155
Steel	490
Cast iron	450
Vitrified brick	140
Common brick	125
Granite and limestone masonry.	165
Sandstone	160
Macadam-Telford	150
Pine, fir, etc.	42
Oak and yellow pine	48
Creosoted timber	60

The weight imposed by earth filling should, in ordinary cases, be considered as including all filling included between vertical planes passing through the faces of the abutments.

If, however, the height of the fill exceeds about two-thirds the distance face to face of the abutments, the live load may be neglected and a very considerable proportion of the weight of the filling considered will be supported by friction between it and the approach filling. The amount of load thus transmitted is greatly affected by the cohesion of the soil, of which there is nearly always more or less.

This whole subject requires further investigation.

Live Loads.—Class "A" Bridges—Main thoroughfares leading from large towns.

In view of the extensive introduction of the heavy motor trucks and traction engines, and the probable general use of such vehicles in the future, it is recommended that bridges on main thoroughfares and other roads which are likely to be used for heavy hauling, be designed to carry 20-ton trucks, with axles about 10 ft. c. to c., 14 tons on rear axle and 6 tons on fore axle; wheels about 5 ft. c. to c. Outside of the large cities it is recommended that only one such vehicle be assumed to be on the bridge at any one time, the likelihood of more than one being on the bridge, in a position to produce maximum stresses at the same time, is so remote that this assumption is considered safe. It is advised that such very heavy loads be considered as occupying only the ordinary width of the road, about 8 ft. in width, and about 35 ft. in length. Congested traffic of heavily loaded wagons or motor trucks will rarely impose a load of more than 100 lb. per sq. ft., over a considerable area. The above-mentioned 20-ton truck gives a load of about 140 lb. per sq. ft., on the area actually occupied, but it is considered extravagant to assume that a large bridge is covered with such heavy loads. One hundred pounds per square foot is thought ample to assume for the loading of spans more than 60 ft. long, in designing the trusses or main girders. It is thought to be safe to reduce this assumed load in the case of longer spans, to the following amounts:

Length of span, ft.	Assumed load, lb. per sq. ft.
80	90
100	80
125	75
200 and over	70

With all intermediate spans in proportion.

The greatest load that is liable to be imposed on a bridge sidewalk, occurs when there is some excitement in the neighborhood, which attracts a large crowd, and for which the bridge affords an especially good point of view. In that case the crowd forms a compact mass, against the railing, not more than 4 ft. deep, making a load seldom exceeding 100 lb. per sq. ft., over a very considerable space. The remaining portion of the sidewalk may be covered by a moving crowd which can scarcely weigh more than 40 lb. per sq. ft. It may be advisable, sometimes, to so design sidewalk slabs, that if a street car or motor truck accidentally gets upon the sidewalk, it will not go through. Such accidents are so rare, that it is thought safe to allow materials to be stressed somewhat beyond the elastic limit in such cases.

Class "B" Bridges—Although it is impossible to determine beforehand, especially in the newer parts of the country, whether any given road is to be used for heavy traffic, it seems extravagant, at least in the cases of larger spans, to design bridges to carry much heavier loads than can be expected to come upon them. It is recommended that bridges of this class be designed to carry 15-ton trucks, with axles 10 ft. apart, 5 tons on the front and 10 tons on the rear axle. This will allow for a considerable overloading of existing motor trucks. It is further recommended, that only one truck be assumed to be on the bridge at one time, in designing the floor system, that it be assumed to cover a width of 8 ft. and a length of 35 ft. and that the remainder of the bridge is covered with a load of about 90 lb. per sq. ft., for spans up to 60 ft.

The longer spans, the trusses and main girders should be designed for the following loads:

Length of span, ft.	Assumed load, lb. per sq. ft.
80	80
100	70
125	65
150	60
200 and over	55

With intermediate spans in proportion.

Sidewalks should be designed to carry the same loads as in the case of Class "A" Bridges.

Special Bridges—City bridges and bridges carrying traffic connected with mines, quarries, lumber regions, mills, manufactories, etc., require special consideration and should, of course, be designed to carry any load which can reasonably be expected to pass over them, bearing in mind the likelihood of heavy traction engines and motor trucks coming into extensive use in the not distant future.

Stringer Loading.—The maximum stress in a stringer, due to a wheel load, occurs evidently when the wheel is directly over it. It is not thought proper to assume any distribution of the load to adjacent stringers, unless the bottom reinforcement in the slab is made continuous. In that case the distribution is proportional to the relative stiffness of the slab and the stringers, said stiffnesses being proportional to the moments of inertia, multiplied by the modulus of elasticity of materials and inversely proportional to the cube of the span. In determining this distribution, due account must be taken of the fact that deflection of the slab decreases toward the end of the stringers, and also of the fact, that whatever load is carried to the adjacent stringers, deflects them also. It is therefore recommended that wherever practicable the bottom reinforcement of slabs be made continuous over the stringers.

Slab Loading.—The distribution in a direction parallel to the supports of a concentrated load resting on a slab, supported at two opposite edges only, evidently depends upon the same principles as those mentioned under "Stringer Loading." The main difference being that what corresponds to the stringer in the former case is of indefinite width in the present case. Adequate theoretical investigations of this question appear to be lacking. For the present it seems fair to assume that the distribution each side of a concentrated load is equal to about one-third the length of the span, and that the cross reinforcement should be designed accordingly, which would require it to have an area of at least one-half of the principal reinforcement. The distribution of a concentrated load through earth filling on the top of a slab does not appear to be very well understood.

Bridges Carrying Electric Cars.—Electric traction is still in its infancy and nobody is able to forecast its future development. It seems probable, however, that it will not be profitable to run cars weighing more than 50 tons each, at a speed that would be permitted on any public road. If very high speeds are desired, the traction company will doubtless be required to operate over its own right-of-way. It is recommended that bridges carrying either urban or interurban electric cars be designed to carry 50-ton cars on two trucks, spaced 30 ft. c. to c., each truck having two axles spaced 7 ft. c. to c. The committee sees no reason for changing the customary practice of assuming that an axle load is distributed over 3 ties.

