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Index to Volume 24

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JANUARY to JUNE, 1913

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The Canadian Engineer

An Engineering Weekly

OVERCOMING OBSTACLES IN RAILWAY LOCATION.

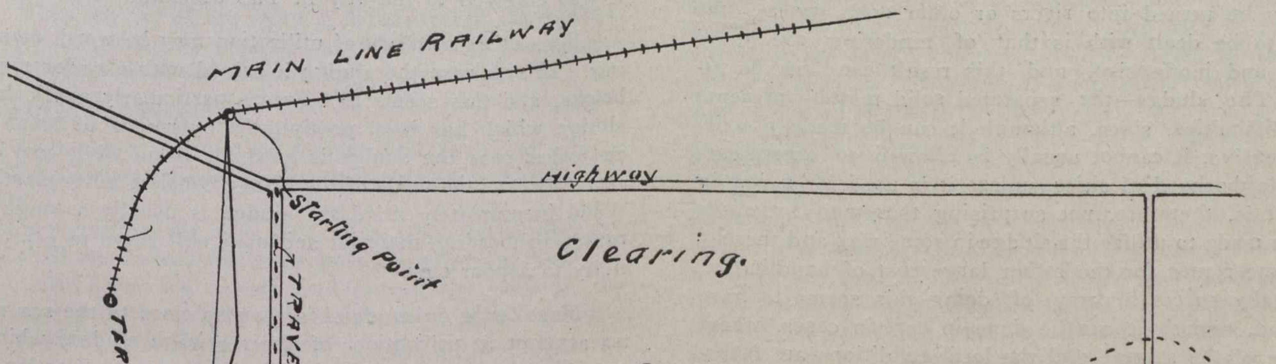
By J. A. MACDONALD.

Greater economy of cost of construction is usually required in an old, settled country than in a new and comparatively unknown one. It was required to run a line on a portion of the Intercolonial from one point to another, a distance of about three and one-half miles, as the crow flies, but over five miles by the reconnoissance route picked out, roughly, by the engineer.

by the four roads, was mostly woods, and known to be almost a solid swamp.

The instructions were to find a cross-country route, if at all feasible, rather than the long round reconnoissance route which, if a long way round, was, however, feasible.

The first thing we did was to run a traverse along the road, as shown in the plan, taking levels as we went along



The engineer had procured a fairly good map of the country, and with this map and provided with barometer, hand-level and compass, drove through the country in a horse and buggy. From the point marked "starting point" on the accompanying map he drove east along the road about two miles to where a road runs northwards towards the objective point. At the junction of those two roads was very high ground. To the left, that is the territory enclosed

and also of setts every 100 feet when we reached the higher ground. This traverse we plotted in both plan and profile. Next we proposed to run a line across through the swamp, starting at stat. 9 + 20, to ascertain the real nature of the country. It might not be as bad as expected. Off our plot we took a bearing for our trial line across the swamp. As we went along with this line we found that, to our right, the swamp ended a short distance from our tangent. Then we took offsetts to the right as we went along with the line. This line, with the offsetts we plotted on our map, also profiles of the offsetts. In this way we had a definite and complete map of our territory. We found that we could get a good cross-country line. This we plotted out on our map and ran it, thus saving at least one and one-half miles of construction in a line only 3½ miles long as the crow flies, besides getting a line of relatively low cost, as cuts and fills were light.

This method would not, of course, answer in a new country where nothing was known of its topography, but for new work in the older, settled parts of Canada it is almost of absolute necessity. The accompanying map and plan illustrates the methods.

THE USES OF SEWAGE SLUDGE.

By H. P. Bell.

With modern methods of treating sewege the disposal of the liquid effluent is comparatively a simple matter. Since it cannot be made to serve any useful purpose and must eventually be turned into rivers or other open waters, the problem to be dealt with is that of rendering the liquid harmless and inoffensive, and this result can now be attained. The sludge—the separated solid matter—presents greater difficulties, since, although it can be made practically inoffensive, it cannot usually be allowed to accumulate in the neighborhood of cities, unless it is used for filling in land. It is, therefore, not surprising that many attempts have been made to utilize the sludge in some way and thereby to get some return for the rather large cost of handling it. No generally successful way of doing this seems to have been found, though it can be done in certain cases, where the nature of the sewage and the local conditions are favorable.

The solid matter which is usually obtained is a porous material, which retains a very large percentage of water, and two great disadvantages result from this. Firstly, the volume of wet sludge to be handled is very large in comparison with the weight of solid matter which can be utilized, and secondly, the removal of the water is a matter of considerable expense. The percentage of water is frequently as high as 90 per cent.; it may be lower with suitable methods of precipitation and separation, but is hardly ever less than 75 per cent. The greater part of this water must be removed before the material can be of any use.

In China and Japan crude sewage is spread over the fields as a fertilizer, and in China enormous quantities are conveyed for the purpose from the large cities, usually by boats on canals, with which the country is so well provided. The practice is probably very ancient and seems to be effective enough under eastern conditions. Sewage, however, not only has a low value as a fertilizer, but tends to clog the pores of the soil, owing to the great quantity of fine suspended matter which it contains. This difficulty can be got over in the east, where, with a good supply of cheap labor for hand cultivation, the soil can be continually broken and turned over. Experiments in the same direction which have been made in Europe have not given satisfactory results, and in western countries, apart from the necessity of rendering the sludge inoffensive, it must be dried off before it is of any use for agriculture. Even then, its value as a fertilizer is so low that the material can hardly ever be worth the cost of transport to any distance, though it may be worth mixing with richer fertilizers, where suitable conditions are to be found locally.

The use of the sludge as a fuel has been recommended and tried, and may be practicable where plant is in use for producing heat and power by destruction of town refuse; the sludge may also be mixed with coal for use in gas producers. Illuminating gas has been made by heating sludge in retorts, but the cost of manufacture is said to be high in proportion to the value of the gas. For any such purpose the sludge must be dried till it contains only about 25 per cent. of water. The calorific value of the completely dried material is only about half of that of good coal. To produce one pound of sludge dried by heat to 25 per cent. of moisture would take about a quarter of a pound of good coal or more than half a pound of the dried sludge itself.

The recovery of grease from sewage may prove sufficiently profitable, at any rate in places where the sewage contains a fairly high percentage of grease. Among such places are those where the working-up of raw wool is carried on on a large scale. Until lately, the methods of recovery usually took the form of extraction by solvents, such as benzine, etc., and apart from the cost of the solvents, the process was rather troublesome and expensive. A method of driving off the grease by means of steam has been introduced in England by Dr. Grossmann, and is said to give good results; it was referred to recently in The Canadian Engineer.

Two other methods of utilization may be worth mentioning. In one case the sludge is mixed with clay for making bricks, and this seems to be more particularly applicable to sludge which has been precipitated by means of lime. In the other case the sludge is used for briquetting coal dust. In both cases the value of the sludge consists in its plasticity. When incompletely dried the sludge is usually a tough and rather rubber-like material and may well serve to give plasticity to a poor clay.

Most large cities which are on or close to the sea make no attempt at utilization of their sewage sludge, which is carried out to sea and dumped in deep water. London, for instance, keeps a fleet of hopper barges for this purpose. At inland places, where the difficulties of disposal are much greater, there seem to be better chances for some kind of utilization, but it is likely that whatever is done in this direction will be done on account rather of local necessities than of any value which may be got from the results.

ONTARIO'S GOLD RESOURCES.

Gold bullion was produced at fourteen properties in Ontario last year, from none of them in large quantity. The principal contributor was The Canadian Exploration Company at Long Lake. At Porcupine the Hollinger and Vipond mines operated small test mills previous to the fire, and the Dome recovered considerable gold in the laboratory. Other producers were the Kenora (formerly Mikado) and Olympia, both at Shoal Lake; St. Anthony (Sturgeon Lake); American Eagle and Detroit Syndicate, in Munro township; Gold Pyramid, in Guibord township; Swastika; Havilah (formerly Ophir); Dr. Reddick (Larder Lake), and the Tingley prospect (Pelican Lake). The number of men employed at the foregoing mines was 597, to whom wages were paid amounting to $442,519. It is evident from these figures that most of the labor was employed in development and construction work, is Mr. T. W. Gibson's summing up in the twenty-first annual report of the Ontario Bureau of Mines.

The revival of interest in gold mining caused by the discoveries at Porcupine and the developments now under way there has put new life into a number of the older fields, which for years have lain dormant.

SPECIFICATIONS FOR ROADS OF DIFFERENT TYPES.

The following specifications are those used by Chief Engineer E. A. James, of the Board of Highway Commissioners of York County, Ontario, on the roads being built under his design and supervision throughout the county of York:

Specifications for Dolarway Pavement.

PREPARATION FOR THE ROAD BED.

1. All streets, prior to laying the pavement thereon, shall be graded as directed by the Engineer. After excavating the sub-grade unless the Engineer deems the natural ground a proper foundation, excavation shall be continued until solid ground is reached and then refilled to sub-grade with sand, cinders, gravel or broken stone.

2. When the street shall have been graded and shaped to its proper form, it shall be thoroughly rolled with a roller weighing not less than six tons, to a thoroughly compact surface. If the ground is wet, cinders, sand or gravel are to be put on before rolling.

3. Any depression discovered after this rolling shall be filled to sub-grade, re-rolled, and this repeated until a roadbed perfect as to grade and form shall have been made.

4. When the use of the roller is impracticable, the foundation must be thoroughly puddled and rammed until compacted to the satisfaction of the Engineer.

CONCRETE FOUNDATION.

5. Upon the sub-grade thus formed shall be placed a layer of Portland Cement Concrete seven inches thick to be made as follows:

The concrete for the base shall be so proportioned that the cement shall overfill the voids in the fine aggregate by at least five (5) per cent., and the mortar shall overfill the voids in the coarse aggregate by at least ten (10) per cent. The proportion shall not exceed one (1) part cement to eight (8) parts fine and coarse aggregates.

When the voids are not determined the concrete shall have the proportion of one (1) part cement, two and a half (2½) parts fine aggregate and four (4) parts coarse aggregate.

The method of measuring the materials for the concrete, including water, shall be one of which will insure separate uniform proportions at all times. A bag of cement (94 pounds) shall be considered to have a volume of one (1) cubic foot.

6. The gravel to be free from clay or other injurious material and shall contain no stone over two and one half (2½) inches in diameter.

7. If broken stone is used for concrete it shall be of the best quality of limestone, or other stone equally good, and shall be broken to such a size that the fragments shall not be larger than will pass through a 2½-inch ring and not smaller than ½ inch in its longest direction. It shall be free from dust, dirt, loam or other injurious material and shall be screened when necessary to remove dust and small particles.

8. The cement used in the work will be submitted to the tests approved and recommended by the Canadian Society of Civil Engineers, and any Cement failing to comply with these requirements, shall be rejected. All Cement used in this work shall be suitably protected from exposure to moisture until used.

9. After the sand and cement have been thoroughly mixed dry, in a mixer approved by the Engineer, enough water shall be added to produce a mass that will settle in place without tamping and not so thin that water will show on the surface.

10. Extreme care should be taken that the sub-grade is kept moist while this concrete is being put in place.

11. No re-tempering of concrete will be permitted, and that in which mortar has begun to set, shall be rejected.

12. No concrete shall be laid when the temperature at any time during the day or night falls below thirty-five (35) degrees above zero, Fahrenheit.

13. Suitable Expansion Joints shall be provided at each curb line and at points every fifty feet across the roadway. The transverse joints shall not exceed three-quarters of an inch in width, and the longitudinal joints shall be one inch in width. These joints shall extend the entire depth of the pavement and be filled with DOLARWAY BITUMEN and fine sand. Great care shall be taken to fill these joints flush with the surface of the pavement, before the wearing surface is applied.

WEARING SURFACE.

14. After the concrete has been laid as above specified, and is perfectly clean and dry, there shall be spread over the entire surface a layer of DOLARWAY BITUMEN, using not less than one-third of a gallon to the square yard, said bitumen to be applied at a temperature of not less than 175 degrees Fahrenheit or more than 200 degrees Fahrenheit.

Immediately following the spreading of the Bitumen there shall be spread over the entire surface a uniform layer of dry, clean granite, trap or other approved rock screenings, using not less than one (1) cubic yard to one hundred and fifty (150) square yards of surface. No bitumen shall be applied when the temperature is below 40 Fahrenheit and the screenings shall be applied while the bitumen is sufficiently soft for the sand or screenings to be imbedded in it and unite with it. After the screenings are spread, the street shall be closed to travel for a period of not less than two (2) hours, after which the street may be opened to travel.

PATENTS:

15. All fees for any patent invention, article, agreement, or other apparatus that may be used upon or be in any way connected with the construction, erection or maintenance of the work, or any part thereof, embraced in the contract or these specifications, shall be included in the price stipulated in the contract for said work, and the contractor or contractors must protect and hold harmless the Corporation against any and all demands for such fees or claims. At least two trademark plates for every 200 lineal feet or less of pavement shall be set by the Contractor at conspicuous places in the pavement.

16. The contractor shall furnish a satisfactory surety bond guaranteeing the maintenance of the pavement during the period of three (3) years from and after the date of completion of the same. The maintenance, however, shall not include any damage to the pavement or to the foundation thereof, or to any of the damage items of work embraced by the contract, which may be incurred by action beyond the control of the contractor.

SPECIFICATIONS FOR BRICK PAVEMENT WITH CONCRETE FOUNDATION

CONCRETE FOUNDATION.

Preparing sub-grade.—The sub-grade is to be formed to the levels and cambers shown on sections; where the ground is soft or otherwise unsuitable it shall be removed and refilled with gravel, broken stone or other approved material, the whole sub-grade shall then be thoroughly rolled with a roller weighing at least eight tons, any depressions discovered after this rolling shall be filled with approved material and re-rolled until brought to the proper levels and camber.

Filling in embankments must be applied in layers of eight (8) inches in thickness and each layer thoroughly rolled.

Tile drains shall be placed under the edge of the concrete or in such places as shall be directed by the Engineer.

Concrete foundation.—When the sub-grade has been completed a layer of Portland Cement Concrete 5 inches thick shall be placed.

The broken stone for the concrete shall be hard quality limestone, free from all refuse and foreign matter, with no fragment larger than will pass, in its longest dimensions, through a 2½-inch ring, and not smaller than half an inch in its longest dimensions.

The sand is to be clean sharp sand and free from clay or other injurious material and to be thoroughly dry when first mixed with the cement.

The cement used shall be an approved brand of Portland Cement, and will be submitted to the tests approved and recommended by the Canadian Society of Civil Engineers, and any cement failing to comply with these requirements shall be rejected. All cement used in this work shall be properly protected from moisture until used.

The water used for mixing the concrete shall be reasonably clean, free from oil, sulphuric acid and strong alkalies. The cement and sand are to be first thoroughly mixed in a dry state until the whole mass shows an even shade, sufficient water shall be added to produce a plastic mass, fluid enough to settle in place without tamping, but not so thin that water will show on the surface. The broken stone must be damped before being added to this mixture, the whole mass to be thoroughly mixed or turned over at least three times, so that every fragment is coated with cement mixture.

The concrete shall be so proportioned that the cement shall overfill the voids in the sand by at least 5 per cent. and the mortar shall over-fill the voids in the stone or gravel by at least 10 per cent. The proportion shall not exceed one part of cement to eight parts of the other materials. When the voids are not determined the concrete shall have the proportions of one part of cement to three parts of sand and five parts of stone. A sack of cement (94 pounds) shall be considered to have a volume of one cubic foot.

The concrete shall be laid while fresh and within twenty minutes after it has been laid it shall be struck off with a template, and as soon as practical trowelled sufficiently to bring the finer particles to the surface and then broomed. When the surface is finished it shall be kept wet for seven days. Care should be taken that the sub-grade is kept moist while this concrete is being put in place. The whole of the concrete must be thoroughly tamped and no re-tamping will be permitted. No concrete shall be laid when the temperature at any time during the day or night fall below 35 degrees above zero Fahrenheit.

Expansion joints shall be provided at each curb-line and at points every 25 feet across the roadway. The transverse joints shall not exceed three-quarters of an inch in width and the longitudinal joints shall be one inch in width. These joints shall extend the entire depth of the pavement and shall be filled with asphaltic paving cement; great care shall be taken to fill these joints flush with the surface of the pavement, and that no dirt, stone, etc., be left in the joints.

SAND CUSHION.

On the concrete foundation shall be spread a ¾-inch cushion of clean sand, free from loam and foreign matter, and sufficiently fine so that it will pass through a (¼) one-quarter-inch mesh; the sand must be spread by means of a template made to conform to the true curvature of the street cross sections, the compression to be done with a hand roller weighing from three hundred to four hundred pounds.

BRICK PAVING.

The bricks used for paving shall be sound, well-burnt paving bricks, showing at least one fairly straight face, free from cracks and excessive laminations, preferably made from shale. They shall be not less than 2½ in. x 4 in. x 8 in., or more than 3¾ in. x 4 in x 9 in., and shall not vary one-fourth (¼) of an inch in width or depth or more than one-half of an inch in length. The brick shall be reasonably perfect in shape, free from marked warpings or distortion. The bricks shall be carefully laid on edge, with best edge uppermost, as compactly as possible, in straight course across the street, with the length of the bricks at right angles to the axis of the street. Whole bricks only shall be used, except in starting and finishing courses, all fractional batting to be next to the curbs.