Loading on Arches.—The deflection of an arch being much less than that of a beam of the same length, the method recommended for determining the lateral distribution of a concentrated load over arch sheeting appears to be different from the distribution over flat slabs. It seems doubtful if the distribution in each direction can be greater than twice the thickness of the arch sheeting. This question should be investigated.

Stresses in Arches.—As all arches that are not provided with hinges act as elastic arches until cracks are formed, due to excessive tension at some point or points in the concrete, it is manifestly proper to calculate the stresses in them according to the elastic theory.

As concrete is a very poor conductor of heat, it is not thought necessary in calculating reinforced-concrete arches, to assume so much variation in temperature as is usual in designing steel structures, although the outside layers of concrete are of nearly the same temperature as the surrounding air, and those layers are stressed more heavily than any of the others, it is thought that an extreme variation of about 80° F. in the Northern States is sufficient to allow for, in any case, and that can be reduced if the arch ring is thicker or if there is much earth filling in the spandrels.

Bearing Power of Piles.—The usual formula for the safe bearing power of wooden piles is:

$$B = \frac{2WH}{S + 1}$$

in which,

W = Weight of hammer in pounds,
H = Height of fall of hammer in feet,
S = Penetration in inches per blow, average of last few blows.

If reinforced-concrete piles are molded before being driven, the head of the pile is usually cushioned more or less, and the pile is generally much heavier in proportion to the weight of the hammer than is the case with wooden piles. It is recommended that the hammer should be at least as heavy as the pile.

If concrete piles are molded in place, measures should be taken to prevent damage to them by the driving of neighboring piles or otherwise.

Bearing Power of Soils.—This subject is under an investigation by a committee from the American Society of Civil Engineers. It may be some years before their final report is submitted and even that will be subject to revision from time to time, as human knowledge is extended. In the meantime the committee would submit the following preliminary table:

Material.	Safe bearing power, tons per sq. ft.		
Quicksands and wet soils	0.1	to	1.0
Dry earth, according to depth below surface	1	to	3
Moderately dry clay confined	2	to	4
Dry stiff clay	4	to	6
Sand confined	2	to	6
Sand compact and cemented	4	to	8
Gravel cemented	8	to	12
Rock	25	to	200

Foundations should be carried down below frost unless they are on rock and thoroughly drained. Soil that contains the roots of plants is generally compressible. Undisturbed soil is much less compressible than filling or similar soil, even though it has been in place many years. The bearing power of sand, gravel and dry clay increases rapidly with the depth below the surface of the ground. None but the smallest structures should be founded on earth filling.

The pressure of earth against abutments, wingwalls and retaining walls varies so widely with the character and condition of the earth in question, that nothing more than a few general suggestions can be given. It is hoped that the committee from the Society of Civil Engineers, which is studying the bearing power of soils, will take up this subject also. In ordinary cases where the filling is well drained its pressure will seldom be more than that of a liquid weighing 25 lb. per cu. ft., and is frequently much less. The pressure due to land slides is often several times this amount. If the filling is clayey and is allowed to become waterlogged, its lateral pressure is greatly increased. The effect of the freezing of the filling must also be considered.

Required Waterway.—The usual formula for waterway for culverts is:

$$a = C A^{\frac{3}{4}}$$

in which,

a = Required area of culvert in sq. ft.
A = Drainage area in acres.
C = A constant, depending on the length and character of the drainage area and may vary from about 0.3 to 2.0 in regions where the mean annual rainfall is about 50 in.

The capacity of the culvert will be much greater if the wingwalls are flush with the abutments and flare about 30°, the sides and bottom of the culvert are smooth and straight, and the bottom has a good slope.

If reliable information covering a number of years can be obtained regarding the adequacy of the old bridge crossing the same stream, it is much more useful in determining the size of a culvert or bridge than any formula.

PANAMA CANAL EXCAVATION.

The grand total of Panama Canal excavation to February 1, 1914, was 216,966,610 cu. yd., leaving 15,386,390 cu. yd. remaining to be excavated under the revised estimate of July 1, 1913. The total excavation for the month of January was 1,514,972 cu. yd., as compared with 1,581,726 cu. yd. for December. The wet excavation amounted to 1,118,464 cu. yd., and the dry excavation to 396,508 cu. yd.

ALASKA TIMBER CONTRACTS.

Arrangements have been made by the United States Forest Service to advertise for bids for 40,000,000 feet of Sitka spruce and hemlock timber in the Tongas National Forest, Alaska. The timber is in two bodies, the larger consisting of 38,000,000 feet on the Fish creek watershed, Baranoff Island, 30 miles north-east of Sitka, and the other 2,000,000 on Thorne River, Prince of Wales Island. Six years will be allowed for the removal of the larger tract and two for the smaller. The initial rate of $1 per M. for the spruce and 50 cents per M. for the hemlock, with two optional increases in the stumpage rates not to exceed 50 cents per M. in the Baranoff tract and one such increase in the Prince of Wales tract, is provided for.

RIVER IMPROVEMENT IN RUSSIA.

It is reported from St. Petersburg that the Russian Government has given to an American syndicate of capitalists the contract for the contemplated improvements on the Volga River and its tributaries. The work includes extensive dredging, is to be supervised by an American staff of engineers, will be finished within 5 years, and is estimated to cost 500,000,000 roubles.

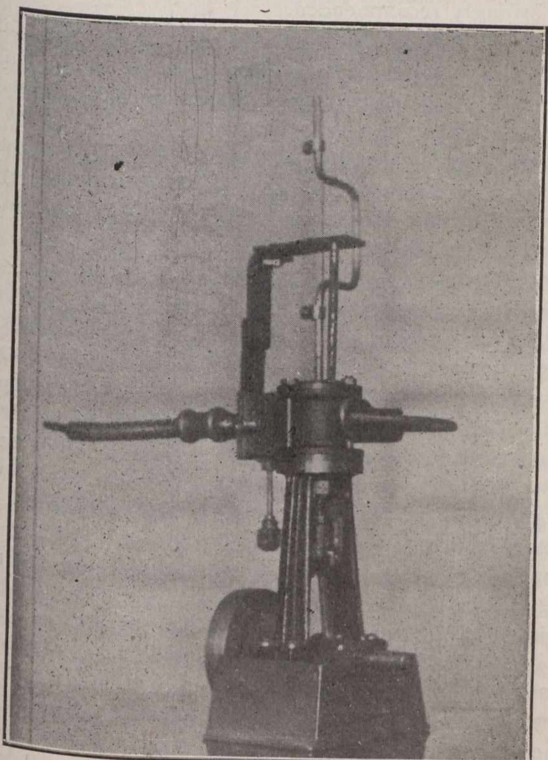
Fraser and Chalmers of Canada, Limited, 4 Phillips Place, Montreal, have been appointed Canadian agents for W. H. Allen, Son and Co. Limited, of Bedford, England, engineers and builders of steam, hydraulic and d.c. electric machinery.

Canadian Allis-Chalmers, Limited, Toronto, have been appointed exclusive agents for Canada and Newfoundland, of the Avery automatic scales. The parent factory, at Birmingham, Eng., was established almost 200 years ago. The scales are of value in power plant installations for checking the amount of coal and water feed to boilers, in weighing liquids for sugar and oil and other industries, and in cement plants to determine automatically the proper proportions of the various ingredients. The Avery scale in the Canadian Government elevator at Port Colborne is said to be the largest automatic grain scale in the world.

A NOVEL USE FOR A STEAM ENGINE.

Mr. W. L. McLaren of Ottawa sends in the following interesting description of an impromptu method which he applied to cutting irregular holes and spaces in some thin pieces of metal. Finding that drilling and filing these holes by hand promised to occupy a considerable time he devised a method of using a small upright steam engine which he had made several years ago for experimental purposes. The stroke and bore of the engine were each about 1 inch in dimension.

After removing the piston rod and head, a hole was drilled the size of the former in the centre of the cylinder head, and the shank of the saw, being of the same cross-sectional area as the piston, was run entirely through and connected with the cross head in the same position is the piston.



To reduce the number of moving parts, the eccentric and eccentric strap were removed, and the fly wheel of the engine was then belted to the countershaft on his bench lathe.

A table was improvised, using an ordinary clamp and a couple of pieces of flat iron as shown in the accompanying photograph, the pieces being bolted so as to allow of small adjustments. The outfit could be readily taken down or set up in a few minutes' time.

The question arises why the shank of the saw was not merely connected directly to the piston and the apparatus run by steam. This was not feasible as steam was not available, and because the engine was of such a small size that it would hardly generate sufficient power to do the work; whereas, when the outfit is operated by belt it transmits sufficient power and allows a variation of speed by the changing of the speed of the countershaft.

By plugging the hole in the centre of the cylinder head the steam engine may again be used for its original purposes.

The Dominion Engineering and Inspection Company, of Montreal and Toronto, have been appointed to inspect the fabrication of the travelers to be used for placing the centre span of the Quebec bridge. These travelers will be manufactured by the Structural Steel Co., Limited, for the St. Lawrence Bridge Company.

SOME FEATURES OF THE MACHINERY EXHIBIT AT THE PANAMA PACIFIC-INTERNATIONAL EXPOSITION.

Such great advances have been made during the last decade in the perfecting of methods of shaping metals, that many of the machines for this work are of extreme interest. Also, the improvement in the processes of producing purer metals has contributed its part toward making many of these methods possible and practicable. Every visitor to an old-time machine shop, and such a shop existed up to a very few years ago, recalls the long lines of shafting, pulleys and belts overhead for transmitting power from the engine that drove the shop to the machine that did the work. All, or nearly all, of this arrangement has now given way to the system of driving each machine by electric motor. The steam engine in the shop no longer drives a long line of shafting, pulleys and belts, but drives, instead, a generator, supplying power to the motor mounted on each machine, and, in this way, any one machine may be operated while the remainder of the shop is silent.

The rapidity of work always counts if quality is not sacrificed, and the use to-day of special steel alloys for making cutting tools has rendered possible high speeds of cutting thought impossible a decade ago. Some of these high speed steels are so hard and tough that they can cut an enormous chip from a piece of metal, making both chip and tool point red hot, yet not wearing away unduly the point of the tool.

These machine tools include lathes, planers, shapers, drills; boring, milling and slotting machines, besides tools for special kinds of work. In fact, a milling machine might be called a special tool, as it can do a remarkable variety of intricate work in shaping metal, and its precision is far greater than can be obtained by hand work.

Among the most interesting of the special machines that will be shown at the Panama-Pacific-International Exposition in celebration of the completion of the Panama Canal is the screw-cutting machine, which makes not only wood screws and bolts, but a great variety of articles that are cut from a revolving piece of metal, such as lock tumblers, sewing machine shuttles, hollow nipples for gas fixtures, and the like. These machines are almost human, and an intelligent boy in a shop can look after the operation of a dozen of them. After the machinist sets one of these machines with the proper tools for cutting any of the shapes required, all that need be done further is to feed a 16 ft. rod of metal into the machine and set it going. The machine automatically cuts from the end of this metal the screw or bolt or other article, moving about as if human hands were handling the piece and finally finishing it and dropping it into a box. The machine of its own accord feeds the rod further in, so that another article may be made and so on until the rod is entirely used up, and if another rod is not put in immediately the machine stops of its own accord.

Another extremely interesting and recently developed class of machines is composed of those for grinding curved or flat surfaces. These do not use steel tools, but use various wheels made up of emery or other hard grinding material, which revolve very rapidly and perform the required work. In this way, surfaces may be ground to far truer shape than by any other process yet known; for example, the smooth parts of an automobile engine crank can be cut from the rough forging in a remarkably short time.