Expansion joints shall be provided at each curb line and at points 25 feet apart across the roadway. The transverse joints shall not exceed three-quarters (¾) of an inch in width, and the longitudinal joints shall be one inch in width. These joints shall extend the entire depth of the pavement, and shall be filled with asphaltic paving cement; great care shall be taken to fill these joints flush with the surface of the pavement and that no dirt, etc., be left in the joints.

After 25 or 30 feet of the pavement is laid, every part shall be rammed with a heavy rammer, a plank laid on the surface parallel to the curb to receive the blows of the rammer, or a steam roller not to exceed five tons may be used. When a steam roller is used it shall first be passed slowly back and forth parallel with the curb until the bricks are firmly imbedded in the sand cushion, the pavement shall then be rolled the entire width of the street transversely at an angle of 45 degrees to the curb, repeating the rolling in like manner in the opposite direction. All broken or injured brick must be taken up and replaced with satisfactory ones, which must be brought to true surface by tamping.

FILLER.

The filler shall be composed of one part of clean sharp, fine sand and one part of Portland Cement, thoroughly mixed dry in small quantities, water is then to be added until a mixture is of the consistency of thin cream, which shall be kept in constant motion until all used up. The filler shall be poured into the joints until it appears on the surface.

The sides and edges of the bricks shall be thoroughly wet by sprinkling before the filler is applied. Care shall be taken that the joints are free from sand, etc., before the filler is applied. After the filler has hardened, a half inch coating of sand shall be spread over the whole surface of the pavement; in dry weather this coating shall be kept damp by sprinkling for three days.

SPECIFICATIONS FOR ROCMAC ROAD

Sub-grade.—Before the base course is laid the roadbed shall be shaped to the proper levels and cross-sections and thoroughly rolled with a roller weighing at least ten tons.

After excavating the sub-grade, unless the Engineer deems the natural ground a proper foundation, excavation shall be continued until solid ground is reached and then refilled to sub-grade with sand, cinders, gravel or broken stone.

Any depression discovered after rolling shall be filled to subgrade re-rolled and this repeated until a roadbed perfect as to grade and form shall have been made.

When the use of the roller is impracticable, the foundation must be thoroughly puddled and rammed until compacted to the satisfaction of the Engineer.

Base Course.—The base course shall consist of best quality limestone, broken so as to pass through a 4-in. ring by its longest dimensions and be retained on a 2-in. ring spread and rolled to a finished depth of four inches.

The base course shall be thoroughly rolled with a heavy roller until the surface supports the roller without yielding.

On the base course shall be spread a coating of ½-inch. limestone screenings, which shall be rolled into the interstices until a sufficiently firm surface is obtained to prevent the Rocmac matrix from penetrating the base course. If thought necessary by the Engineer, the base course and screenings shall be watered before the Rocmac is put in place.

Rocmac Matrix.—The Rocmac matrix shall be composed as follows: one-third cubic yard of limestone crushed to pass through a one-fourth web screen and containing 50 per cent. limestone dust; add to this five gallons of Rocmac solution and thoroughly mix on a mixing board into a stiff mortar and at once spread on the base course.

The limestone shall be dampened to facilitate the chemical action of the solution.

The Rocmac matrix shall be spread on a base course to a depth of 1 1/3 inches or about 1/3 cubic yard of matrix to 9 sq. yards of road surface for each additional inch of pavement 1/3 inch is added to the depth of the matrix.

Top Course.—The material for the top course shall consist of trap rock from an approved quarry, broken to pass a 2½-inch ring and be retained on a 1½-inch ring. The trap rock shall be put in place immediately after the spreading of the matrix in such quantities as will give a finished depth of 3 inches sprinkled with water and rolled with a roller weighing ten tons.

The road is to be rolled rapidly until the matrix appears on the surface, and is then rolled as slowly as possible; as the matrix rises it is to be brushed with a hand-broom so as to prevent it lying in particles.

If the stones are picked up from the road by the roller wheels the latter are to be sprinkled with water.

The roller is to be continued until the whole surface of the road is thoroughly flushed up with the matrix and supports the roller without yielding; the surface is then to be spread with a thin coating of limestone dust to absorb excess of solution and to form a cushion while the process of setting is going on.

SPECIFICATIONS FOR WATERBOUND MACADAM PAVEMENT

M. 1.—BROKEN STONE.

The contractor shall submit with his bid a written statement of the quarries, ledges or other source of supply from which he proposes to obtain the stone for the road, together with a sample of such stone weighing at least 30 pounds. If the proposed quarries are developed and a uniform product satisfactory to the Engineer can be obtained from them, this will be accepted and the contractor will be so informed. If after trial it is found that for any reason product from any source at any time proves unsatisfactory to the Engineer, he may decline to continue its use and can require the contractor to develop other quarries of source of supply, and the contractor shall have no claim for increased payment on account of such requirement. If the qualities of the sample of stone submitted are satisfactory to the Engineer and are accepted by him, the sample will be retained and all stone brought on the road inferior in character to the sample will be rejected. All broken stone used must be hard and compact and of uniform character. It must have enough cementing value to thoroughly bind the surface of the road after rolling. The broken stone shall have the rough surface of fracture, and shall be as nearly cubical as possible. It shall be free from earth or other objectional material, and screened to the required sizes. No soft, disintegrated stone shall be used.

M. 2.—DRAINAGE.

The side ditches and gutters shall have true grades and sufficient incline as provided in the plans and profile to furnish a free and uniform flow of water to the nearest natural outlets of culverts. Where natural outlets are utilized, they shall be so improved where necessary as to carry the water quickly away from the highway. The ditches must conform in all cases to the standard cross-sections for the class of road which is being improved.

SHAPING SURFACE OF SUB-GRADE AND SHOULDERS.

Before the broken stone is spread, the roadbed shall be shaped to a true surface, conforming to the cross-section of the highway, and thoroughly rolled by the steam roller. If the road shows a wavy motion after passing the roller over it three or four times, it may indicate too much moisture in the sub-grade. If on examination this is found to be the case, the rolling should be stopped, the roller moved ahead, and time allowed for the sub-grade to dry out.

M. 3.—SCARIFYING.

When called for on the plans or ordered by the Engineer, the old macadam surface shall be thoroughly scarified by hand or with a mechanical scarifier of an approved type, to the width and depth shown on the plans, after which the loose stone shall be raked to a uniform grade and crown.

M. 4.—MACADAM.

The width of the macadam shall be ... feet, unless otherwise shown on the plans. The macadam road shall be laid in layers of courses, as follows:—

First Course.—First course shall have a thickness of four inches after rolling, and shall consist of limestone that will pass through a 4-inch screen and be retained on a 2-inch screen. No piece shall be more than four inches in length.

The broken stone in this course shall be spread evenly over the sub-grade to such a depth that they will have, when rolled, the required thickness of three inches. Each layer shall be rolled with a self-propelled roller, weighing not less than ten tons, until the broken stone shall not creep ahead of the roller and is thoroughly compacted to the satisfaction of the Engineer. Rolling must, in all cases, begin at the sides of the road and work towards the centre. Under no circumstances shall the centre be rolled first. In case the Engineer should consider it advisable, a thin course of screenings may be spread over this layer of the compressed stone and rolled. If any depressions occur during or after the rolling they must be filled with broken stone of the size that has been used in the course and re-rolled until a firm, even surface is obtained and the course has the required thickness. The Engineer may at any time during the laying of the broken stone require the roller to be operated sixteen hours each day, and the contractor must provide the extra shift operators when so required.

With certain rocks it has been noted that after the roller passes over them a few times, they fail to compact and the sharp edges are broken off. A slight sprinkling of sand or stone screenings or water may prevent this. One after another of these should be tried until the work progresses to the satisfaction of the Engineer. In the case of heavy fills, the roller must not be run to the outer edge of the shoulders unless the fill has had time to settle. The roller should be worked out slowly under these conditions.

Second Course.—The second course shall have a thickness of three inches after rolling, and shall consist of granite stone, which shall pass through a two-inch screen and be retained on a three-quarter-inch screen. No piece shall be more than two inches in length. Broken stone shall be placed and spread, as specified for the first course, and spread to such a depth that it will have when rolled the required thickness. Second course shall be rolled with a self-propelled roller weighing not less than ten tons, until it is completed to form a firm, smooth surface approved by the Engineer. Rolling must in all cases begin at the sides of the road and be worked towards the centre, and care be taken to preserve the grade and the crown of the road. If any depressions occur during or after the rolling they must be filled with broken stones of the size specified for the second course and re-rolled until a firm, even surface conforming to grade and cross-sections is obtained.

M. 5.—WATER-BOUND MACADAM SCREENINGS.

After the two courses above described are thoroughly compacted to the satisfaction of the Engineer in charge, broken limestone screenings that will pass through a three-quarter-inch screen and containing dust of fracture shall be spread in a thin layer over the course of stone and sprinkled sufficiently to wet it thoroughly, but not so much as to saturate the foundation, then rolled and more screenings applied, sprinkled and rolled, until the voids in the course of stone is just covered. Each application of screenings shall be sprinkled until hard and smooth to the satisfaction and acceptance of the Engineer in charge. Screenings shall be applied from piles at the sides of the road, sprinkled from wagons or carts and shall not be dumped on the sub-grade nor upon the layer of course stone in advance of the final surfacing. The Engineer will not permit any travel upon the layer of screenings before rolling. The binder course in all cases must only be sufficient to completely fill the voids and just cover the course of stone after it has been rolled separately and evened up with stone of the same sizes as have been used in that particular course. During final rolling of macadam the earth shoulders outside of the macadam shall be thoroughly compacted by rolling and sprinkling. Any part of macadam that cannot be reached by the roller shall be thoroughly tamped by hand rammer.

M. 6.—GRAVEL SHOULDERS.

Where directed by the Engineer gravel that will pass an 1½-inch ring and composed of hard, durable stone and assorted sizes of finer materials sufficient, but not more than sufficient, to fill the voids, and shall be three inches thick after rolling.

It shall be sprinkled until thoroughly wet and rolled with a self-propelled road roller weighing approximately ten tons until smooth and thoroughly consolidated.

M. 7.—SHOULDER DRAINS.

Shoulder drains shall be constructed according to the plans, on either side of the roadbed, where found necessary by the Engineer.

M. 8.—METHOD OF CARRYING ON WORK.

This improvement shall be started at the end of the road farthest from the source of supply of the broken stones, unless otherwise ordered by the Engineer. All courses of stone shall be carried along as nearly together as practicable. Each course, after being spread, shall be promptly rolled and covered with the next course as soon as possible. No allowance or extra compensation will be made for material driven into the sub-grade, or for mistakes made by contractor in preparing sub-grade.

Before the road will be finally accepted the broken stone surface must be hard, smooth, regular and well-balanced. The shoulders must be rolled down to grade with the required slope to the ditches and thoroughly compacted. Side ditches must be brought to an even grade and provided with outlets as directed by the Engineer, and must be clear of all obstruction.

M. 9.—HIGHWAY INTERSECTIONS AND DRIVEWAYS.

At all highway intersections, private driveways or entrances macadam shall be carried out to full width of the roadbed, at least twelve feet from the centre line, as specified or shown on the plans or as directed by the Engineer in charge.

M. 10.—ROLLING.

Include all rolling necessary to thoroughly compact the sub-grade and broken stone, and in finishing and binding the road.

M. 11.—SPRINKLING.

Include all sprinkling with water required by the Engineer in the construction and finishing the road.

M. 12.—ALTERNATE BIDS.

In each case where an alternate bid is submitted such bid must be accompanied by drawings, cross-sections and a complete description of the materials used and the method of construction employed in building the same. Each alternate bid must further contain the following clause written into such bid:

The prices stated in this tender and stipulated in the contract must be understood to cover every contingency, the furnishing of all labor, materials, power and plant which may be required for the performing and completing of the work described in these specifications and for maintaining same in good order for a period of one year from date of acceptance of the work by the Board of Highway Commissioners for York.

M. 13.—

The work must proceed as rapidly as conditions will allow and not less than 500 lineal feet per week must be completed.

WIDTH OF TIRES.

With the growth of Toronto, the interurban and suburban traffic on our highways has increased, and, with the increase, in the volume of traffic, there has been an increase in the tonnage carried per inch of tire.

Narrow tires carrying heavy loads have a very destructive effect upon the road surface, while wide tires from the point of view of maintenance are desirable. The concentration of the heavy load on a narrow tire has the effect of cutting the road surface, while the same load on a sufficiently wide tire would act as a roller and on improved roads it would be even better if the front end and rear wheel did not track. Wide tires must not be carried to excess, for we will find on a well-crowned road a tire of 5 inches in width would only come partly in contact with the road and the load would be carried on one edge of the tire and the same cutting effect will occur as with a narrow tire.

The wide tire is a distinct disadvantage on bad roads, so that (under present conditions) with a few improved and many unimproved roadways, the question of narrow vs. wide tires is one that will require careful consideration.

If improved roads are to be cheaply maintained there must be a ratio fixed between the width of tire and the load carried for at the present time our roads are requiring to take traffic which is extremely injurious.

The steamship "Vanellus," the latest addition to the fleet of the Cork Steam Ship Company, Limited, Cork, sailed from the Tyne on Tuesday, the 10th inst., on the completion of a very successful trial trip.

The steamer has been built and engined at the Neptune Works of Swan, Hunter & Wigham Richardson, Limited. She is 285 feet in length by 38 feet beam, and carries over 2,700 tons deadweight on 19½ feet draft. She has been constructed to attain the highest class in Lloyds' Register, has accommodation for a few passengers, and is in every way a cargo steamer of the highest class.

Her propelling machinery, which consists of a set of triple expansion engines, supplied with steam by two boilers, and the whole of which have been constructed at the Neptune Works of Swan, Hunter & Wigham Richardson, Limited, worked on the trial trip without the slightest hitch, and gave satisfaction to all concerned, driving the vessel at a speed of over 12 knots per hour.

The owners were represented on the trial trip by Capt. Hore, of Liverpool, their marine superintendent, and by Mr. Flockhart, of Liverpool, their superintendent engineer. After the trial trip, the vessel sailed to take up her station in the company's service between Liverpool, Manchester and Dutch and Belgian ports.

THE BRIDGE OF THE CANADIAN PACIFIC RAILWAY AT LACHINE, P.Q.

In connection with the double tracking of the Canadian Pacific Railway it became necessary to change the bridge which crosses the River St. Lawrence at Lachine, and which is located about two miles above the Lachine Rapids, from a single-track structure to accommodate the double tracks. Some months ago the engineers began the preparation of plans for the widening of the bridge. In order to effect this work it was necessary to change the old structure to a great extent. In the issue of *The Canadian Engineer* of January 18, 1912, the work of enlarging the old piers, which was undertaken by the Foundation Company, of Montreal, was described.

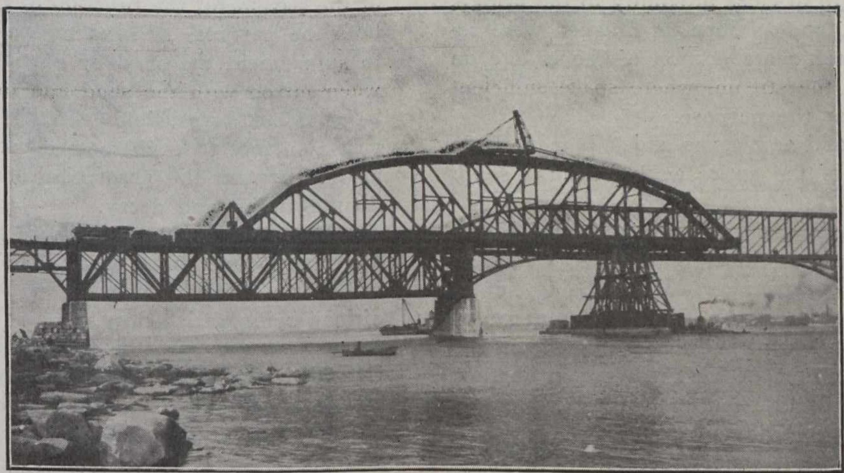


Fig. 1.—Floating One of the New Spans into Position.

It was on July 12, 1910, that the first operation was made on the enlargement of the old piers to carry the new girders before any of the new steel could be swung. This in itself was a huge job, and the Foundation Company undertook to complete the first eleven piers during the first season. However, this was not accomplished, but was completed by November 8, 1911, leaving only one pier on the up-stream side to be finished when the cantilever is taken out. The work on the superstructure was commenced on March 15, 1911, when the placing of the two eighty-deck plates was first undertaken.

The bridge, when completed, will have a total length of 3,138 feet, consisting of six 80-foot deck girder spans, two 122-foot deck truss spans, fourteen 120-foot 8-inch deck truss spans, eight 238-foot 6-inch deck truss spans, four 268-foot 4-inch deck truss spans, four 405 foot 7-inch through truss spans, two 119-foot 2-inch deck truss spans.