The metal presses form still another class of special interest. There are many varieties of these for pressing such things as rifle cartridge cases, lead pencil ferrules, collar buttons, small tin boxes and many other articles. These are made from flat discs of metal, and many of them are shaped completely in one motion of the machine. An interesting process accomplished by one of these machines of the heavy type is that of pressing hubs for automobiles or other vehicles. A hub is pressed, in about 20 different motions of the machine, from a steel disc 15 inches in diameter, and ⅜ of an inch thick. This pressing is done with cold metal, only occasionally is the steel heated to redness to anneal it and keep it from cracking, but it is cooled again before further pressing.

The cutting and shaping of metals is so remarkable that such machines as these, that will be exhibited at the Exposition, will be highly instructive.

NOVA SCOTIA STEEL AND COAL, ANNUAL REPORT.

The annual report for 1913 of the Nova Scotia Steel and Coal Company, recently published at Montreal, stated that the demand for the company's products during the early months of the year had been good. During this period a large tonnage was booked at fair prices sufficient to keep the mills fully employed until the closing weeks of the year, the result being that the outputs of iron ore, pig iron, steel ingots, billets, bars and forgings all showed substantial increases over previous years. Referring to the Wabana iron ore property, the report stated that the company's holdings under title from the Crown now covered 91 square miles; that the submarine development had been further extended by the opening up of levels, cross-cuts, headways and rooms; and that the ore won from this section of the property was over 40 per cent. greater than that of the previous year. It was also reported that good progress had been made in the sinking of the new Jubilee shaft, which would be equipped by 1915 for an output of 1,500 tons per day. A new open-hearth steel furnace was completed during the summer, and a number of improvements to plant and equipment had been carried out.

Investigation of water power development facilities in Nova Scotia has shown that that province has many rivers with capacious lakes for storing purposes, and with a fall from 15 to 100 feet, where from 100 to 30,000-h.p. could be developed at a very reasonable cost. The River Mersey is one of the largest rivers in Nova Scotia. It has a fall of 248 feet from First Lake to tide water, a distance of 17 miles. For power developments already exist on the river, occupying nearly 6 miles of its lower reaches. The whole river has lately been surveyed. It is proposed to raise the level by 20 feet to provide for storage for future developments. Three additional dams are to be built. These dams will transform the river into a series of mill ponds. The total amount of continuous 24-hour shaft horsepower available on the Mersey is estimated at 29,830. The development of this river means the establishment of various new industries in Queen's County.

BACK COPIES WANTED.

One of our subscribers, anxious to bind his copies of *The Canadian Engineer*, lacks the following issues: Aug. 13th, 1909; Sept. 17th, 1909; Dec. 10th, 1909; Jan. 25th, 1912, and would be glad to pay 25 cents per copy for any of them. Will subscribers who happen to have these numbers, and who do not care to keep them, kindly send them in to this office in order that they are put into the hands of the party interested?

Coast to Coast

Winnipeg, Man.—Before proroguing, the Manitoba Legislature passed a bill to grant $2,500,000 for good roads in Manitoba.

Port Arthur, Ont.—The annual report of the city engineer of Port Arthur for 1913 shows a total expenditure on civic works of $889,749.70.

Brantford, Ont.—At the inaugural meeting of the Brantford Board of Trade for 1914, the purchase of the street railway was strongly recommended.

Saskatoon, Sask.—1913 commenced with a civic deficit of $36,280, and finished with a surplus of $15,130. This is shown by the city auditor's final figures recently presented to the city council.

Toronto, Ont.—Toronto received from this February's street railway earnings $72,057.90, compared with $65,156.95 for February, 1913. The total receipts were $461,274.45; and in 1913, $434,380.17.

Sydney, N.S.—It is reported from Pittsburg, Pa., that within the past several weeks, the Dominion Iron and Steel Corporation of Sydney, N.S., has made sales aggregating nearly 20,000 tons to Philadelphia and New England buyers.

Ottawa, Ont.—The report of the eighth year of operation of the Ottawa Light, Heat and Power Company showed a total net revenue for 1913 as $297,766; while the gross revenue was $834,662, an increase of $54,688 over 1912. During the year $808,331 was expended on new equipment.

Edmonton, Alta.—As soon as the Edmonton city council passes the estimates for the civic works proposed for 1914, it is planned to commence immediately the new system of scavenging. It is believed that greater efficiency will be gained and that also a saving of about $25,000 per year will be effected.

Edmonton, Alta.—The monthly report of the Edmonton power house for December, 1913, which was recently received by the city commissioners, shows a surplus of $9,404; also that the revenue derived from the electric light department was $48,872; street railway, $15,124; and from the waterworks department, $10,480.

Ottawa, Ont.—That portion of the main line from Ottawa to the West on the C.N.R., joining with the Toronto-Winnipeg line at Capreol, is expected to be completed before the end of 1914. Some 150 miles of steel have now been laid; and it is expected that within four months the grading of the line will be entirely completed.

Brandon, Man.—The estimates of the city of Brandon for 1914 allow to the finance committee $52,000 in contrast to $81,000 granted in 1913; to the health department $21,297, as against $22,600; to the board of works department, about $36,000, an increase of about $5,000 over last year; and to the fire and light departments, $65,000, whereas in 1913 an expenditure of $61,500 was allowed.

Moncton, N.B.—The report of the Minister of Public Works for New Brunswick shows an expenditure on ordinary bridges of $173,910.36 out of an appropriation of $272,500; on permanent bridges, $525,123.20; on roads, $138,236.12 out of an appropriation of $272,500; on buildings, $27,101.58 out of an appropriation of $30,500; and on wharves, $16,985.91, out of an appropriation of $17,000.

Saskatoon, Sask.—The city council will make formal application to the local government in the very near future to pass upon new by-laws to the extent of $553,586.95, made up as follows:—various civic public works contemplated, totalling $293,755; excess expenditure on by-laws already passed, $167,500; and expenditure on works completed or intended to be completed, for which by-laws have not been passed, $92,331.95.

Hamilton, Ont.—The financial statement of the Hamilton hydro-electric department shows a total expenditure on plant up to the end of February of $541,552; and for the year ending December, 1913, a surplus of $5,494 is reported. The principal items of revenue for the year were:—commercial lighting, $22,203; house lighting, $34,451; power, $28,968; and waterworks, $15,542; and the payment of the city to the Provincial Hydro-Electric Commission for power was $47,307.

Port Mann, B.C.—One of the projects which the C.N.R. has under way in British Columbia is the laying out at Port Mann of an immense series of shops and yards which will cost when completed, millions of dollars. The yard accommodation will find room for over 10,000 cars, while an elaborate scheme of trackage, round houses, shops, wood turning mills, and all the adjuncts of a great modern railroad yard and shops will be featured in the most modern and efficient way.

Moose Jaw, Sask.—The report of Moose Jaw's electrical plant shows a tentative financial statement which estimates that the surplus of receipts over expenditures in 1913 will be around $17,000. The total output at the switchboard for the year was 3,762,470 k.w. hours, which is the largest yearly output in the history of the plant. The total amount sold was 2,725,916 k.w. hours. Also the report states that in 1908 the peak load attained was 209 k.w., while in 1913 the highest point reached was 1,475 k.w.

Hamilton, Ont.—The McKittrick bridge to be constructed on King Street West, Hamilton, and the approaches to the bridge, are estimated to cost $110,419, exclusive of the cost of piling. The total cost of the bridge was placed by City Engineer Macallum, including a 120-foot addition to the structure, at $135,000; but so far the cost compiled from tenders submitted and recommended is under this estimate. The Hamilton Bridge Works purpose commencing at once work upon their contract for the superstructure.

St. John, N.B.—The St. John Railway Company reports a successful year's operations, showing a net profit of $66,328.85. A loop extension 1½ miles long has been added to the trackage; new car barns and repair shops, completed; new boiler house and stack in connection with the power plant, erected; considerable new equipment in the power house, installed; and new street cars, purchased. The gas and electric services have been extended and extensive improvements have been made to the company's Seaside Park.

Toronto, Ont.—The public accounts submitted on March 3 in the Ontario Legislature, which show total receipts from all sources for 1913 of $18,472,638, and a total expenditure of $16,091,672, include among the heaviest items of expenditure:—colonization roads, $406,034; Hydro-Electric Commission, $139,592; public buildings, $2,778,689; roads in New Ontario, $1,063,655; advances to the Toronto and Northern Ontario Railway, $950,000; and good roads statutory fund, $288,367. The accounts as presented show a surplus of over two million dollars, but the Government figures a net surplus of $320,000.

Edmonton, Alta.—$41,000 has been subscribed by Edmonton people toward the $50,000 fund to be raised by the Edmonton Industrial Association to explore the natural gas fields at Vegreville. Contracts for boring will be awarded within 10 days. Experts, formerly in the employ of the Governments of Mexico and China, report that commercial gas should be reached in the first well at less than 2,000 feet, in the event of which it will not be necessary to sink more than 1,300 feet on the other two. If the exploration work is successful the industrial association will turn the fields over to the municipality at actual cost.

Newcastle, N.B.—The wireless station at Newcastle is fast nearing completion. One of the two powerful engines, each of 200 h.p., has been erected and tested satisfactorily. The engines are of the Diesel type, burning crude oil, and were manufactured in Legano, Italy, by the Franco Tosi Co., and erected under the personal supervision of Mr. Oslander, of that firm. The work of installing the dynamos and electrical apparatus has been done by Mr. Phael, of Berlin, Germany. Although no messages have been sent from Newcastle, several have been heard in passage from one station to another, mostly from the Glace Bay station.

Prince Albert, Sask.—The Provincial Government is being urged to put in operation the act passed at its last session to provide for the raising of further funds to finance the Prince Albert hydro-electric undertaking. The plant is located at La Colle Falls, and already $840,000 has been spent by the municipality in its construction; but the difficulty confronting the city and hindering progress on the scheme is that no provision has been made for disposing of the power when it has been developed. The original estimate of the cost of the work was placed at $800,000. It is stated, however, that to complete the project satisfactorily, an additional $1,000,000 will be required.

Swift Current, Sask.—The water has been turned on in the new water supply at Swift Current. A dam of 100,000,000-gallon storage capacity has been constructed by the Ambursen Hydraulic Construction Company, and this will provide for a population of 30,000 with a daily consumption of 50 gallons per head. The dam was commenced in August and finished on December 24 at a cost of $100,000. But the pipe line from the dam to the sedementation basement, which was laid by the McManus Construction Company, was completed only within the past two weeks. This main consists of an 18-inch and a 12-inch cast-iron pipe, and exclusive of the land value, has brought the total cost of the new water supply project up to $150,000.

Vancouver, B.C.—With the exception of a 56-mile section south of Albreda Summit, grading has been finished on the Yellowhead Pass-Kamloops portion of the C.N.R. Grading operations from the eastern end of construction have been completed from railhead near Yellowhead to Albreda, a distance of 75 miles; and track laying will be started early in the spring from both ends. Steel has been installed to mile 121 from Kamloops and five miles south from Yellowhead Pass. Several bridges have to be built south of Albreda Summit over the upper reaches of the Fraser River, and a viaduct is now in course of erection over Lyon Creek, a big gully 122 miles north of Kamloops. The latter will be 1,450 feet in length and will be one of the largest bridges on the section.