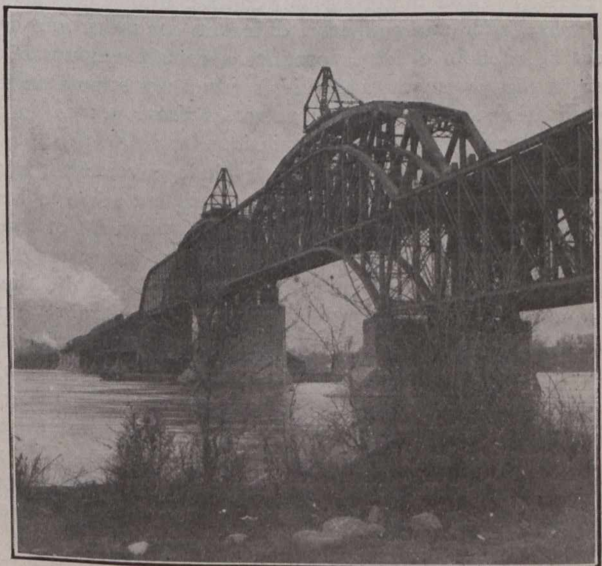


Fig. 2.—General View from South Shore.

The erection of steel was begun at the Highlands end, and by working from the old bridge the new spans for the second track east of the old track were placed out to pier No. 7. By sliding the old 240-foot span and the two new 120-foot spans between piers 6 and 7 it was possible to place a crossover about at pier 6 and turn the traffic over the new east track from that point to the shore. The old structure under the west track was then removed between pier 6 and the shore and the new superstructure placed. The erection of the east half between piers 7 and 12 was then completed and a crossover between piers 11 and 12 was made by slewing the outer end of these two spans so that the new span connected the east side of pier 11 with the west side of pier 12. Traffic was then turned over the east track between pier 12 and the Highlands shore, and the old structure between piers 7 and 12 was dismantled and the new spans were placed. The approach span on the Caughnawaga side between piers 14 and 15 was completed about the same time as the eastern spans between piers 7 and 12, and when traffic was turned over the west track between pier 12 and the Highlands shore the new through truss channel spans for the east track were erected over the deck approaches on either side. The channel spans will be pushed out to place by mounting the back ends on rollers so they can slide over the approach spans, the front ends being carried on scows floating in the river. When these spans are in position, traffic will be turned over this track for the entire length of the bridge, while the south approach span and two channel spans on the west track are

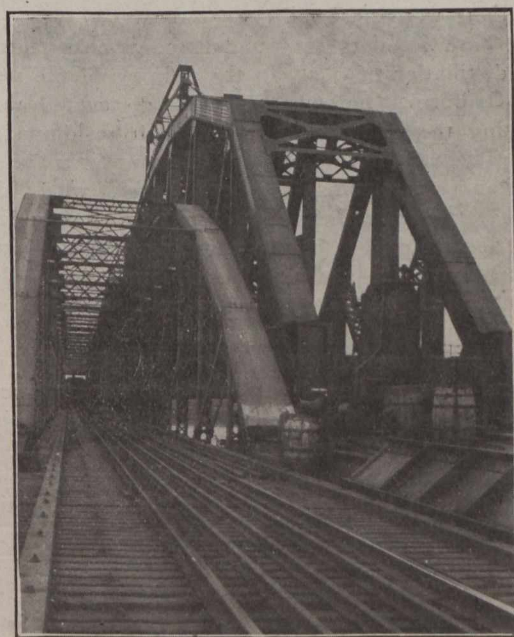


Fig. 3.—View Showing Old and New Spans from the South End.

placed. It is expected that this work will require several months to complete.

It is interesting to note that in the new bridge there are no less than 8,072,252 lbs. of steel. The eight-ft. lengths run 110,000 lbs., the 120's 226,000 lbs., the 240's 960,000 lbs., the 270's 1,324,138 lbs., and the 480's 2,600,000 lbs.

Fig. 1 is taken from a photograph secured while one of these large spans was being floated into position.

The spans were erected at the yards of the Dominion Bridge Company, which are in close proximity to the bridge, connected by a spur line, and as soon as finished were re-erected on the finished deck plate portion of the bridge on the Caughnawaga side of the stream, where space sufficient in length had been left for the purpose.

Fig. 2 shows the old and new spans and it is made from the south end. A view of the entire work from the south shore is shown in Fig. 3.

The design of the new bridge was made under the supervision of Mr. P. B. Motley, engineer of bridges, Canadian Pacific Railway, and the construction work is being supervised by Mr. J. H. Barber. The Foundation Company, of Montreal, built the piers and furnished the equipment on the deep-water piers. The equipment for the piers in shallow water was furnished by the C.P.R., and the work was handled by their men. The Dominion Bridge Company, of Montreal, fabricated and erected the steel superstructure.

BITUMINOUS PAVEMENTS FOR CITY STREETS.

By George W. Tillson.†

The first asphalt pavement of any quantity in this country was laid in 1877 on Pennsylvania Avenue, in Washington, and since that time it has been in general use all over the country. In 1890 in the eight cities of Boston, Brooklyn, Buffalo, Chicago, New York, Philadelphia, St. Louis and Washington, there were 246 miles of asphalt pavement. So great was its popularity that in these eight cities in 1911 there were 2,348 miles.

The hard asphalts save undoubtedly been formed by natural distillation of oils. In the refining of the petroleum oils of California, however, it was discovered that after evaporating the volatile oils an asphalt residuum was obtained. These California oils are different from the Ohio or Pennsylvania petroleums, as these latter, when distilled, produce paraffine rather than asphalt; consequently the Eastern oils are said to have a paraffine base while the California oils have an asphaltic base. Similar oils also have been discovered in Texas, Mexico and on the Island of Trinidad.

The natural asphalts are too hard for direct use in pavements and must be fluxed with some softer material, either an asphalt or a paraffine flux. This mixture of asphalt and flux, after it is prepared for the pavement, is known as asphaltic cement, and as this is the material to be actually used it has been thought by many that specifications for asphalt should specify tests for the asphaltic cement without any regard for the asphalt itself. In the present stage of the industry it would seem to the writer that this is hardly a safe proceeding. A natural, hard asphalt may possibly be fluxed with a certain material so that it will make an asphaltic cement that will be satisfactory in every way at the time it is made, but when laid upon the street and subjected to the action of the atmosphere the lighter parts of the flux may volatilize, so that the pavement will crack badly.

Construction of Pavement.—It is assumed that the pavement is laid upon a stable foundation. This is an important feature in all structures, and particularly so in an asphalt pavement, as the asphalt is simply a carpet, the foundation being the floor which must sustain the actual load. The wearing surface proper is made up of asphaltic cement, sand and mineral dust. The sand is really the wearing part of the pavement, the function of the asphalt being simply to hold the particles of sand together and of the mineral dust to supplement the sand by partially filling its voids so that when mixed with the sand and the asphalt the mixture will be as dense as possible. This is necessary not only to obtain a surface that will best resist the action of traffic, but also to prevent the absorption of water, which would cause disintegration and decay.

There has always been more or less discussion as to the size of the sand to be used. The following classification, it is believed, would produce a first-class pavement, other conditions being satisfactory.

Per Cent. Composition of Standard and Permissible Asphalt Pavements.

	Standard Heavy.	Limits.	Standard Light.	Limits.
Bitumen	11	10.5—12.5	10	9.5—10.5
Passing 200-mesh	12	10 —14	10	8 —12
Passing 80-mesh	26	22 —30	12	10 —14
Passing 40-mesh	34	30 —38	38	34 —42
Passing 10-mesh	17	14 —20	30	26 —34
Penetration 77° Fahr.	45	40 —55	65	55 —75

The relative proportions of the asphaltic cement and the sand and dust to be used will depend upon both the character of the sand and the asphaltic cement and the traffic of the street, as well as climatic conditions. The refined Trinidad asphalt contains approximately 55 per cent. of bitumen, Bermudez asphalt 95 per cent., and the oil asphalts generally 99.5 per cent., and the flux can be considered as being 100 per cent. bitumen. It will be seen that a cement made of these different materials will contain different amounts of bitumen, and consequently different amounts of cement must be used in order to produce a certain amount of bitumen in the pavement, and this is generally stipulated in the specifications. This amount varies from 9.5 to 12.5 per cent., according to general conditions.

In the construction of an asphalt pavement there are two points upon which the practice does not seem to be uniform in the different cities. One is the treatment of the gutter and the other the area adjacent to the street car tracks. Many cities lay a gutter of brick, or stone. While there is no question that a stone or brick gutter is more durable than one of asphalt, it has generally been the practice in the borough of Brooklyn to lay the asphalt up to the curb; in no case has the cost of repairing the pavement in the gutter exceeded the average on the street surface enough to make it necessary to lay the more permanent gutter. The same difference in practice applies to the treatment of the area adjacent to the rails of the street car track, and here the Brooklyn practice has been to lay the asphalt up to the rails themselves without any intervening material. If the tracks are laid in the most approved modern way there is no objection to laying the asphalt up to the rails. On a railroad street the best possible construction, where asphalt is to be used, is to lay the asphalt from the curb to the tracks and pave the remainder of the street with brick, wood or smooth stone blocks. With a modern grooved rail and proper construction pavement can be so laid that traffic will pass across

* Abstract of paper delivered to American Road Builders' Association, at Cincinnati, December 3 to 5, 1912.

† Consulting Engineer to the Borough President of Brooklyn, New York.

the tracks from one side to the other with no appreciable interference.

Maintenance and Repair.—In Brooklyn a municipal plant has been in use for five years, and the cost of repairing all of its asphalt streets out of guarantee has been 3.68 cents per square yard per year. As an indication of the effect of street car tracks upon the wear and tear of pavements, it should be noted that in 1911, in Brooklyn, the cost on street car track streets was 6.5 cents per square yard, while on streets without car tracks it was but 2.9 cents. In Buffalo, where probably a larger amount of asphalt has been kept in repair than in any other city, the cost for maintaining 43,000,000 square yards, scattered over a term of years, has been 3.78 cents per square yard. In this city the repairing is done by contract, the contractor being paid a unit price per square yard for work actually performed. In Toronto, Canada, repairs made with the municipal plant cost 77 cents per square yard of pavement actually laid, while in Detroit, which also used a municipal plant, the work cost $1.06 per square yard during the past eight years.

Life of an Asphalt Pavement.—In a careful analysis of the results of the work in Buffalo for many years Mr. H. Norton, deputy engineer-commissioner, deduces that the average life is 20 years. Officials of the city of Washington also estimate the life to be 20 years under ordinary conditions. The writer has generally taken the life to be 18 years.

In studying this subject during the past season the writer obtained from the cities of Buffalo, Rochester, Washington and the borough of Brooklyn, New York City, the cost of keeping their different pavements in repair for the successive years out of guarantee, the rule being applied to those pavements where the guarantee had been for five years. The costs in Washington have been applied to streets that have been laid 33 years. For the first year out of guarantee the pavement cost 2 cents, for the second year about the same, running up to a little over 4 cents the third year, gradually increasing to a little over 5 cents in the eighth, then decreasing to 4 cents in the eleventh, and running in a fairly uniform line to the nineteenth, when they reached 6 cents, and then gradually reducing to 2 cents in the twenty-eighth year. These figures refer to a large number of streets, except in the streets that have been out of guarantee more than 23 years. The strange thing is that the cost has been not more than 6 cents for any one year, and after the nineteenth year becomes less.

The records in Rochester have been kept for pavements 27 years old, in Buffalo 25 years old, and in Brooklyn 15 years old. These costs on the whole are about the same and fairly consistent with themselves, the Rochester costs being slightly less and Brooklyn slightly more than those for Buffalo.

Asphalt Block Pavement.—When asphalt blocks were first used they were made 4 in. wide, 5 in. deep and 12 in. long, but the thickness has been gradually reduced until at the present time the usual thickness is 3 in., and in some instances 2 in. for light traffic streets. The specifications which are now in use in Brooklyn, and which are probably as definite as any in the country, provide that the stone shall be trap rock as nearly cubical as possible, of a size to pass a ¼-in. sieve not less than 40 per cent. to be retained on a 20-mesh sieve and not less than 12 per cent. to pass a 100-mesh sieve. If the stone as received does not have this amount of fine material, dust is added to make the desired quantity, and in any case not less than 6 per cent. of dust shall be added. The blocks shall contain not less than 5¾ nor more than 8 per cent. of bitumen; the specific gravity of the blocks to be not less than 2.5. It is further provided that after being dried for 24 hours at a temperature of 150 deg. Fahr., the blocks shall not absorb more than 1 per cent. of water when immersed for seven days.

In bitulithic pavement the binding material is either asphalt or coal tar. The pavement is patented and it was originally intended to use coal tar, but asphalt has since been substituted to a greater or less extent. The principal idea is that the voids in the stone should be as small as possible, the materials being predetermined and apportioned by weight by elaborate machinery. The maximum size of stone used is approximately 1 in. in diameter, and on this account the pavement can be laid on steeper grades than the sheet asphalt. The first pavement of this character was laid in Pawtucket, R.I., on a 7½ per cent. grade, and the engineer of that city says that no trouble whatever has been caused by slipperiness. Up to February, 1912, about 20,000,000 sq. yd. of this pavement had been laid in this country.

ROAD BUILDING AT A MILE-PER-DAY RATE.*

By G. Howland Leavitt.†

During the last four months 102 miles of highways in the borough of Queens, New York City, have been resurfaced at an average rate of 10,000 sq. yd. daily or practically 1 mile per day. The work has been done under contracts involving a total expenditure of $1,877,820.

The old macadam roads generally had good foundations, many of them, in fact, having a Telford bottom, and with few exceptions the grades are light and the drainage good, the sub-soil being sandy. In a few instances the grades ran between 5 and 8 per cent., and these sections received special attention.

The controlling features in deciding upon the character of paving to be used were: The nature of the traffic, the construction then in place which was to be used to best advantage, the first cost and the cost of maintenance. Probably 75 per cent. of the traffic is automobile. This portion of the traffic demanded a smooth pavement and one that could be kept in smooth condition continuously. The heavy horse-drawn traffic demanded a surface affording a good foothold and easy draft. For heavy grades the choice was granite block. Generally a bitulithic carpet placed upon the old macadam seemed best to meet all requirements. The first cost of a bitulithic macadam by the penetration method would have been considerably lower than a bitulithic concrete by the mixed method. Under the traffic to which these loads are subjected a light flush coat of bitumen and stone at a cost of from 10 to 15 cents. per square yard would be necessary yearly to maintain bitulithic macadam in good condition. Experience has demonstrated to us that such is the case. Adding this to first cost, as determined by actual contract cost, would bring the cost at the end of five years to about $1.25 per square yard for bitulithic macadam. We estimated that a bitulithic concrete on a properly prepared macadam foundation, including the preparation of the foundation and 5 years' guarantee, would not exceed this. The low bids as received have varied generally from $1 to $1.20 and the average for 1,396,550 sq. yd. was $1.11, including a five years' maintenance.

Owing to differences in the length of haul for materials used and also in the varying requirements as to gutters, binders, etc., the price bid varied in the different contracts. In the case of the Hoffman Boulevard, a street of unusually

* Abstract of paper delivered to American Road Builders' Association, at Cincinnati, December 3 to 5, 1912.

† Superintendent, Bureau of Highways, Borough of Queens, New York City.

heavy traffic, the price ran as high as $1.44 per square yard, while on the other hand there were a number of cases in which prices ran below $1, going as low as 86 to 91 cents in several cases.

The essential features of these specifications for a bitulithic concrete wearing surface are the requirements for the asphalt, mineral aggregate, the method of preparing the old macadam foundation and the laying of the asphaltic concrete. A high grade of asphalt was specified and materials from five different sources were used by the various contractors. About three-fourths of the entire amount used, however, was Bermudez asphalt.

The old macadam road was as lightly scarified as would permit of the reshaping of the old road to the crown desired. After shaping with rakes and forks it was then rolled and filled, additional stone being added where necessary, until the foundation was tight and compacted, to a width 1 ft. wider than the finished pavement; 2-in. planks were then drift-bolted to the foundation along the lines to which the asphalt was to be laid and the asphalt spread and raked. In rolling the rear roll was run over these planks so as to grip them, and in this way good compression was obtained on the edges; neat cement was cast over the surface after the preliminary rolling and swept with a broom so as to fill in the small voids in the surface and the rolling continued to final compression. After the removal of the planks the macadam along the edges was partly removed and bricks, generally in three courses, laid along the edge and filled with a bitulithic filler. In some instances the bricks were omitted and broken stone was used along the edges filled with screenings and thoroughly rolled in. The latter method seems to prove satisfactory where the travel is not crowded so as to compel vehicles to run along the edge of the pavement constantly. The wings of the roads were then graded to a gutter line generally from 5 to 7 ft. from the edge of the pavement.

Although the seepage into the subsoil is good, there were places where water would collect, and we took special pains to drain these places by building small basins with drains to carry off the water. Stone gutters were used wherever it was deemed advisable to prevent wash.

This work was distributed over an area of 65,000 acres, and was divided into 57 contracts. The greatest length covered by a single contract was 6.2 miles, the shortest 0.47 mile. In every case the contracts were allotted to the lowest bidder. All the asphaltic concrete contracts were identical as to form, and there was a single standard set of specifications throughout, which, however, provided sufficient elasticity to be adaptable to any conditions of the old roads.

Portable plants of several different types, all working on the same principle as the permanent asphalt plants, were used, in addition to three permanent asphalt plants. The Continental Public Works Company used a semi-portable plant, consisting of high-speed engine and locomotive boiler; sand-heating devices consisting of an American process driver 30 ft. long, 4 ft. in diameter, jacketed with asbestos and equipped with a Dutch oven with fuel oil burner attachments; a mixing unit consisting of an inclosed hot sand bucket-elevator, sand screens, sand hoppers with the necessary bins for the separation of the mineral aggregate, measuring boxes and a 9-ft. asphalt mixer. The usual asphalt kettles of about 1,000 gal. capacity were used. In this particular plant fuel oil was used both in the heating drum and in the boiler with excellent results. This plant had a maximum capacity of about 1,500 sq. yd. of 2-in. asphalt concrete per 8-hour working day.