Victoria, B.C.—The Provincial Government has cut its estimates of expenditure for the year beginning on April 1 by over $4,000,000 less than the estimates furnished for 1913. The estimates call for an outlay for all services of $13,742,000.40, the supplementaries for the year 1913-14 come to $1,298,179.07, and those for the year 1912-13 to $210,438.91 more, or a total to be voted this session of $15,250,627.58. Last year there was voted a total of $19,003,316.50. The revenue estimated for the coming year is $10,048,915.13, which is $277,170 less than was estimated last year. Among the itemized estimates, there is included an expenditure for public works and buildings of $2,319,500; roads, streets, bridges and wharves, $2,861,000; subsidies, steamers, ferries, and bridges, $96,075.

NEWS OF THE ENGINEERING SOCIETIES

Brief items relating to the activities of associations for men in engineering and closely allied practice. THE CANADIAN ENGINEER publishes, on page 90, a directory of such societies and their chief officials.

TORONTO BRANCH, CAN. SOC. C.E.

On the evening of March 5th, the members of the Toronto branch of the Canadian Society of Civil Engineers met to discuss the draft of standard specifications for concrete and reinforced concrete as presented at the last annual meeting of the society. (See *The Canadian Engineer*, January 22nd, 1914, page 198-203.) About 50 members of the branch were in attendance. Mr. A. F. Stewart presided.

Several hours were spent in an interesting discussion of the specifications. Among those who took part were Prof. P. Gillespie, Prof. C. R. Young, Messrs. C. W. Noble, A. W. Connor, D. A. Molitor, H. F. H. Hertzberg, Frank Barber, W. Monds, E. R. Clarke, C. S. L. Hertzberg, E. P. Muntz, T. R. Loudon and A. H. Harkness.

The discussion involved quite a number of clauses in the proposed specifications, relative to both design and workmanship. Among them might be mentioned proportioning of Tee-beams; vertically reinforced columns; use of re-rolled reinforcing bars, spacing of rods; requirements as to sizes of gravel and sand; percentage of compressive stress to ultimate compressive strength; reinforced cinder concrete; proportioning of columns; the use of stirrups; the weight of 1 cu. ft. of cement as 87½ lbs.; modular ratio; bending moments of beams and slabs; form work; measurement of materials; machine mixing; temperatures of placing concrete, etc.

The scope which the specification should have was likewise thoroughly discussed, it being felt by some that the specifications of the Canadian Society of Civil Engineers should be drawn up as a guide to establishing uniformity in design among its members. Others felt that the specification might be complete in itself so that it could be referred to as occasion required by the engineer in his own specifications, in such a way that points not covered in his specifications, might be dispensed with by a clause requiring compliance with the standard specifications on concrete and reinforced concrete of the Canadian Society of Civil Engineers.

Another point that received a small amount of consideration was one in connection with the advisability of embodying in the specifications clauses covering flat slab design.

It was decided by motion to furnish each member with a copy of his discussion in order that he might prepare it for submission to the committee on reinforced concrete.

The meeting was in accordance with the resolution adopted at the annual meeting in Montreal, whereby the draft was to be subjected to a discussion by the branches, the discussion to be submitted to the committee with instructions to report to the Council of the Society.

The Toronto branch held a midday luncheon at the Woodbine Hotel on Thursday, March 12th. Mr. Geo. G. Powell, Deputy City Engineer, Toronto, was the speaker. A good representation of the members of the branch was present.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

On Thursday, March 5th, Mr. J. Stadler addressed a monthly meeting of the Society in Montreal on the subject of "Pulp and Newspaper Manufacture."

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.

The first National Conference on Concrete Road Building was held in Chicago, February 12th, 13th and 14th. The attendance was between 300 and 400, comprising engineers, contractors, laboratory experts, highway officials and cement representatives. During the sessions 14 reports and six addresses were presented, a notable feature of them all was the earnest endeavour on the part of the speakers to supply the demand for accurate data and scientific knowledge concerning road construction, serviceability and permanence. Although the proceedings of the Convention was restricted to concrete roads alone, with little or no reference to any other type, the subject in itself was found by no means narrow and the sessions produced some valuable information and animated discussion. The conference will undoubtedly result in a greater interest in the general subject of road building, and the educative work associated with the meeting will make itself felt throughout the country.

The results of the Conference were summarized in the recommendations of the Committee on Resolutions, the important points of which are briefly abstracted as follows:—

1. The aggregates should be clean and hard.
2. The sand should be coarse and well graded.
3. A rich mixture should be used.
4. The materials should be correctly proportioned.
5. The materials should be thoroughly mixed.
6. The inspection should be intelligent and thorough.
7. When in doubt, reinforce the pavement.
8. The sub-grade should be of uniform density, thoroughly compacted and drenched with water immediately before placing concrete.
9. The concrete should be of a viscous, plastic consistency.
10. After placing, the concrete should be immediately covered and kept moist and not opened for traffic for four weeks.

Besides the addresses, the principal reports received and discussed dealt with the following topics:—Contraction and Expansion of Concrete Roads; Aggregates for Roads; Preparation and Treatment of Subgrade Reinforcement.

Summaries of reports and addresses will shortly appear in *The Canadian Engineer.*

AMERICAN ROAD BUILDERS' ASSOCIATION.

The 11th annual convention of the American Road Builders' Association will be held early in December next in Chicago.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The Toronto section of the A.I.E.E. held its third regular meeting for the year on the evening of March 6th. Mr. Geo. H. Hill of the General Electric Company, Schenectady, N.Y., presented a paper entitled "High Tension Direct Current Railways." The address was illustrated by motion picture and lantern views.

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.

At its meeting on February 27th, the members of the Engineering Society of Queen's University were addressed by E. L. Cousins, B.A.Sc., Chief Engineer, Toronto Harbor Commission, who spoke upon the proposed improvements to the Toronto water front. In the course of the description of the supposed development of the Toronto harbor improvement (which was outlined in part in *The Canadian Engineer* for November 21st, 1912), Mr. Cousins announced some interesting points that have lately developed in connection with the scheme.