The Barber Asphalt Paving Company on a portion of its work used a semi-portable plant very much of the same type as the one above described. This plant, as well as several others, was equipped with the necessary compressed air fixtures to convey the asphaltic cement from the tanks directly to the mixing platform. This plant would prepare and mix enough bituminous macadam mixture to lay 1,200 sq. yd. 2 in. thick in 8 hours' operation. The other plant used by this company was a permanent asphalt plant with a capacity of about 3,400 sq. yd.

The Cleveland Trinidad Company put up a permanent plant on the waterfront. This plant has a capacity of about 3,000 sq. yd. of 2-in. asphaltic concrete per working day of 8 hours. This plant was equipped with a compressed air purveyor for the asphaltic cement.

J. F. Hill used two Cummer railroad plants, each having a rated capacity of 2,000 sq. yd. These plants are mounted on railroad trucks and so constructed that they can be dismantled and made to travel on their own wheels when in transit. They are provided with horizontal revolving drums mounted over a fire box and surrounded with a fire-proof arch through which the mineral aggregate is fed. These plants weigh about 90 tons each and they have their melting kettles, mixing apparatus, boilers, engines and shafts so arranged as to enable one to readily prepare them for transit or for operation after transit. This company carried a fully equipped laboratory and employed experienced chemists at the plant to supervise tests and analyze its mixes and pavements.

The Standard Bitulithic Company used six portable asphalt plants of the Warren type in carrying out its portion of the work. One of the main favorable features of these plants is the fact that they can be put in operation in new locations in a few hours; although simple in their construction, they are so arranged that there is no guesswork as to the proportions of the ingredients, but every step and every portion is under direct control of the operator.

There were fourteen plants engaged on this work during the season, and the main features of the others were similar to those above outlined, or a combination of the same. There was one plant used by the Newton Paving Company, known as the Equitable asphalt plant. This plant differed from all the rest in that the mineral aggregate was put directly into the mixing drum and heated by a hot air blower and then the asphaltic cement was supplied by an air compressor directly from a measuring tank, the stone dust added and the heating and mixing continued until the proper temperature was reached. This plant weighed 36 tons and can be moved readily. It worked very satisfactorily and had an average capacity of 1,000 sq. yd. of 2-in. asphaltic concrete in an 8-hour run; in some instances this amount was exceeded by several hundred yards.

The Borough Asphalt Company mixed its material in a permanent plant located on Newtown Creek, Brooklyn; the capacity is 4,000 sq. yd. of 2-in. material in a run of 8 hours. This plant is probably as complete and well arranged as there is to be found, it being practically dustless when in full operation, and after the first elevation of the material the whole operation is by gravity. All material is under cover and kept from the weather from the time it is unloaded from the scows until it is sent out as a finished product.

The Uvalde Asphalt Company carried out its work from a permanent plant of the usual type located on Newtown Creek in Brooklyn. This plant was located from 6 to 12 miles distant from the site of the work; the material was brought in trolley freight cars to a switch near the work, from which it was then trucked to the street, and in some instances where a trolley track was on the street the material was shoveled directly from the cars into the place to be paved. This plant has a capacity of 4,000 sq. yd. of 2-in. material in an 8-hour working day, and their highest run for a single day of 8 hours was 3,500 sq. yd.

THE PURCHASE OF LIME FOR WATER PURIFICATION.*

By W. F. Monfort.

Lime for water treatment is valuable in proportion to its percentage of water-soluable calcium oxide; but its value is diminished disproportionately by the presence of inert materials natural to the stone—magnesia, alumina, silica—and unburnt stone, although for other purposes these materials may be nearly harmless if not positively beneficial. Hydrated lime has been used by numerous railroad and commercial softening plants and in some smaller cities, but its relatively high cost, the difficulty of feeding it in a large way, and the abundance of dust liberated in handling it have limited its application. In most of the larger plants quicklime is used. The present discussion relates to the vagaries of specifications for the purchase of this latter material.

A contract based solely upon the percentage of lime in deliveries is unjust to the purchaser, in that he pays at contract rate for calcium oxide, however much stone and other impurities are contained. The vendor sells whatever he happens to have; the purchaser receives what he must, without recourse for expense of unloading, crushing, storing, and using a considerable proportion of inert material, which clogs slaking tanks, involves waste of power in stirring, and necessitates more frequent cleaning of tanks. That this expense is not inconsiderable is evident from the following illustration. Between cleanings 253 tons of lime averaging 90 per cent. were slaked at times last year at St. Louis when half the lime used was low in inert matter, against an average of 171 to 175 tons of 83 per cent. lime during the remainder of the year. The accumulation of pieces of core and rubbish from 105 tons of lime caused stoppage of a 10-h.p. motor. The cost of cleaning a tank and starting a new one is approximately 5c. per ton greater with an 83 per cent. lime than with a 90 per cent., not counting the waste of power in stirring. It is obvious that some system of penalizing for impurities should be enforced.

The impossibility of procuring a commercial lime containing 100 per cent. water-soluble calcium oxide influences most purchasers to write specifications upon the basis of a lower guarantee content. In some cases this has resulted in confusion in adjustment of purchase price for better and poorer limes, with purely nominal and misleading bonus and penalty clauses.

If the vendor is to receive full payment for pure lime delivered, with neither bonus nor penalty, the increment is, of course, found by the general formula: 100 guaranteed per cent. = per cent. of contract price to be added or subtracted for each 1 per cent. variation from the guarantee. (See Table I.).

Table I.—Increment for Various Guaranteed Percentages of Lime.

(Without bonus or penalty).

Guarantee.	Increment.
50%	2.00 % of contract price
60	1.666
70	1.428
80	1.25
85	1.176
90	1.111
95	1.052
100	1.00

* A paper presented to the American Public Health Association, Washington, D.C., and to the Central States Water Works Association, Detroit, Mich., September, 1912.

Considering a contract based upon a guarantee of 90 per cent. CaO, any bonus or penalty paid or exacted must be by an increment greater than 1.11 per cent. of the contract price; so that, for example, a nominal bonus and penalty of plus or minus 1.5 per cent. of contract price is equivalent to an actual penalty or bonus of 1.5 less 1.11, or 0.39 per cent. of the contract price for each 1 per cent. variation from 90. A nominal bonus of ½ per cent. would be an actual penalty on any basis of percentage guarantee; a nominal penalty of 1 per cent. of contract for each 1 per cent. deviation in percentage of lime delivered below that guaranteed would be an actual bonus on any basis of guarantee other than 100 per cent. CaO.

In considering the fairness of specifications for lime it is expedient to calculate the purchase price per ton as delivered, and the cost per ton of pure lime to the user, as representing the working of the contract from the viewpoint of vendor and purchaser, respectively. By way of illustration, Table II. gives an analysis of some contracts proposed or operative in connection with waterworks plants.

Table II.—Data on Various Lime Contracts.

		A	B	C	E	F
Contract price		$4.23	$4.23	$4.70	$4.23	$3.925
Guarantee		90–95%	90%	100%	90%	85%
Nominal bonus		0.5%	1.11%	.....	1.5%	1.5%
Nominal penalty		1.0%	1.11%	1.0%	1.5%	1.5%
Purchase price.						
Delivery	100%	$4.33	$4.699	$4.70	$4.685	$4.808
	95	4.23	4.46	4.46	4.547	4.513
	90	4.23	4.23	4.23	4.23	4.219
	85	4.018	3.995	3.995	3.914	3.925
	80	3.81	3.76	3.76	3.59	3.62
	75	3.59	3.52	3.52	3.278	3.336
	70	3.28	3.29	3.29	2.96	3.042
	65	3.17	3.05	3.05	2.644	2.747
	60	2.96	2.82	2.82	2.333	2.453
Cost per Ton CaO.						
Delivery	100%	4.33	4.695	4.70	4.865	4.808
	95	4.452	4.70	4.70	4.786	4.751
	90	4.70	4.70	4.70	4.70	4.683
	85	4.727	4.70	4.70	4.604	4.618
	80	4.759	4.70	4.70	4.449	4.526
	75	4.794	4.70	4.70	4.370	4.449
	70	4.83	4.70	4.70	4.23	4.345
	65	4.88	4.70	4.70	4.061	4.226
	60	4.93	4.70	4.70	3.88	4.088
Per Cent. of Contract Price to Give Purchase Price.						
Delivery	100%	102.5%	111.1%	100%	115%	122.5%
	95	100	110	95	107.5	115
	90	100	100	90	100	107.5
	85	95	94.44	85	92.5	100
	80	90	88.88	80	85	92.5
	75	85	83.33	75	77.5	85
	70	80	77.77	70	70	77.5
	65	75	72.22	65	62.5	70
	60	70	66.66	60	55	62.5

Contract A is unjust to the seller, in that the contract price obtains for any lime delivered which falls within the limits of 90 to 95 per cent. The framers of these specifications intended to be kind in this clause; but the guarantee is actually raised to 95 per cent. for good lime, and lowered to 90 per cent for bad, with no discrimination in what is really the highest range of commercial limes.

The increment of 0.5 per cent. above 95 per cent. is a bonus only in name, as has been shown; the vendor receives a trifle more for a 96 per cent. than for a 95 per cent. lime; but the increment is 0.61 per cent. less than the normal increment for a 90 per cent basis (1.111 per cent.), and therefore an actual penalty is placed upon deliveries better than the guarantee. The deduction of 1 per cent. instead of 1.11 for each 1 per cent. below the guarantee leaves an actual bonus of 0.11 per cent. operative. Stated in another way, the actual penalty is put upon the delivery of good lime in that, instead of receiving 111.11 per cent. of the contract price for 100 per cent. lime, as under a contract on a percentage basis, the seller is paid under a supposed bonus clause only 102.5 per cent. of the contract price, while the purchase price on deliveries of 90 per cent. or less is always 10 per cent. of contract price above the per cent. CaO delivered.

From the standpoint of the user, the cost of pure lime is $4.70 in a 90 per cent. delivery; $4.427 in 100 per cent. delivery; $8.46 in a 10 per cent. delivery; $44.63 in a 1 per cent. delivery; whereas unburnt stone at a purchase price of 43c. per ton would afford a ton of pure lime at an infinite cost.

The vendor receives no bonus and has no incentive to furnish good lime; but, since this contract imposes no penalty for poor lime, he has every reason to send the maximum proportion of unburnt stone which will be accepted. The purchaser pays more for poor lime than for good, and suffers further losses entailed by unloading, crushing, using and removing from his tanks this obstructing material. The facts are manifest in the accompanying table and diagrams.

Contracts B and C, though differently worded, yield the same figures for cost of pure lime and for purchase price without bonus and penalty, and give normals for establishing the value of increments in other specifications.

Contract E gives a bonus and exacts a penalty of 0.39 per cent. of the contract price for each 1 per cent. deviation from the guarantee. The vendor, therefore, receives some compensation for care and labor in preparing a well burnt lime; the purchaser is safeguarded to some extent against loss in refuse material. It is probable that a larger increment would result in greater economy to the purchaser, by securing a lime of higher calcium-oxide content and reducing the power cost.

Contract F is now operative at St. Louis, in lieu of Contract A, which was in effect last year. The contract price ($3.925 per ton for 85 per cent. lime) is the average of two lettings to the same contractor. The increment 1.5 per cent. leaves a net bonus and penalty of 0.324 per cent. of contract price, which is again too small, if the advantage of good lime to the department is considered. In the Table III. comparison is made of cost of calcium oxide and of purchase price for contracts A, B and F throughout the range of percentages in deliveries for June-August, 1912.

Table III.—Comparison of Workings of Lime Contracts—1912 Deliveries.

		Per Cent. Delivered.				
Cost CaO		90	85	80	75	70
Contract	A	$4.70	$4.727	$4.759	$4.794	$4.83
	B	4.70	4.70	4.70	4.70	4.70
	F	4.683	4.618	4.526	4.449	4.345
Purchase price						
	A	$4.23*	$4.018	$3.81	$3.59	$3.38
	B	4.23*	3.99	3.76	3.52	3.29
	F	4.22	3.925*	3.62	3.34	3.04

* Contract price.

The average of available lime for eight summer weeks was 85 per cent. on 1,950 gross tons delivered, or 1,572 tons of pure calcium oxide therein contained. Cost per ton of pure lime and purchase price fall below last year's figures by about 10c. per ton for this particular percentage.

In two cities a form of contract is used which gives a bonus and penalty of so many cents per ton for each 1 per cent. departure from the guarantee. Whether this results in payment for lime on a percentage basis; in a bonus for good and a penalty for worse lime, or in a bonus for bad lime and a penalty for better, depends upon the contract price, since the value of the increment with respect to the contract price is a variable quantity. One current contract gives a bonus of 7c. per ton for each 1 per cent. above, and deducts the same amount for variations below the guarantee (88 per cent.). Older specifications gave a bonus and penalty similarly of 14c. per ton on the same guaranteed percentage. Analyses of these specifications on the lines of the foregoing discussion give the results shown in Table IV. (The normal increment for an 88 per cent. lime is 1.13636 per cent. of contract price).

Table IV.—Comparison of Increments, Bonus and Penalty of Lime Purchases.

(Contract Price Assumed at Various Values; Percentage Guarantee, 88 per cent.)

	Nominal Bonus—14c. per ton.		7c. per ton.	
Contract price.	Increment.	Bonus and penalty, actual.	Increment.	Bonus and penalty, actual.
$12.32	1.13636%	0.0 %		
11.00	1.153	0.01636		
10.00	1.168	0.03164	1.084%	0.05236
9.00	1.1866	0.05024	1.09	0.04636
8.00	1.21	0.07364	1.105	0.03136
7.00	1.24	0.10364	1.12	0.01636
6.20	......	....	1.13548	0.000878
6.00	1.28	0.14364	1.14	0.00364
5.00	1.336	0.1996	1.168	0.03164
4.00	1.42	0.2836	1.2	0.07364

Under the first specifications (14c. bonus and penalty) the increment is too small between $6 and $7 per ton, the probable range of prices in that district, with extinction of bonus and penalty at $12.32. Under the second specifications, extinction of bonus and penalty occurs at about $6.20 per ton, leaving above that price a penalty on better deliveries, and a bonus for poorer deliveries than are called for by contract. The amount of bonus is too small to be an incentive to keep the quality of lime delivered up to a desirable standard. In such case dependence must be placed upon some additional clause in specifications as a basis for rejection of unsuitable material.

The common practice in commercial analysis of returning as available the total calcium oxide soluble in hydrochloric acid renders it advisable to incorporate in the specifications a statement of the method of sampling, sample reduction, and of analysis. The scheme adopted in this laboratory follows: Lump lime in bulk is received in car lots and crushed to ¾ in. or less upon receipt. By means of a small pivoted chute at the outlet of the crusher small portions at 15-min. intervals are collected during the unloading of the car making a total sample of about 50 lb. per car. This is passed through a second crusher in order that no pieces exceed ½ in. in greatest dimension. A sample reducing machine described in Engineering News for November 23, 1911, is used to reduce the 50-lb. sample to about 2 lb., after which the entire small sample is pulverized to about 60 mesh in a Sturtevant pulverizer.

In the laboratory a Buskett mechanical riffle reduces the 2-lb. sample to about 14 grams. Approximately 7 grams (8 c.c.) of powdered sample is accurately weighed in a weighing tube, and emptied directly into a 1-liter volumetric flask containing 70 grams cane sugar dissolved in about 800 c.c. cold carbon dioxide free distilled water. Brisk rotation of the flask before introducing the weighed sample prevents caking. Flasks are shaken on a Camp machine 20 min., and allowed to stand over night. The solution is shaken, made up to the mark, mixed thoroughly and 200 c.c. are diluted to a liter, 100 c.c. of this dilution is titrated with tenth normal hydrochloric acid, using phonolptalein. The method is a modification of one commonly used in sugarhouse practice (Croghan, C. A., 1908, p. 768).

Delivery of limes containing appreciable quantities of magnesia may be guarded against by a clause in specifications, and occasional analyses made. Limes of the St. Louis district commonly contain less than 1 per cent. magnesia.

Shippers are prone to consider deterioration in transit as working a hardship to them, although the lowered percentage of calcium oxide through absorption of moisture prior to weighing on receipt is balanced by increase in weight of car contents. The protection of the bulk of the car load by the layer of finely divided (air-slaked) lime has been long known. Further, our experience of the summer of 1912 with cars of well-burned lime covered with paper during transit indicates that serious deterioration may be avoided. Two cars shipped and received on the same dates showed the advantage of "overburning" in the meaning of the lime trade. One (ordinary run of kiln, containing some core, and covered with paper), was badly air-slaked, analyzing 76.7 per cent. calcium oxide soluble in sugar solution. The other (well burned—slightly overburned in the opinion of the kiln operator) covered with paper in transit, ran 90.8 per cent. calcium oxide. Fourteen cars of overburned lime in the summer months averaged 88 per cent. The degree of overburning was below that which would make trouble in drawing the kiln; sufficient, however, to greatly reduce the amount of core. The product slaked well. It is better described as well burned than as overburned lime.

Nevertheless, in our latest specifications a clause appears making an allowance from April to October of 2c. per ton for each 24-hour delay in unloading after a lapse of 48 hours from receipt on our tracks. The concession is larger than is equitable; it is, however, rarely operative.