AMERICAN CONCRETE INSTITUTE.

The 10th annual convention of the American Concrete Institute, the new name adopted last July by the National Association of Cement Users, was held in Chicago, February 16th to 20th. Between 150 and 200 members and guests were in attendance. The annual Chicago Cement Show, which was held February 12th to 21st, in conjunction with the Convention and also with the Conference on Concrete Road Building made Chicago a rendezvous for road builders and manufacturers of cement and road building machinery to such an extent that the broadening use of concrete was strongly reflected in many ways.

A review of the technical committee reports and papers presented at the annual convention will be published in an early issue of this journal.

ILLINOIS WATER SUPPLY ASSOCIATION.

The sixth annual meeting of the Illinois Water Supply Association was held at the University of Illinois, March 9th to 11th. The subjects covered by addresses and reports were broad and included practically every phase of the problem of obtaining and conserving an abundant supply of pure water for the towns and cities of the State.

Among the papers which were read might be mentioned the following:—Removal of Anchor Ice by Means of Air; Remodeled Underdrain System for a Mechanical Filter Plant; Water Treatment for Railroads; Underground Movement of Contamination; Locating Leaks in Water Mains by Means of Water Hammer; the Use of the Nitrite Test in Determining the Source of Pollution of a Water Supply; the Addition of Inorganic Salts to Culture Media Employed in Water Analysis; Public Control of Water Supplies in Illinois; Rates and their Relations to Meters; Surface Water Supplies of Illinois; Value of Mathematics in Economic Design of Some Water Works Detail; Relations of Out-of-Pocket Cost to Rate-Making; Necessity for State Supervision of Water Purification Plants; and others.

COMING MEETINGS.

AMERICAN WATERWORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11-15, 1914. Secretary, J. M. Deven, 47 Slate Street, Troy, N.Y.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—To be held in Montreal, May 18th to 23rd. 1914. Mr. G. A. McNamee, 909 New Birks Building, Montreal, General Secretary.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30 to July 4, 1914. Edgar Marburg, Secretary-Treasurer, University of Pennsylvania, Philadelphia, Pa.

AMERICAN PEAT SOCIETY.—Eighth Annual Meeting will be held in Duluth, Minn., on August 20, 21 and 22nd, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.

PERSONALS.

H. DOUGHTY, superintendent of the Regina Municipal Street Railway, has submitted his resignation to the City Council, to take effect April 30th.

It was announced in these columns recently that GEO. D. MACKIE had been appointed city engineer of Moose Jaw. His correct official title is Engineer Commissioner.

PROF. J. ANSEL BROOKS, of Brown University, on March 2nd, delivered an illustrated lecture on "The Principles of Efficiency Engineering Applied to Highway Engineering," before the Graduate Students in Highway Engineering at Columbia University.

MAJOR W. W. CROSBY, M.Am.Soc.C.E., Chief Engineer, Maryland Geological and Economic Survey and Consulting Engineer, Baltimore, Md., on February 28th delivered an illustrated lecture on "The Value of Cost Data in Highway Engineering," before the Graduate Students in Highway Engineering at Columbia University.

FILIBERT ROTH, Dean of Forestry at the University of Michigan, addressed a meeting of the University of Toronto Foresters' Club, on March 5th. Prof. Roth was born in Germany, but came to America over 40 years ago. Since then he has seen almost every phase of life on the ranch and in woods, city and university. His forest school is now the largest in America.

ROBERT W. ANGUS, Professor of Mechanical Engineering, University of Toronto, delivered a lecture on the proposed Victoria Park water supply scheme for the City of Toronto, to a meeting of the Engineering Society of the University, on Monday, March 9th. The scheme, in connection with which Prof. Angus was consulting engineer to the Department of Works, was outlined in *The Canadian Engineer* for January 22nd. (Page 227-232.)

W. W. PEARSE, a prominent structural engineer of New York City, recently addressed the Ontario Association of Architects on "Structural Problems in New York Fireproof Buildings." Economical design of steel for floors, different types of fireproof floors were discussed and wind bracing and foundations analyzed. There was a special discussion on reinforced concrete and some very useful formulæ were given for the architects' use, as Mr. Pearse pointed out, Toronto and New York codes are similar in many respects.

OBITUARY.

E. R. DOE, head of a prominent Victoria contracting firm, died recently at the age of 47. Mr. Doe, formerly a native of Norway, with his brother, had undertaken and successfully completed a number of important engineering contracts in British Columbia during the past ten years. At the time of his death, he was engaged in constructing a steel bridge over Arbutus Canyon, B.C.

The Imperial Wire and Cable Co., Limited, and the Northern Electric and Manufacturing Co., Limited, have been consolidated into one company, which will be known in future as the Northern Electric Co., Limited. The new company will continue to operate without change in management.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

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

21413—February 27—Suspending, pending investigation by the Board, tariffs of the G.T.R., Wabash R.R., Central Vermont Ry., Rutland R.R., Michigan Central R.R., and Toronto, Hamilton, and Buffalo Ry., C.P.R., and Quebec Central Ry., requiring additional railway tickets for exclusive use of drawing-rooms or compartments in sleeping or parlor cars.

21414—February 9—Approving detail plans of the subways to be constructed by the C.P.R. Forsyth Branch, in the City of Maisonneuve, namely: Desjardins St., Pie IX. Ave., Jeanne D'Arc St., D.Orleans St., Bourbonniere St., Charlemange St., Lasalle St., and Latourneux St.

21415—February 23—Relieving, for the present, the G.T.R. from providing further protection at the crossing of the 4th Con., Twp. of Raleigh, or the third public road west of Chatham station, Ontario.

21416—February 26—Authorizing the Kaministiquia Power Co. to construct the said temporary trestle and sluice way across the C.N.R. at a point 1,390 feet west of Kakabeka Falls station, Ont.