The substance of this paper was put into the hands of all bidders on our current contracts. It was given wider circulation in the hope of directing attention of both writers of specifications and bidders to some essential facts which have been overlooked in purchasing lime for water treatment.

Summary.—Specifications for purchase of lime should be based upon a single percentage guarantee.

Bonus and penalty clauses introduced to guard against loss incident to impurities should be in terms of percentage of contract price.

The increment should be sufficiently large to provide an actual bonus and penalty for variations in quality of lime delivered, and should be based upon the source and quality of lime available.

Instances are cited illustrating the injustice of specifications drawn without analysis of their workings.

Well burned lime ("overburned" of the trade) suffers slight deterioration in transit, especially if covered with paper.

Methods of sampling and of analysis should be described in specifications.

A GRAVEL WASHING PLANT.

The western coast of Canada is the scene of great building activity, which is the result, not of a boom, but of a healthy, though rapid, growth, and although this country is rich in its forests and lumber is plentiful, it is a noteworthy fact that quantities of brick and concrete are being used and the building is being done for the future. On account of the large amount of concrete construction, there is a great demand for sand and gravel and many gravel washing plants have been erected in this territory during the past year. It is also interesting to note that the usual source of sand and gravel in this territory is the river beds, and many of the plants of the western coast have been located on rivers and supplied by barges bringing in dredge excavations.

The plant of the Higgins-Fisher Company is located in Elburne, B.C., a small suburb of Vancouver. This plant is unique in serving a double purpose, enabling one business organization and one plant to serve for two businesses, which have alternate seasons of activity. During the building season the plant receives gravel from barges on the Fraser River, which it screens and crushes and stores in bunkers for supplying the market with concrete aggregate. In winter, coal is received in the same way and is screened and graded in the various bunkers and likewise drawn off to wagons for city delivery. In this way, the one plant serves the purpose of a coal pocket and a gravel screening plant with only an investment equal to that required for either purpose.

When rock or sand and gravel is unloaded from the barges, which is done by means of a grab bucket, it is dumped onto a grizzley, covering the main hopper. This grizzley is set at an angle of 60 degrees, inclined toward a No. 2 Gates gyratory crusher, and all material over 2½ inches in diameter, is rejected to this crusher. The material from the crusher is passed onto a 14-inch Stephens-Adamson belt conveyer, 93 feet centres, leading on an incline to a point above the crushed rock bins. Discharge to the bins is made through a revolving screen which sizes the material and distributes to two compartments.

The gravel, passing through the 2½-inch grating above the first hopper, passes down onto the main conveyer. This conveyer is 24 inches wide and 207 feet between centres; it rises on an incline to a point above the main bunkers and then breaks over a snub pulley and runs horizontally to the farther side of the building. This horizontal run of the conveyer is equipped with an automatic tripper which may discharge to any one of the bunkers, or into a revolving screen, which washes the gravel and separates it into three sizes, namely, 2¼, 1¼ and ¼-inch.

When coal is handled in the winter months, the grizzley is removed from the hopper and the small conveyer and crusher are disconnected by means of steel plate friction clutches, which control the drivers. Coal is then delivered to the main conveyer and distributed over the tripper, directly to the bunkers or through the screen. Coal may then be drawn off through the gates in the bottom of the bunkers. The capacity of the main bunker is approximately 1,000 yards and the small ones hold 150 yards. The drive for the plant is from an electric motor, located at the head end of the main conveyer, and the short conveyer and screens are driven through rope drives from this conveyer countershaft. The crusher is driven from the extended countershaft of the tail pulley of the main conveyer.

Another feature of this plant, and one unusual in most gravel plants, is a car puller, which is used for spotting the cars on the track beside the bins. This car puller makes it a very simple matter for one man to handle a small string of cars without the use of a locomotive and in considerably less time than is required when using hand car-movers. This car puller is driven from the motor at the head of the main conveyer and the operator uses it simply by winding the rope about the capstan and keeping the rope taut. This produces sufficient friction between the rope and the capstan to move five loaded cars.

This plant was completely designed and equipped by the Stephens-Adamson Company. Both conveyers operate on unit ball bearing carriers, and provision is thus made for a later increase in capacity as well as cutting down the power requirements.

WOOD BLOCK PAVEMENT LAID BY CITY LABOR. *

By Ellis R. Dutton.†

The city of Minneapolis has at the present time over 1,000,000 sq. yd. of creosoted wood paving, laid by day labor. In 1901, the city officials began as investigation of paving materials. Sheet asphalt, laid by contract under a guarantee, was not kept in repair by the company; brick paving was noisy and sandstone blocks wore badly. In 1902, the city council ordered one of the streets to be paved with creosoted wood blocks similar to those used on Michigan Boulevard in Chicago. The blocks were 4-in. southern yellow pine, treated with 12 lb. of Kreodone oil. There were laid 13,500 sq. yd. at a cost of $2.79 per square yard, the city doing all the work by day labor and purchasing the blocks from the Republic Creosoting Company at $1.95 per square yard f.o.b. Minneapolis. These blocks were laid at an angle of 62 deg. with the curb upon a 6-in. natural cement concrete foundation over which was spread a 1-in. cushion of sand. There were no transverse expansion joints but a 1-in. longitudinal joint was made on each side of the street parallel with the curb. These joints as well as the joints between the blocks were filled with paving pitch, and the street was finished with a ¼-in. coating of sand to absorb the excess pitch on top of the blocks. It was considered better practice to lay them at an angle with the curb, instead of at right angles, both on account of the travel and also the expansion; the correctness of this assumption has been proved by experience. The wear up to the present has been only ⅛ in.

Norway and Yellow Pine.—Since Minneapolis is situated in a pine country the use of Norway pine for paving blocks was suggested. Accordingly, arrangements were made for the erection of a treating plant in Minneapolis, if the city would use 30,000 sq. yd. of creosoted Norway pine blocks. The price of this class of blocks was $1.64 per square yard f.o.b. Minneapolis, using 12 lb. of Kreodone oil per cubic foot. In the paving of Third Avenue South in 1903 there were left over from 1902 about 300 sq. yd. of the yellow pine blocks which were used in this street, and the remainder was Norway pine. Samples of these two classes of wood, which had received exactly the same travel and wear, were taken from the street in 1911. The yellow pine blocks showed a wear of ⅛ in. and the Norway pine blocks twice as much. This was an actual comparative test of the two kinds of wood on the same street and under the same conditions.

In 1904 the price for blocks was $1.73 per square yard f.o.b. Minneapolis, but there were proposals as low as $1.51 per square yard, using common commercial creosote oil. The engineers and the paving committee considered the highest blocks treated with the best grade of oil to be the better and cheaper. It was believed that the oil that contained the larger per cent. of residue after distillation to 315 deg. C. was the better. The cheaper oil showed 43 per cent of residue, and the best showed 70 per cent. of residue, and this was the oil used. The wisdom of the purchase has developed by the experience. One piece of work that was done in another city using the cheaper oil never was satisfactory, and has been replaced some time ago with a better grade of paving blocks

Specifications for Oil.—The specifications of 1905 required an oil of a gravity of 1.09 at 20 deg. C. and specified the fractional distillation percentages. These were the first specifications of the kind and they have been followed throughout the country ever since. There is no class of paving that requires rigid inspection more than the creosoted blocks, and if it is possible to obtain a competent person to do the inspecting it is money well spent.

The required amount of oil per cubic foot was raised to 16 lb. this year, as it was considered better to fill the wood more thoroughly and make the blocks more waterproof. This amount has not been changed since, though other cities have put in 20 lb. or more, which I think has caused other trouble. The price of the blocks was $1.49 per square yard f.o.b. Minneapolis for 4-in. Norway pine.

We continued the use of Norway pine tamarac and hemlock until 1911, when we returned to yellow pine blocks which seemed to give the best results, especially on heavy traveled streets. We also used a 3½-in. block on the lighter traffic streets. We have had no trouble with our creosoted block pavements though on one particularly heavy traveled street the Norway pine blocks have worn about 2 in. and will soon have to be relaid.

Cost of Wood Block Pavement.—On January 1, 1912, we had a total of 968,000 square yards of creosoted wood block paving, put in at a cost of $2,466,000, or an average cost of $2.52 per square yard. The prices have varied, as the prices of material varied, from $2.29 in 1908 to $2.82 per square yard in 1907. The price of crushed limestone used in the concrete base averages about $1.75 per cubic yard delivered on the street. The sand costs about 75 cents per cubic yard, and Portland cement has cost from $0.865 to $1.80 per barrel delivered f.o.b. Minneapolis, depending on the year. This cost of paving, as given above, includes the grading for the foundation, the laying of the concrete base, the paving blocks, pitch and all the labor connected with making a complete paving. I have not heard of a city that gets as much for the money as we do. The city of Minneapolis does all of its public work by day labor and has done so for the past 12 years, with the exception of asphalt paving, which it could not do as it had no asphalt plant. The wages paid common labor in paving work has increased from $1.75 per day of 10 hours to $2.40 per day of eight hours in 1912. The skilled labor and teams have increased almost as much in proportion.

To show the preference from the different classes of paving from 1902 to 1912, the following table is given:

Types of Pavement in Minneapolis.

Kind of Pavement.	Sq. Yd. Jan 1, 1912.	Sq. Yd. Jan. 1, 1902.	Increase.
Sheet asphalt	164,441	206,471	*42,030
Brick	390,869	171,144	219,725
Creosote blocks	967,616	....	967,616
Granite blocks	403,915	156,994	246,921
Sandstone blocks ...	347,939	61,661	286,278
Macadam	335,159	129,305	205,854

* Decrease.

* Abstract of paper delivered to American Road Builders' Association, at Cincinnati, December 3 to 5, 1912.

† Assistant City Engineer, Minneapolis.

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ENGINEERING OUTLOOK FOR 1913.

Last year was a period of extensive development throughout Canada. A great deal of construction work of a private nature and for the municipalities and federal and provincial governments was completed. Probably the total cost of the work done totalled more than any previous year in the history of the country.

The indications for 1913 are exceedingly bright, and it is very likely that the total amount of construction work of a public and private nature will far surpass last year; particularly in the West, the towns and cities are increasing in population at so fast a rate that during 1913 it will be very difficult to keep pace with the demand for pavements, sidewalks, water supply, sewerage systems and transportation in general.

A digest of the projected work under the heading of "Engineering Outlook for 1913" will be found on another page of this issue. Its perusal will give some idea of what a few of the municipalities intend doing. These figures are all based on the present financial situation. If the market for municipal debentures improves, however, and it is altogether likely that it will, the amount shown under the different headings will be greatly increased.

It is expected that the public works estimates will total nearly $40,000,000, which will make provision for the works now under contract and for the new ones in view. Last year's total was a little over $30,000,000. It is altogether probable that a vote will be included for the Georgian Bay Canal; probably about $3,000,000. There will be also an additional appropriation for the Welland Canal construction. The Government have signified their intention of co-operating with the Toronto Harbor Commission improvement, which was outlined in these columns some weeks ago, to the extent of $6,000,000. Only a part of this, however, will be voted this session.

Toronto will also secure appropriations for the proposed Federal Square of a half million dollars, and also for progress work on the Toronto barracks. A million and a half will be given to Ottawa for new departmental buildings, and a large amount of money will be spent on the Montreal harbor improvements.

The big appropriations will be for a continuance of extensive harbor works at Victoria, B.C., Toronto, Quebec and St. John, and for the new Intercolonial Railway terminals at Halifax. Tenders have just been called for the two million dollars improvements at the St. Charles River, Quebec, involving the construction of a dam and two locks. Another work for which proposals are being asked is that of improving the river in Pictou to make it navigable. The improvements will greatly add to shipping facilities for the Nova Scotia Steel and the industries. Besides the above, the estimates will make provision for many public buildings, such as post-offices and custom houses at the smaller centres throughout the country.

In connection with the announcement that the Winnipeg-Cochrane section of the Transcontinental Railway is to be opened for grain traffic next week, the total expenditure to the end of the fiscal year was $116,000,000, of which $21,000,000 was spent in the year 1911-12. The total for completion of the work will be around $140,000,000.

REINFORCED CONCRETE AND FORMULÆ.

In view of the diverse opinions from time to time expressed regarding the strength and stability of reinforced concrete structures it is desirable that engineers and architects should determine at what point there is divergence from the common ground of agreement, and in what manner experience with such structures, and the advance of theory respecting design, can be made to dispel the present misunderstandings. The London "Times" states that so long as there is controversy between experts there must necessarily be doubt in the minds of the public, and this attitude will properly be reflected in the restraining laws and ordinances of boards and councils. When the various commercial interests concerned are considered and weighed it becomes obvious that the task of collecting positive evidence must be attended task of collecting positive evidence must be attended with difficulty. Nevertheless, a great amount of work is being done to improve knowledge of the preparation and behaviour of concrete, and contributions to the theory of reinforcement are numerous. Why, then, should the disputings be so prolonged and at times so acrimonious? The answer surely is that it is a war arising largely from terms requiring definition and centring upon a substance which itself is indefinite. Too often equations relating ta perfectly elastic, homogeneous isotropic solids are made to do service for aeolotropic portions of matter, but when such equations are requisitioned for the purpose of solving problems relating to the stresses and strains in sandwiches of steel and concrete, the result is necessarily disquieting. What, for example, is the meaning of the modulus of elasticity in such circumstances? Even in comparatively homogeneous solids this modulus has only a courtesy title to be a constant—it is far more likely to be a logarithmic function of the displacement—and its use as a constant in formulæ relating to reinforced concrete should be either amended or discountenanced. The line of agreement must follow closely the line of direct observation and practical tests on standard sections and frames, followed by makers' guarantees, but considerable assistance would be derived from a friendly conference upon nomenclature and formulæ.

ROADS IN SASKATCHEWAN.

The report of the Highway Commissioners for the current year up to October 31 has been brought into the Saskatchewan Legislature recently. By order-in-council of April 25, 1912, the sum of $1,500,000 was appropriated for expenditures in the construction and improvement of highways, and an additional sum of $100,000 for steel bridges on concrete foundations. The sums were divided by the Commissioners into two amounts, $1,300,000 for highways, and $300,000 for bridges. In the report of expenditures, $663,233.17 is shown, as the total expended on road improvement direct; $56,723.70 expended by municipalities, and $47,923.79 expended on roads under regulations. That is jointly with municipalities. When miscellaneous expenses are added, the total sum expended on road account by the commissioners and municipalities during the period covered by the report is $938,070.19.

Provision was made, the commissioners state, for undertaking permanent bridge work to the extent of $300,000. Contracts are under way or entered into that will absorb the whole of the $300,000, but up to October 31 the expenditure did not amount to $100,000.

ENGINEERING OUTLOOK FOR 1913.

The coming year will probably surpass all previous ones in the total amount of municipal construction work to be done. The present plans of a number of the towns and cities throughout Canada, as outlined in the following, will give some idea of the general trend of engineering work throughout the Dominion. The figures as given are in all cases on the conservative side. If the present financial situation improves and the municipalities are able to secure a ready sale for their debentures, the amount of work will be very greatly increased. The country is developing so fast, especially in the West, that the towns and cities will find it exceedingly difficult to provide the necessary accommodation in the way of pavements, sidewalks, water supply, sewerage system and transportation.

Sydney, N.S.—There is no large work in prospect in this city. There will be the usual sewer and water extensions, street and sidewalk work. Estimates are being prepared for a large extension to the waterworks system, but the work will hardly be reached in 1913. City engineer, D. M. Campbell.

Halifax, N.S.—The city expect to construct a 3,000,000-gal. concrete reservoir for the high service water supply system, at an estimated cost of $40,000. Extensive changes to the water distribution system, estimated cost $60,000. The construction of an intercepting sewer along the shore of the northwest arm of the harbor, approximate cost, $100,000. Concrete sidewalk construction, $50,000. Sewer extension, $50,000. City has under construction a garbage incinerator to cost $46,000. The Acadia Sugar Refining Company are constructing a sugar refinery at a cost of about $500,000. The railway department will construct during the next year a terminal pier, total cost, $1,000,000. Contract for this work was made by the Laurier Government. The Dominion Government are making surveys and designs for a new terminal on the waterfront. Estimated cost, $15,000,000, of which the average expenditure will be $1,000,000 a year. The railway department has also under construction a line of railway from Halifax to Musquodoboit. City engineer, F. W. W. Doane.

Public Works Department, Halifax, N.S.—The Department of Public Works, of Canada, district engineer's office, Halifax, which comprises the counties of Halifax, Lunenburk, Hants and Colchester. The annual appropriation for dredging harbor improvements, breakwater, public wharves, etc., will be about $300,000, of which $100,000 is for dredging and the balance for construction. It is expected that a number of large works will be taken up this session and that the appropriations for this year will be larger than usual. District engineer, H. A. Russell.

Fredericton, N.B.—The city will carry on work to an amount upwards of $10,000 on concrete curbs and gutters, pavements, surface sewers; distribution water mains, and sewerage system extension. Some large contracts are contemplated also. City engineer, John O'Neill, B.Sc.

Toronto, Ont.—During 1912 there has been spent on local improvement work about $1,500,000; on storm overflow sewers, $350,000; trunk sewers, $2,000,000; the filtration plant has cost to date $700,000; and the new 36-inch main from the main pumping station to the reservoir, $120,000. In addition a 24-inch and 20-inch supply main was laid at a cost of $120,000. The mileage of pavements laid was 40 miles; the mileage of sidewalks, 52 miles. 2.7 miles of trunk sewer were completed, and there will be about one-half mile to complete next year. It is expected that work on the Crawford Street bridge, Gerrard Street bridge, Toronto Avenue bridge, and other bridges not including the Bloor Street viaduct, will be proceeded with during 1913. An estimated cost of this work is about $550,000. The following money by-laws are being submitted to the ratepayers: $200,000 grant to the National Sanitarium Association for the fight against tuberculosis; $6,677,000 for a waterworks system at Scarboro' Bluffs; $1,375,000 for a new filtration plant and conduit; $2,500,000 for the Bloor Street viaduct; $1,000,000 for a modern garbage disposal plant; $954,000 for storm overflow sewers. Commissioner of Works, R. C. Harris.

London, Ont.—This city expects to do a good deal of work during 1913. Among other things, the construction of a complete storm water sewer scheme for the entire city is contemplated at an estimated cost of $985,000; a portion of the permanent breakwater on the west bank of the River Thames will be built at a probable cost of $30,000; a highway bridge over the River Thames will be erected at a cost of $30,000; also, the completion of an incinerator plant, capable of disposing of fifty tons of garbage per day; the laying out of a federal square, and construction of a new city hall at a cost of $250,000; the London and Port Stanley Railway, which is owned by the city, will probably be electrified at a cost of $900,000; approximately two miles each of permanent pavement, sidewalks, curb and gutter, and sanitary sewers will be constructed under the Local Improvement Section of the Municipal Act; a good deal of work will be done on the extension of the London Street Railway and the electric lighting of the recently annexed districts composed of Pottsburg, Knollwood Park, Chelsea Green, and Ealing. City engineer, H. A. Brazier.

Sudbury, Ont.—The building permits for 1912 totalled to nearly $550,000. Next year promises to be even greater than 1912. There are many new buildings to be erected; the Bell Telephone Company have called for tenders for a $40,000 building. The Bank of Ottawa will erect a large block, and a $25,000 fire hall will be built. There is a scarcity of contractors for this work as, although tenders were called for the three above some time ago, no tenders were received.

Steelton, Ont.—A waterworks by-law is to be submitted to the ratepayers in January for $50,000 for the installation of an intake pipe, pumping station, force main, standpipe, etc., and it will probably pass. There will be considerable concrete pavements laid, also concrete sidewalks. Some sewer extension work will be done, as well as extensions to the waterworks distribution system. It is expected that $100,000 will cover the amount to be spent in improvements in 1913. W. B. Redfern, town engineer.

Niagara Falls, Ont.—The city will probably spend $50,000 on permanent pavements; $10,000 on permanent walks; $10,000 on sanitary sewers; $25,000 on waterworks extensions. City engineer, J. C. Gardner, B.A.Sc.

County of Welland.—The county will probably spend $100,000 on macadam roadways. Road superintendent, J. C. Gardner, B.A.Sc.

Belleville, Ont.—The city expect to spend on the sewerage system for West Belleville, $250,000. Permanent roads, $75,000; concrete walks, $20,000; buildings, $400,000. Total, $745,000. City engineer, James G. Lindsay.

Welland, Ont.—There is a good year's work ahead in this town. It is expected that 15,000 sq. yds. of street paving will be laid at a cost of $50,000; about four miles of concrete walk, $13,000; 1.7 miles of sewers, 8-in. to 20-in., $25,000. The disposal plant and trunk sewer system will probably be commenced. The estimated cost of this work is $250,000. One and a half miles of water mains (6-in. to 12-in.) will be laid at an estimated cost of $21,500. It is probable that work on the new water intake will be begun; estimated cost, $50,000. The Niagara, Welland and Lake Erie Railway Company will construct about one and three-quarter miles of street railway on North Main, West Main and East Main Streets. The Niagara, Welland and Dunnville Railway Company will construct new lines on Patterson Avenue, Hellems Avenue and Plymouth Road, about one and a quarter miles. It is expected that work on the Welland Canal will commence in 1913. This will mean that under the present plans vast changes will be made in the present layout of the town. Extensive harbor accommodation will be provided and there will be two new heavy swing bridges installed. Town, engineer, D. T. Black.

Souris, Man.—The town anticipate installing an electric light plant at an estimated cost of $40,000. There will also be extensions of sewer and waterworks to parts of the town which are not already served. The present sewer and waterworks system has just been completed, and covers about eight miles of roads. Town engineer, Percy C. Smith.

Winnipeg Man.—The following is a statement of works under construction in this city, or to be constructed in the immediate future. A waterworks reservoir situated at the waterworks main pumping station, Logan Avenue, to be constructed of concrete, capacity 18,000,000 gallons. Excavation for this work nearly completed. In connection with the waterworks extension a series of fifteen wells are being constructed in a northerly course from the city at intervals of one-half mile, the wells being eighteen inches in diameter and to be bored to a depth of 300 feet. The water is conveyed by a steel pipe line eight and a half miles long, to the city. Estimated cost of the works complete, including erection of small pump houses, pumps, etc., is $1,000,000; operation started last week. In connection with the City of Winnipeg hydro-electric plant at Point du Bois, two new units are to be installed at Point du Bois, and a new transmission line erected from that point to the city. The estimated cost of the units with the transformers being $250,000, and of the transmission lines $750,000. This addition has been made necessary by the very large increase in the sale of power in the city. There will be the usual quantity of new work constructed within the city at an estimated cost of $1,000,000, consisting of sewers, water mains, plank and artificial stone sidewalks, asphalt, asphalt macadam, cedar block and macadam pavements. All city work and requirements are advertised and let by tenders. City engineer, H. N. Ruttan.

Department of Public Works, Manitoba.—The department have under construction two large drainage ditches to the west of Lake Manitoba, comprising some 600,000 acres of land, and another district has just been formed in the municipalities of Springfield and Broken Head, embracing 107,000 acres. A drainage system in the municipality of Dauphin is being formed, which will cover about 250,000 acres. Work will be begun on the ditches in the spring. The department have under construction at the Agricultural College at St. Vital a system of waterworks and sewerage. A very large amount of work will be undertaken by the various municipalities under the "Good Roads" and the "Improvement of Highways" Acts. This will be under the supervision of the highway commissioner, who is one of the officials of the department. The department has also under construction a number of important public buildings, namely, the Agricultural College, costing about $2,000,000; new law courts, costing about $1,000,000; insane asylum at Brandon, $500,000; and expect shortly to call for tenders for parliament buildings, which will probably cost $2,500,000. Deputy Minister, Chas. H. Dancer.

Regina, Sask.—This city will build at least eight miles of street paving and twenty miles of concrete sidewalks during 1913. City engineer, F. McArthur.

Saskatoon, Sask.—The following work is contemplated in this city for 1913. On account of the present financial outlook, there is considerable uncertainty as to the amount of work which will be undertaken; therefore these figures provide only for absolute necessities. Extensions to the sanitary sewer and waterworks system, $400,000; house connections, $75,000; sidewalks, $75,000; pavements, $100,000; storm sewers, $30,000; extension to intercepting sewer, $40,000; additional sedimentation for water purification plant, $35,000; making a total in all of $755,000. However, if conditions from a financial standpoint have improved by spring some of this work will be doubled or trebled. City engineer, Geo. T. Clark.

Prince Albert, Sask.—In view of the present situation it is difficult to say how much work will be done during 1913. The following, however, gives an approximate idea: Street opening and grading, $50,000; sidewalks, $100,000; water main extension, $75,000; sanitary sewers, $100,000; storm sewers, $20,000; electric light, $60,000; disposal works, $60,000; power plant at LaColle Falls (in 1913), $500,000; new pumping plant, $75,000; steam power house, $50,000; making a total in all of $1,090,000. City engineer, F. A. Creighton.

Lethbridge, Alta.—During the past year the city has expended nearly $1,000,000 for improvements, nearly half of which was in connection with the installing of a street railway system. This coming year the ordinary extensions of present utilities will be made. The probable capital expenditure by the city during 1913 will be about $175,000, made up as follows: Sewer extension, three miles, $20,000; water extension, three miles, $80,000; cement walks, five miles, $20,000; street paving, one-quarter mile, $30,000; parks, $10,000; street railway extension, $15,000. There are other expenditures which do not show on the above statement. These include maintenance of all improvements and the expenditure of a large sum to operate the various utilities owned by the city. These utilities embrace a municipal coal mine, water and electric power plant, and street railway.

Medicine Hat, Alta.—The city expect to spend approximately the following amount on the works here listed: Domestic sewers, $150,000; surface sewers, $50,000; curbing, $30,000; sidewalks, $50,000; street grading, $35,000; paving, $250,000; water extensions, $100,000; gas extensions, $50,000; subways, $200,000; fire alarm system, $25,000; public improvements, $40,000; new parks and developments, $60,000; electric light extensions, $25,000; electric power plant extensions, $50,000; making a total of $1,135,000. In a general way it is anticipated that the expenditure of the city for the year 1913 will be $1,250,000. Medicine Hat owns its own water, electric light and gas plants, which are operated as public utilities. All public works are executed by the city construction department on a day labor basis. City engineer, A. K. Grimmer, M.Sc.

Calgary, Alta.—The city contemplates completing three concrete bridges at a cost of about $900,000. The installation of a sewage disposal plant; a water filtration plant; extension of the gravity system by two miles of 42-in. wood stave pipe; building of an asphalt paving plant at a cost of $50,000. Under local improvements there will be 500,000 sq. ft. of concrete walk; 300,000 sq. yds. paving; 50 miles of waterworks; 50 miles of sewerage, including 2½ miles of 42-inch trunk sewer, and an additional 2,000 ft. to the 6-ft. trunk sewer. City engineer, C. S. Dennis.

Macleod, Alta.—City are constructing a mechanical water filtration plant to cost $55,000. It is intended in 1913 to proceed with a system of sewage disposal at an estimated cost of $55,000. The construction of a new trunk sewer and extension to the sewerage system, approximate cost, $32,000. Plans are already prepared for a municipal town hall, to cost approximately $165,000. General improvements in water extensions, concrete walks, etc. City engineer, G. H. Altham.

Fernie, B.C.—By-laws voted on and approved by the city last year, amounting to $35,000, include street improvements; central school addition, and a concrete warehouse and workshop for the city. Provided the debentures are sold this coming year, the above work will be done. The Provincial Government Works Department is calling for tenders for an armory and drill shed, 80 x 130 ft., brick and concrete, with a steel roof truss. Estimated cost, $40,000. Sanitary sewerage system contemplated, $12,000. City engineer, Wm. Ramsay.

PROGRESS ON DESIGN OF QUEBEC BRIDGE SUPERSTRUCTURE.

Considerable progress has been made in the revised design for the double-track cantilever bridge now being built by the Dominion Government across the St. Lawrence River a few miles above Quebec. The board of engineers and contractors has very carefully revised and verified the contract design and modified it materially in some important features and has worked out the principal connections and details of members to an advanced stage of completion. As noted in the Engineering Record, in order to secure the greatest possible accuracy in the computation of dead load stresses and proportioning of cross sectional areas the stress sheets have been repeatedly revised to correspond with successive approximations of dead loads, so that the final stresses are computed from estimates of weight made from the details approved for the actual shop drawings. The detailing is being executed from the centre of the bridge towards the anchorages, and the suspended span has been completely designed, thus giving the true loads on the cantilever arms for which they can be accurately proportioned and the details of the anchor arms finally determined.

This method has the advantage of insuring such certainty and accuracy that Mr. Joseph Mayer, in charge of the computations for the board of engineers, expects to compute the total weight of the bridge within 1 per cent. of the actual shipping weight. It is subject, however, to the disadvantage of completing the design first for that portion of the bridge which will last be erected and conversely finishing last the design for the portion which must first be erected. On this account no material has yet been ordered for any part of the superstructure except steel required in the anchorage piers and for the floor system which is independent of the design of the trusses. It is expected that the design and computations will be finished so that the truss material may soon be ordered in detail and fabrication of it commenced during the coming winter.

Some of the principal features of the contract design were illustrated and described in the Engineering Record of April 22 and May 27, 1911. The principal dimensions of the trusses remain the same, but the outline is slightly modified by the introduction of false members connecting the top chords of the centre span and the cantilever arms. The riveted top chord members in the cantilever and anchor arm trusses have been superseded by double lines of 16-in. eye-bars in half-panel lengths. Their pins at sub-panel points pass through the webs of light lattice girders connecting the tops of the vertical posts to carry the dead weight of the eye-bars.

The bottom chord, about 10 ft. wide and 7 ft. deep, has a maximum panel length of 86 ft. Each panel will be composed of two pairs of built channels with a full length longitudinal diaphragm making an H-shape section. Each pair of channels has a field-riveted transverse splice midway between main panel points and the two pairs are field riveted together by three lines of very heavy lattice bars extending from end to end and thus forming a full length longitudinal splice. Each full panel of the bottom chord is thus fabricated and erected in four separate pieces with a maximum weight of about 100 tons for each piece, or 400 tons for the full panel length of member.

The 30-in. pins at the feet of the main vertical posts and bottom chards will take bearing on a built-up pier member resting on sectional cast steel pedestals. The pier members will weigh about 500 tons each.

The stringers are through plate girders fully equivalent to ordinary viaduct spans and are seated with their bottom flanges supported on the top flanges of the floorbeams. One end of each slide to provide an expansion joint in every panel and thus avoid the possibility of transmitting longitudinal chord stresses through the floor system. Wherever the conditions are such that rigid connections between the floorbeams and the truss members might cause the development of excessive secondary stresses the floorbeams have one and sometimes two pin bearings. They are massive plate girders 10 ft. deep with a maximum weight of about 60 tons each.

A large force of draftsmen is now employed by the contractor in working out the details and making shop drawings, and for their convenience and assistance an accurate model of one of the anchor arms of the main trusses is being built in the contractor's city office, adjacent to the main drafting room. It is to a scale of ¼ in. to the foot, with all compression members represented by solid rectangular pieces of pine to show relative dimensions without details. The eye-bars are made of thin sheet metal, cut to the required shape and dimensions, and the gusset plates and principal connections are also made of thin sheet metal bored for steel pins of proper dimensions. This model has been found very useful in showing relative positions, complicated connections and necessary clearances.

It is proposed to erect the anchor arms on massive steel falsework, which, together with the erection plan, are now being studied and designed. The erection problem is considered as a new and independent one to be treated as a whole with due recognition of local conditions and requirements rather than as the amplification of ordinary construction methods. Special attention is being given to the centre suspended span which will be erected on falsework and floated to position beneath the ends of the completed cantilever arms and connected through vertically slotted holes to ends of adjustable plate hangers suspended from the cantilever arms. The span will be lifted to position by specially powerful hydraulic jacks. In order that there may be no possibility of a drop on account of any failure of the jacks, the lifting movement of the latter is followed up by a system of power driven wedges, which prevent any slips of the hangers at all stages of the operation.

Extensive new shops with a complete equipment of powerful electrically driven machine tools have just been constructed for the fabrication of the steel work at Lachine, near Montreal, at an estimated cost of nearly $1,000,000, including the cost of the very valuable site. It is anticipated that this expense, together with the purchase of materials, cost of labor, equipment and erection plant, plus the required surety deposited, will aggregate $3,000,000 more than the contractors will have received in payment at the time erection is commenced.

The design and construction is under the direction of a board of engineers, composed of Mr. C. N. Monsarrat, chairman and chief engineer; Mr. C. C. Schneider and Mr. Ralph Modjeski. The contract for the steel superstructure was awarded to the St. Lawrence Bridge Company, of which Mr. Phelps Johnson is president, and Mr. G. H. Duggan, chief engineer. Mr. S. P. Mitchell, Philadelphia, has been retained as consulting engineer for the erection.

THE GAS ENGINE AS AN ECONOMICAL POWER PRODUCER.*

By W. C. Mountain.

Gas engines have been very greatly improved in design and construction during the last few years and undoubtedly offer the most economical means of producing power. The heat consumption of large gas engines in practical working is about 10,000 B.t.u. at normal full load and about 9,500 B.t.u. at the maximum overload. The net heat value of blast-furnace gas varies with the duty of the furnace and the character of the fuel used, but in general varies between 90 and 110 B.t.u., or, say, 100 B.t.u. per cu. ft. as an average. Therefore, the consumption of blast-furnace gas per brake horse-power per hour would be approximately 100 cu. ft.

With coke-oven gas the heat consumption is the same. The heat value of coke-oven gas varies considerably, but is generally in the neighborhood of 450 to 500 B.t.u., occasionally less. Taking 450 B.t.u. as the usual figure, the consumption per brake horse-power per hour at normal full load is about 22½ cu. ft.

The exhaust gases from gas engines can also be used for generating steam, and when an engine is developing something like its full load, from 2 to 2¼ lb. of steam per brake horse-power at 60 lb. pressure is regularly generated. and this steam can be utilized for driving auxiliaries, heating and other purposes.

As regards the power available from blast-furnace and coke-oven plants, the following figures are interesting:

The calorific value and volume of gases evolved by a blast furnace depend upon the character of the furnace burden, and to some extent upon the method of driving, but, as an average figure (Northeast Coast practice) the gas evolved per ton of pig iron produced is about 160,000 cu. ft., measured at atmospheric temperature and pressure. Of this gas, about one-third is used by the ovens, about one-eighth by the blowing engines (if driven by gas engines), and about 10 per cent. is lost or used up in miscellaneous ways; thus about 45 per cent. of gas is available as surplus, or approximately 72,000 cu. ft.