21417—February 27—Approving plan of the Edmonton, Dunvegan and B.C. Ry. showing design for fifty-foot half-deck plate girder span of bridge to be constructed over the Athabasca River, at mileage 131 west of Edmonton, Alta.

General Order No. 121—Rescinding General Order No. 109, as from March 1st, 1914.

21418—February 14—Authorizing the C.P.R. to construct, maintain and operate a branch line of railway, or spur, on Harbor Quay, town of Goderich, Co. Huron, Ont., at mileage 111.8 on the C.P.R. Guelph and Goderich Subdivision.

21419—February 24—Amending Order No. 20817 by adding the following words after the words, "It is ordered that," in the first line of the operative part of Order, namely: "subject to the condition that the Applicant consent to accepting a new notice offering $600 instead of $1,200."

21420—February 27—Authorizing the C.L.O. & W. to construct bridge No. 88.0 aross the Trent River, Trenton, Ont.

21421—February 27—Authorizing the Esquimalt and Nanaimo Ry. to construct its railway across the railway of the Anderson Logging Co., near mileage 33 of the extension of the E. & N. Ry., from McBridge Junction to Courtenay; said crossing to be protected by an interlocking plant.

21422—February 26—Amending Order No. 21137 by striking out the words, "men appointed by the G.T.R." after the the word "operated" in the third paragraph of the operative part of the Order, and substituting therefor the words, "by the train crew of the G.T.R. Co."

21423—February 28—Authorizing the C.P.R. to use and operate bridges Nos. 15.69 and 103.7 on its line of railway.

21424—February 28—Authorizing the C.P.R. to construct, by means of grade crossings, the tracks of its Bassano Easterly Branch across road allowances between Sec. 6, Twp. 22, Rge. 3, W. 4 M., and Sec. 31, Twp. 21, Rge. 3, W. 4 M., at mileage 97.8, and between Secs. 28 and 29, Twp. 21, Rge. 4, W. 4 M., at mileage 92.8.

21425—February 27—Authorizing the C.P.R. to construct, maintain and operate branch line of railway or spur in lane in Block 200, town of Swift Current, Sask., to serve premises of John J. Perrigo and Calgary Brewing Co., situate in Subdivision, Lots 7, 8 and 9, in said Block 200.

21426—February 27—Authorizing the C.P.R. to construct, maintain, and operate a branch line of railway, or spur from a point on existing spur in lane in Block 69, thence across Subdivision Lots 7, 8, 9, 10 and 11 of Block 69, Calgary, Alta., to and into premises of Crown Feed and Produce Co., situate in Subdiv. Lots 7, 8, 9, and 10 in said Block 69, on C.P.R. main line, Alta. Div.

21427—February 27—Rescinding Order No. 20407, in so far as it directs a crossing at the west boundary of M. W. Smith's farm.

21428—February 27—Amending Order No. 19546 by striking out paragraph 3 of the operative part of the Order and substituting therefor the following:—

> "3. That the normal position of signals on both lines be at 'danger,' except between the hours of 1 a.m. and 6 a.m., during which period the normal position of signals shall be at 'clear' for the Toronto, Hamilton and Buffalo Railway Company, and at 'danger' for the Applicant Company; and that in the movements of trains of the same or of a superior class over the said crossing, trains of the Toronto, Hamilton and Buffalo Railway Company have priority at all times."

21429—March 2—Extending until the 31st May, 1914, the time within which G.T.R. are to construct and complete siding to and into premises of the Harris Abattoir Co., in Lot 10, Con. 1, Twp. Barton, Hamilton, Ont.

21430—February 24—Approving agreement between Bell Telephone Co. and the Municipal Corporation of the Twp. of Waterloo, dated Feb. 7th, 1914.

21431—February 28—Ordering the G.T.R. to stop its train No. 69 on flag signal at Glanford Station, Ont.

21432—March 2—Amending Order 21310, by inserting between the word Section and the figure 6 the following figure and words, "5 and the Northeast Boundary of Section, in the recital and operative parts of the Order.

21433—March 2—Authorizing the C.P.R. to use and operate bridges Nos. 90.2, 60.6, 63.3 and 0.3 on its line of railway.

21434—March 3—Rescinding Order No. 21402, in so far as it suspends Sup. No. 40 to the C.P.R. Tariff C.R.C. No. E-2353; directing that Sup. No. 44 to the C.P.R. Tariff No. E-2353, be lawfully in effect from and including Feb. 25th, 1914.

21435—March 3—Authorizing the C.P.R. to construct road diversion in Section 3, Twp. 23, Rge. 28, W. 3 M., Sask.; and to construct the tracks of its Swift Current Northwesterly Branch Line across such diversion at mileage 101.07.

21436—March 3—Ordering the C.P.R. to appoint and maintain a station agent at Ralph, Sask.

21437—March 3—Authorizing the C.P.R. to construct, maintain and operate extension to trackage for the Crown Grain Co., Limited, Winnipeg, Man., from a point on existing spur of the C.P.R. in Block G, St. Boniface, Man., on the C.P.R. main line, Manitoba Division.

21438—March 3—Relieving for the present the G.T.R. from providing further protection at the crossing of Main St., just east of Thorndale Station, Ont.

21439—March 3—Granting leave, subject to terms and conditions contained in said by-laws, to the Hamilton St. Railway to cross with its tracks, at rail level, the tracks of the G.T.R. (Northern and Northwestern Div.), and the tracks of the Hamilton Radial Electric Ry. on Kenilworth Ave., in the Twp. of Barton, Co. Wentworth, Ont.

21440—March 3—Ordering the American Express Co. to put in a twenty-three (23) cent rate from Springfield to Hamilton, Ont.; said rate to become effective not later than April 3rd, 1914.

General Order No. 122—Rescinding General Order No. 116, dated December 24th, 1913.

21441—March 3—Establishing collection and delivery limits of the Express Companies in the city of Edmonton, Alta.; and rescinding Order No. 20972, dated Oct. 31st, 1913.