Taking an average heat value of 100 B.t.u. per cu. ft., the horse-power developed by large gas engines would amount to about 30 brake horse-power for every ton smelted in 24 hours. If ordinary steam blowing engines were already installed, the available surplus would drop to about 25 brake horse-power per ton of pig iron in 24 hours, and might even
horse-power per ton of pig in 24 hours, and might even

With coke ovens the production of gas naturally varies with the quality of the coal, but an average figure is 10,000 cu. ft. of gas per ton of coal. The surplus gas, when regenerative ovens are employed, amounts to about 5,000 cu. ft. per ton of coal. Where non-regenerative ovens are employed, the surplus is very much less, sometimes amounting to 2,500 cu. ft. In these cases the high temperature of the escaping gases enables a good deal of steam to be evaporated by suitable boilers heated by the waste gases. Roughly speaking, about 1 to 1¼ lb. of steam will be generated for each pound of coal coked, and this steam may be used for driving steam turbines or other classes of engines. It will thus be seen how much power can be obtained by utilizing what was at one time a mere waste product.

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* Abstract of the presidential address delivered at the annual meeting of the British Association of Mining Electrical Engineers, in Sheffield, England, Sept. 27, 1912.

CLAY PRODUCTS OF CANADA.

The actual production and sale of clay as such in Canada is as yet very small and practically limited to a small quantity of fire clay sold by a few operators. With this exception, all of the clay production in Canada is manufactured by the producer, states Mr. J. McLeish, B.A., chief of the division of mineral resources and statistics in his annual report.

The clay products made in Canada comprise brick of various kinds, including common and pressed, ornamental and fancy building brick, paving brick, firebrick, porous fireproofing brick and blocks, sewer pipe and drain tile, pottery and sanitary wares, the last two products chiefly from imported clays.

The production of clay products has been rapidly increasing, the value of the output having almost doubled in three years. The total value of the production in 1911 was $8,359,933, as compared with a value of $7,629,956 in 1910, showing an increase of $729,977, or over 9.5 per cent.

While the increase in gross output was not as large as that shown in 1910, the industry apparently made very satisfactory progress during the year.

Demand in most districts exceeded supply and higher prices generally were realized. For the year 1911 about 419 active firms reported, as against 438 active firms reporting for 1910. A larger number of men were, however, employed in 1911, an average of 9,131 being engaged, as compared with 8,656 in 1910; while the wages paid were $3,524,058 in 1911, as against $3,308,609 in 1910.

Considered by provinces, Ontario in 1911 had the largest output, being credited with 47 per cent. of the total value. Quebec was second with 16 per cent., Alberta third with 12½ per cent., Manitoba fourth with 10 per cent., followed by British Columbia with 8 per cent.

In 1907, Ontario contributed 54 per cent. of the production of clay products, while the western provinces contributed only 21 per cent., as against over 33 per cent. in 1911.

Of the total value of production in 1911, building and paving brick, including fireproofing, contributed $6,915,792, or nearly 84 per cent.; sewer pipe and tile production were valued at $1,152,528, or about 14 per cent. of the total.

The total value of the production of pottery was reported at $439,264, of which $102,493 is estimated as being attributable to Canadian clays and the balance to imported clays; the value of production of fireclay and firebrick was $89,130. Compared with the previous year, the production of building, paving and fireproofing brick shows an increase of nearly 12 per cent., while the production of sewer pipe and drain tile increased less than one per cent.

The average price of common building brick for the whole of Canada in 1911 was $8.37, as compared with $8.13 in 1910 and $7.81 in 1909. The average price of pressed or front brick for the same years was, respectively, $12.53, $11.89, and $11.01, thus showing the general increase in cost of building brick.

The total value of the imports in 1911 was at least $5,156,544 (certain items probably covering clay products not being included), showing a total approximate consumption of clay products valued at $13,416,537, of which only 62 per cent. was of domestic production.

In 1909 the approximate consumption was valued at $9,172,995, of which about 70 per cent. was of domestic production.

In the case of building brick, the imports while increasing rapidly are still small compared with the home production; it is different, however, with paving brick and firebrick. The imports of paving brick in 1911 were over twice, and the imports of firebrick nearly ten times the Canadian output.

While the production of sewer pipe and drain tile remained nearly stationary, the imports of these products more than doubled in 1911, and amounted in value to about one-third the domestic production.

CONSTRUCTION OF CONCRETE GRAIN ELEVATORS.*

By R. P. Durham.†

There is nothing in connection with the construction of foundations and first story of a concrete grain elevator, and very little in the construction of the cupola, calling for special comment as to method of procedure. Aside from the fact that foundation loads are exceedingly heavy and the item of the complicated construction sometimes necessary in the cupola, the ordinary methods of concrete warehouse construction are in general followed in building such portions of grain elevators. The building of the bin walls has, however, developed a method of construction not used, as far as I am aware, in connection with other buildings. This arises from the great height of bin wall of the same thickness, which early suggested that a short form which could be moved up continuously would be the most economical design.

All moving bin forms have certain characteristics in common, the variations between those used by different contractors, or by the same contractor at different times and on different work, being more in method than in principle. The form consists of horizontal framing pieces to which vertical sheeting is attached. The form may vary in height from 3 ft. to perhaps as much as 5 ft., measuring by the length of the vertical sheeting, but is always a comparatively short form. It must, of course, extend along both sides of each wall, the forms on the two sides of the wall being connected by vertical timber or steel yokes which are usually attached to the horizontal framing of the form. The sheeting is generally of wood dressed on the side in contact with the concrete. Galvanized sheet steel on a wood framework has also been used, and in some cases the wood sheeting itself has been covered with steel, either on the forms for the outside walls or on all the forms. The purpose of covering the wood sheeting or lagging with sheet steel has been to make smoother walls It has been found that the use of steel is not necessary if the raising of the form is carried on rapidly and continuously and a gang of pointers follows closely after the moving forms. In such cases the wooden sheeting has produced workmanship which is all that can be desired and in some ways is superior to that produced by stationary forms.

The principal difference in methods of building bin walls with moving forms is dependent upon the procedure followed for raising the forms. It is necessary, in order to obtain walls which are smooth and results which are economical, that the forms be raised continuously and that the movement be at a steady rate. The concrete at any particular point must have a reasonable length of time to harden before the bottom edge of the sheeting gets above it. This means that the progress in any one day is limited to a maximum of approximately twice the depth of the form, which insures that there will never be any exposed concrete which is less than 12 hours old. Assuming a 4-ft. form, this means that the movement must not exceed 4 ft. in 12 hours, and it is generally less than that; so that a very slow, but at the same time a very steady, upward movement is desirable. It will probably be asked, Why not build forms with longer sheeting and jack faster? The answers are, first, that it is not desirable to put a much greater load on green concrete; and second, that 6 to 8 ft. of concrete a day on a large building has been found to be the maximum which can be got

* Abstract of paper delivered to National Association of Cement Users, Pittsburg, December 10-13, 1912.

† Vice-President, John S. Metcalf Company, Limited, Montreal.

into the forms, when the placing of reinforcing and other items tending to delay have been considered.

The Canadian Pacific Elevator at Port Arthur, built in 1903, was the first elevator as far as I am aware on which moving bin forms were used. The jacking was done by means of, I think, ordinary locomotive jack screws. Brackets were fastened to the lower horizontal members of the forms and the jacks were set on vertical posts, with the top of the jacks bearing against these brackets. As the forms were raised to the limit of each jack, another section of post was added below the jack and the entire form structure thus gradually raised from bottom to top by increasing the length of the post. The jack posts were probably of varying length so that all jacks would not have to be released simultaneously.

Another method of raising moving forms, and that used by our company at the Missouri Pacific Elevator, Kansas City, and on one or two other contracts, was somewhat similar except that the jack was placed at the bottom of the bin instead of at the top next to the form. Locomotive jack screws were placed below the posts and the entire form structure and scaffolding gradually raised, the new sections of post being put in at the bottom from time to time as the limit of travel of any jack was reached.

After this time, with the increased number of concrete elevators being constructed and the increased number of engineers working on schemes for raising the forms, the method of jacking becomes more diversified. The style of jacks may, however, be divided into two general classes, the screw jack and the pump jack. The former depends on the travel of a nut on some form of threaded rod, either in the jack or in the bin wall; the latter depends on a toggle arrangement operated by a lever with pump handle motion and working on a plain rod. Practically all builders now support the forms, not on a scaffolding between the bottom of the bin and the form, but on steel rods which are embedded in the bin wall. The jack travels upward on these rods, the jack itself generally being attached to the yoke, to the lower end of which the bin forms on either side of the wall are secured.

The question as to whether the pump jack or the screw jack is the better style is one on which experts disagree. Some who have used both kinds are very much in favor of the pump jack; others who have had experience with both kinds stick to the screw jack. We have experimented with the pump style, but have never seen fit to adopt it in actual construction work. We have used two or three different styles of screw jacks and have built about 10,000,000 bu. capacity of storage bins with the jack we are now using. In this case the vertical rod which is embedded in the wall, and on which the jack operates, is threaded the entire length with a double V-thread about 3½ pitch. The jack casting is attached to the yoke and consists of one supporting casting and a revolving casting with apertures for the jack levers. The revolving casting is set over a square nut on the threaded jack rod. As the revolving casting is turned the nut climbs the jack rod and the yoke and forms are raised. This jack enables us to make steady progress, is capable of exerting great power in case of the forms sticking, and is sufficiently fast. On two different sections of the Montreal Harbor Commissioners' elevator, each section being about 150 x 100 ft. in plan, we have run up 86 ft. of bin walls in less than 14 days, or better than 6 ft. per day. This is, of course, working night and day; for if a moving form is stopped after it is once started a joint in the work is sure to show, and generally a small offset or shelf is left at the joint.

One company uses another type of screw jack; in its case the vertical rod in the wall is a plain rod. The jack is, briefly, an extra heavy pipe about 2 ft. long and threaded on the outside. The jack rod runs through this pipe, which is provided with a clutch at the lower end. The travelling nut operates on the pipe and when the limit of travel has been reached the clutch is released, the threaded pipe run to the other end of the travel and the operation repeated. The company has secured good results with this jack. The Macdonald Engineering Company, of Chicago, on the other hand, after trying various styles of jacks, has abandoned screw jacks altogether and uses only a pump jack.

The rate of progress of which I have spoken is possible only with a comparatively quick setting cement such as is used in the United States and Canada.

It is not possible to build a very thin wall with a moving form, the determining factor being the relation between the weight of the concrete in the form and the friction of the concrete against the sides of the form. The area of form exposed to the concrete is the same no matter what the thickness of the wall, while the weight, of course, varies in direct proportion to the thickness. I think it is entirely practicable to build a 6-in. wall with moving forms, but that it is dangerous to go much below this unless very special precautions are taken to prevent lifting of the concrete. We have built concrete elevator legs 2 in. thick with moving forms and got good work, but in that case we lifted the forms with chain blocks and went with comparative slowness.

The speed of the work and the freedom from trouble will also depend somewhat on the aggregate used and, it would seem in some cases, on the cement. Three elevator builders have had trouble with one particular brand of cement in moving forms and decline to use it further. A fourth has used it with success and is not afraid of it. Whether the trouble arises from this particular cement having properties which cause it to stick to the forms more than other cements, or whether it sets before the forms have been moved and thus causes the top of the walls to break away from the portion below it, is a question no one, not even the cement people themselves, has been able to answer satisfactorily.

The question of aggregates seems to be a comparatively unimportant one. We have had good results with crushed stone concrete and with gravel concrete. The crushed stone concrete has, perhaps, less tendency to lift in the forms, but on the other hand, on account of the likelihood of sharp corners of the stones catching in the wood of the sheeting when tamped and thus being displaced as the form is raised, smoother walls are generally obtained with gravel concrete. We have successfully run bin walls with sand and cement alone, though in general we should consider this taking a chance because of the tendency of a concrete mortar to stick to forms.

CONCRETE BRIDGE DESIGN.

In a recent paper on concrete bridge design, Daniel B. Luten, Indianapolis, Ind., states that the ideal highway bridge must include among its qualifications the following: Permanence, eliminating repairs, artistic appearance to harmonize with its surroundings, strength increasing with time and traffic, safety, meaning not merely security, but slow failure in case of defects; stable on insufficient foundations and under extreme flood conditions, effective waterway providing maximum discharge, efficient and economical in use of materials, employing home labor and materials, providing a roadway continuous over bridge and approaches, easily widened to provide for increasing traffic, easily modified in design to conform to improvement in surroundings, simplicity in design and erection.

SEWAGE TREATMENT STANDARDS.

By R. O. Wynne-Roberts, M. Inst. C.E., F. R. San. I.

The Royal Commission on Sewage Disposal has just issued its eight report, which deals with "standards to be applied to sewage and sewage effluents discharging into rivers and streams."

The commission has had under consideration tests of which three have been more fully investigated, viz.:

1. The quantity of ammoniacal nitrogen present.

2. The quantity of oxygen absorbed from permanganate in four hours.

3. The quantity of dissolved oxygen taken up in five days.

Of these tests the commission consider the last provides the most trustworthy chemical index of the actual state of a stream and should be adopted for purposes of a standard.

It appears that this test has been objected to an the grounds that it is difficult to carry out, and gives discordant results. But, in the opinion of the commission, the objection is not well grounded. A considerable number of chemists at different British sewage works have made numerous tests and with a little practice any well-trained chemist can apply it with ease, and obtain accurate results.

The commission concluded, after many experiments, that if 100,000 cubic centimeters of river water do not normally take up more than 0.4 gram of dissolved oxygen in five days the river will ordinarily be free from signs of pollution. If, on the other hand, a greater absorption of dissolved oxygen takes place, then the river will almost certainly show signs of pollution, except perhaps in very cold weather.

This "limiting figure," in the opinion of the Royal Commission, should be the foundation upon which standards should be based.

As temperature is an important factor, the results of five days' tests will vary during varying temperatures and different seasons. So, the commission carried out the experiments at a constant temperature of 65 deg. Fahr. A stream can be more highly polluted in cold weather without creating a nuisance and, therefore, the above standard temperature has been adopted.

The amount of dissolved oxygen taken up in five days by a mixture of river water and sewage effluent depends (a) on the amount taken up by the sewage, (b) on the amount taken up by the river water, and (c) on the proportion in which the two liquids are combined. A mixture complying with the standard of 0.4 parts dissolved oxygen per 100,000 of water may thus be expressed in equation form as follows:

$$\frac{x + yz}{z + 1} = 0.4$$

x = parts of dissolved oxygen taken up per 100,000 parts of effluent.

y = parts of dissolved oxygen taken up per 100,000 parts of river water above outfall.

z = dilution (proportion of river water to effluent).

Thus, for example, (given in report) if an effluent is discharged into 10 times its volume of water which itself takes up 0.1 parts of dissolved oxygen in five days the formula gives

$$\frac{x + (0.1 \times 10)}{10 + 1} = 0.4$$

$$x + 1 = 4.4$$

$$x = 3.4$$

In other words, the effluent in this case may be permitted to take up 3.4 parts of dissolved oxygen per 100,000 in five days and that figure would be the standard for this particular discharge.

The commission report goes on to state that a standard should be fixed which would be suitable for majority of places. But in Canada this must manifestly be varied, as what will apply in rapid streams will not suit sluggish and small streams. This is a point which the report deals with when it states that provision should be made for fixing one or two higher or lower standards to meet cases in which a different standard could be justified.

After making allowance for the practical difficulties in the way of removing suspended solids in a uniform manner, the commission considers that the dissolved oxygen test should be applied to the effluent as discharged, that is, with its suspended solids, and recommend that the normal figure for dissolved oxygen absorption test should be fixed at 2 parts per 100,000.

An effluent which takes up 2 parts of dissolved oxygen in five days will need some dilution if nuisance is to be avoided. The minimum degree of dilutes required for safety is to be found by means of the formula

$$\frac{2 + (0.2 \times z)}{z + 1} = 0.4$$

$$z = 8$$

The commission recommend that in the case in which a complete system is called for, the effluent should not contain more than three parts of suspended matter per 100,000, and that, including its suspended matters, it should not take up more than two parts of dissolved oxygen per 100,000 in five days at 65 deg. Fahr. (18.3 deg. C.). This standard is given for normal conditions and in special cases should be modified.

Where the dilution is very low it is suggested that the standard should be made more stringent, and if the dilution is very great the standard may be relaxed.

The commission state that their experience leads them to think that as a general rule if the dilution, while not falling below 150 volumes, does not exceed 300, the dissolved oxygen absorption test may be omitted, and the standard for suspended solids fixed at six parts per 100,000.

There are several other points of interest in this report which may be referred to later on.

LATHE FOR TURNING PROJECTILES.

A motor-driven lathe for turning projectiles has recently been developed. This service requires rigidity of equipment and wide speed range; a very high spindle speed is necessary when finishing the point of the projectiles. The lathe, which is of Pond make, is especially designed for individual motor drive, and is not a belt-driven lathe modified for motor drive; the motor is placed on the lathe head, thus saving floor space, and doing away with any chance of injury to employees from coming in contact with the motor or gears; at the same time the motor is protected from harm.

The control handle is to the extreme right of the tool apron, and very convenient for the operator.

The lathe is driven by a Westinghouse 20-h.p. machine tool motor, 400-1,500-r.p.m. Commutating poles insure excellent commutation at all loads within its capacity.

With the liberal speed adjustment of the motor, in combination with the gear-changing device operated by means of the levers at the left end of the tool, the wide adjustments needed in turning up projectiles are made readily available.

LIME-SAND BRICKS.

The manufacture of lime-sand bricks on a commercial scale was commenced in Germany about the year 1894, since which time many improvements have been made in the design and construction of machinery especially adapted for the purpose. That the industry is far beyond the experimental stage is proved by the fact that in Germany numerous plants are in operation, producing, it is estimated, over 1,000,000,000 per annum, Berlin alone consuming 400,000,000 annually. In the United States about 150 plants are in operation and many are being erected, the output for 1910 in the States being estimated at 350,000,000. In other countries the progress has been slow, but plants are now being erected in all parts of the world.

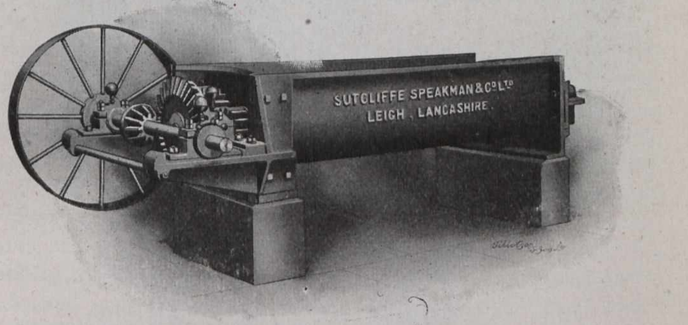

Fig. 1.—Differential Mixer.

Lime-sand bricks, as their name implies, are made from a mixture of slaked lime and sand. These materials, being suitably prepared and thoroughly mixed, are pressed into brick form by powerful presses, and then hardened by the action of high-pressure steam in suitably closed hardening chambers or vessels for a period ranging from eight to ten hours, the whole period of manufacture from taking the raw materials to completion ready for building not exceeding 24 to 26 hours.

They possess many advantages. Being perfect in shape, and uniform in size, less mortar is required in laying them, and when used for inside walling one coat of plaster is sufficient, the face of the wall being quite true. Their specification and use by the governments of Australia, Germany, Sweden, America and other countries are sufficient to prove that they are found to have all the weather-resisting and other properties of a durable brick. In general, they have the appearance of a natural sandstone, and may be compared to a good even-grained one; in fact, there are many varieties of sandstone from which they cannot be distinguished. They are cheap to manufacture, being made at a less cost than clay bricks, and when reasonable care is taken in making them, every brick is a facing brick. Their natural color depends upon the sand and lime used; generally they are white or gray, but variety in color may be obtained by the use of coloring ingredients.

PRINCIPLES OF MANUFACTURE.

Percentage of Lime Required.—As mentioned before, they are made from a mixture of sand and lime, the proportions varying with the kind of sand and the purity of the lime. A good, clean, silicious sand, consisting of well-graded fine and coarse particles mixed with 5 to 6 per cent. of a good fat lime gives excellent bricks, but in some cases up to as high as 8 or even 10 per cent. lime will be required. If the lime is hydraulic or an impure lime, or is not thoroughly calcined, the higher percentage is required. The average composition may be taken to run as follows:

Sand	85 per cent.
Lime	8 per cent.
Water (in combination)	7 per cent.

Preparation of the Materials.—Before the materials are ready for pressing it is necessary to ensure that the lime is thoroughly slaked, or hydrated and the mixing of the lime and sand intimately effected. If this is not effected the bricks will either crack or swell during the steaming, or be of a very weak and friable nature. When the manufacture of these bricks was first commenced, it was thought to be a simple matter to slake the lime, and that it could be done in the same way that builders prepare their lime. This method was soon proved unsuitable. If insufficient water was added, the lime was not slaked, and if too much water was added, the lime was made too wet, and it was impossible to make a homogeneous mixture. To overcome this difficulty, numerous methods have been adopted and the difficulties overcome as they have arisen by such systems as the nature of the material and the existing conditions on the site may demand. Exhaustive tests have proved that by proper methods lime-sand bricks of good quality may be made under almost any conditions, and that crushing strength and absorption varies with the qualities of the sand and lime used. By finely grinding through a tube mill of the preliminary mixture the results are excellent as the following figures from results of tests made will show:

	Crushing strength in tons per sq. foot.	Absorption.
Ordinary bricks made without fine grinding through tube mill, tested when 3 days old	150 to 400	8 to 12 per cent.
The same, but material treated in tube mill	300 to 600	3 to 7 per cent.

It is well known that lime-sand bricks improve with age, due to the further combination of lime and silica and to the absorption of carbonic acid from the atmosphere converting any uncombined lime into a carbonate.

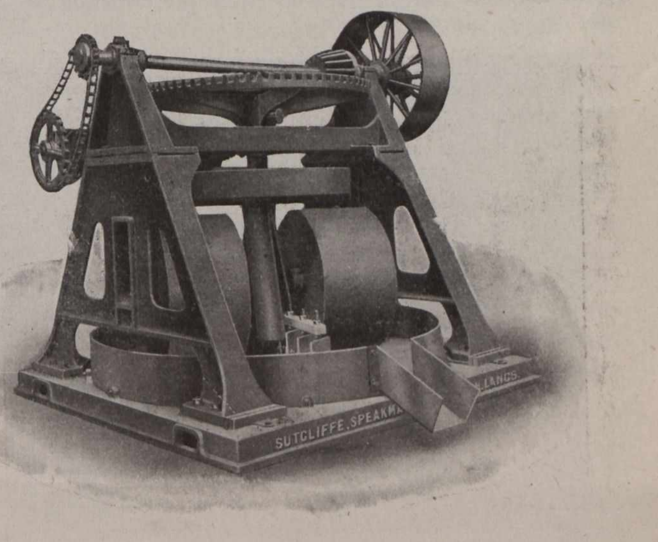

Fig. 2.—Edge Runner Mixing Mill.

Pressing the Bricks.—For pressing the material into bricks, the press must be a strong and powerful one, the bricks requiring a pressure of at least two tons per square inch, or a load of 80 tons on each brick. One hundred tons is preferable and is recommended. The pressure must be applied slowly in order to press out the air, and when the bricks are required for facing purposes they should be pressed equally on top and bottom.

Hardening the Bricks.—After coming from the press, the bricks are stacked closely together upon platform wagons, each wagon holding 650 to 800 bricks. They are then wheeled into hardening chambers or autoclaves. These are steel cylindrical vessels similar to Lancashire boilers without flues, one or both ends being fitted with a removable door. In these chambers the bricks are subjected to the action of steam at a pressure of 120 lbs. per square inch for a period of 8 to 10 hours. This treatment hardens the bricks and when drawn from the chambers they are ready for use.

Machinery and Plant Used.—For a successful manufacture of these bricks it is necessary that machinery of high-class make, specially designed for the purpose, be employed.

Through the courtesy of Messrs. Sutcliffe Speakman and Co., some particulars of the machinery they make for this industry are herewith given.

For the fine grinding of the lime an improved ball mill is used. These mills are made in sizes depending upon the work to be done.

When the fine grinding of the preliminary mixture is adopted, the use of the tube mill is recommended. This mill consists of a long steel tube, revolving on tyres and rollers. The tube is lined with silica paving, and is charged rather more than half full with hard flint pebbles. The material to be ground is fed in at one end, and passes out automatically at the other end, the grinding being effected by the rolling and tumbling of the pebbles on the material.

The differential mixer is illustrated in Figure 1. Various sizes are made to suit the output required. It is used both for the first mixing of the materials for the silo and for the final mixing prior to the mixture being pressed into bricks. The mixer consists of two shafts carrying knives or blades set at an angle to propel the material through the containing trough. One shaft revolves twice as fast as the other and the two shafts revolve in opposite directions. It forms a very simple and efficient mixing apparatus.

The mixing mill is shown in Figure 2. It consists, as shown, of two rollers revolving in a stationary pan, and so works that the material is not only turned over and mixed by the scrapers, but at the same time the crushing action of

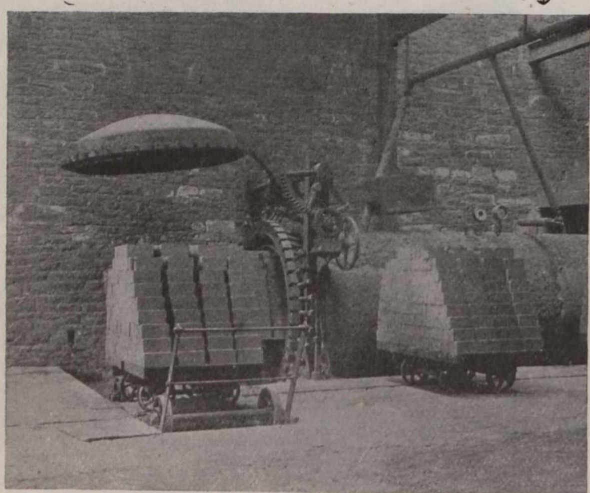

Fig. 3.—Hardening Chamber End, Showing Door Opening Arrangement.

the rollers gives a kneading effect. It gives a mixture in which each particle of sand is painted or covered with a thin coating of lime. It is made in various sizes and with rollers ranging up to five tons in weight each.

In any lime-sand brick plant one of the most important items is the press, as upon this depends more particularly the output, the general quality, and the finish of the bricks.

After an extensive experience in press manufacture, the result of the company's work is the "Emperor" press. This is a rotary table press capable of pressing the bricks equally from top and bottom.

The hardening chambers are specially designed for the required pressure, usually 125 lbs. per square inch, and are constructed in accordance with the requirements of the insurance companies. The most usual diameter is 6 ft., but on occasion they are made up to 6 ft. 6 in. and 7 ft. in diameter. Figure 3 shows the ends of a chamber and the arrangement recommended for opening the door.

When fuel is expensive and freights high, and first cost of plant is required to be reduced as far as practicable, small hardening chambers are supplied 3 ft. in diameter,

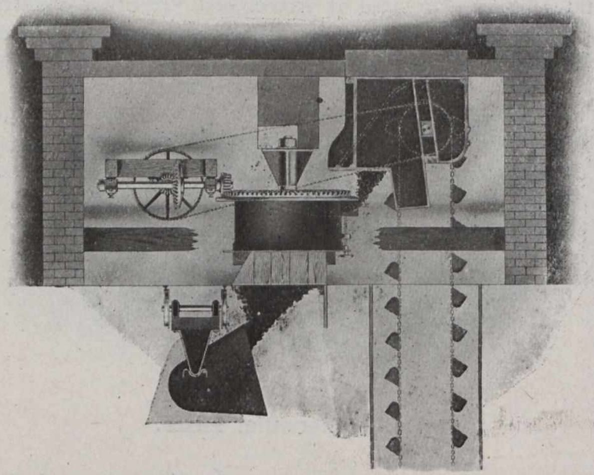

Fig. 4.—Automatic Feeder.

working at 200 lbs. pressure. This admits of steaming being effected in four hours, and if the chambers are so arranged that they can be operated day and night, the saving of steam is considerable, as one chamber can then be arranged always to exhaust into one ready for steaming.

For automatically measuring the feed to elevators and mixers circular automatic feeders, as illustrated in Figure 4, are used. This illustration shows the feeder automatically feeding an elevator. A wagon load of material can be tipped into it at one time, and it can be adjusted to pass the material at the required rate of feed.

This prevents the possibility of choking the elevators, and does away with the necessity of labor feeding the machines or elevators, whilst at the same time it acts the part of a measurer

MOVING A LONG BRICK WALL.

In order to widen the train shed of one of the railroad stations in Antwerp, Belgium, it was found necessary to move a brick wall, about 236 feet in length, a distance of 80 feet. The plan first decided upon consisted of demolishing the wall and rebuilding it of the same material at the new location, but when the contractor undertook to do this he found that the masonry construction was so solid that tearing it down would so damage the old material that it could not be used again. Therefore, he had the wall cut off in one solid piece, and moved on rails to its new location. The complete operation was accomplished by 18 men in 14 days, the actual moving taking but 27 minutes. The plans were so well carried out that not even one crack appeared in the wall.

At Souris, Manitoba, a money by-law to authorize the expenditure of $40,000 for electric lighting was defeated because the majority was one vote less than the required sixty per cent. necessary for it to become law.

MINING IN ALASKA IN 1912.

The annual report on the mineral resources and production in Alaska for 1912 is now in preparation, under the direction of Alfred H. Brooks, of the United States Geological Survey. Some of the important features of this report relating to mining development during the year are abstracted in the following statement. Complete statistics of the mineral production of Alaska cannot be collected within less than four or five months after the close of the year, but meanwhile it appears advisable to give prompt publication to preliminary estimates, which are believed to be not over 5 per cent. in error.

Value of Mineral Output.—It is estimated that the total value of the mineral output of Alaska in 1912 is $21,850,000, compared with $20,650,000 for 1911. The value of the gold output of 1912 is estimated at $16,650,000; that of 1911 was $16,853,256. It is estimated that the Alaska mines produced 28,940,000 pounds of copper in 1912, valued at about $4,630,000. In 1911 the output was 27,267,871 pounds, valued at $3,364,584. The silver production in 1912 is estimated to have a value of $300,000, as compared with $243,923 for 1911. The value of all other mineral products in 1912, including tin, marble, gypsum, coal, petroleum, etc., was about $260,000, compared with $176,942 in 1911. The total value of Alaska's mineral production since 1880, when mining first began, is, in round numbers, $229,000,000, of which $202,000,000 is represented by the value of the gold output. The total output of copper in Alaska since 1901 is about 90,000,000 pounds, valued at about $13,145,000.

Important Features.—The increase in the value of Alaska's mineral output is to be credited to the larger copper output as compared with the previous year. While no new copper properties were put on a productive basis, a large amount of development work was accomplished in several of the copper-bearing districts. The gold-mining industry was marked by important advances in developing lode deposits. Work was continued on a number of large lode-mining enterprises in the Juneau district, and considerable advances were made at Fairbanks and in other districts. In addition to this, promising discoveries of auriferous quartz were made at Port Wells and in the Innoko-Iditarod region, as well as in other parts of the territory.

The output from the placer mines was less than in the previous year. On the other hand, discoveries of rich auriferous gravels were made on Hammond Creek and in the Koyukuk Valley, and workable placers were found in the Ruby district. Extensions of gold-bearing gravels were also found in several of the older districts. The installation of large plants has not yet gone ahead rapidly enough to insure the keeping-up of gold-placer production. It is significant, however, that the output in Seward Peninsula was practically the same as that of 1911. The maintenance of this output in Seward Peninsula is to be credited to the installation of dredges, which was continued in 1912, as in the previous year. The data at hand indicates that in 1912 about 40 dredges were operated in Alaska, besides a number of others under construction. Of these, three are in the Fortymile district, one in the Fairbanks district, one in the Birch Creek district, one in the Iditarod district, one on the Kenai Peninsula, and the rest on Seward Peninsula.

There has been no change since the previous year in the opening of coal fields. One coal mine was operated for a part of the year at Chignik, in the Alaska Peninsula, and the mining of coal for local use was carried on in a small way at several other localities. Investigations were made in the Bering River coal field under the joint auspices of the Navy Department and the Bureau of Mines, to determine the availability of coal for naval use. One well was drilled at Katalla, and there was a small production of petroleum from this field, the oil being refined near the well, and the gasoline disposed of in the local market.

Transportation.—Except for the continuation of the work of the Alaska Road Commission in the building of wagon roads and trails, there was no marked improvement in transportation facilities during the year. The total railway mileage for Alaska in 1912 is 465, the same as in the previous year. Most of the railways were operated, except those in Seward Peninsula. The Copper River and North-western was blocked by landslides for about six weeks in the early fall.

In accordance with an Act of Congress, the Alaska Railway Commission was appointed about the 1st September, and spent about three months in the territory investigating railway routes and conditions of transportation. The report of this commission is in preparation.

Gold-Lode Mining.—It is estimated that there were about 22 gold-lode mines in Alaska that made some production in 1912, compared with 18 in 1911. In addition to this, development work was done on many lode prospects widely distributed over the territory. The value of the output from the auriferous lodes in 1912 is believed to be about $4,600,000, an increase of about $400,000 over that of the previous year. This increase must in large measure be credited to the Treadwell group of mines, but there was also a considerable production from various small properties in different districts.

South-Eastern Alaska.—The most notable mining advances in the territory during the year were those in the Juneau district. The Treadwell Mine increased its gold output. Work was continued on the 6,000-foot tunnel of the Alaska-Juneau Mine, and was begun on an adit tunnel of the Alaska-Gastineau, which will be about two miles in length. This tunnel is to undercut the Perseverance Mine, which, with adjacent properties on Sheep Creek, has passed under one management. The ore is to be carried to a mill of 6,000 tons daily capacity, which is to be erected at Tidewater. These enterprises, together with the continuation of work on the Kensington Mine and the reopening of the Jualin Mine, in the Berners Bay district, constitute an assurance that the production of gold in Alaska will not fall off, even aside from the promise of a larger output from other parts of the territory. It is reported that discoveries of rich gold-bearing quartz veins have been made on Funter Bay, Admiralty Island. Two mines were operated in the Sitka district, as in the previous year, and the discovery of a new gold-bearing quartz vein in the district is reported.

There was considerable advance of auriferous lode mining in the Ketchikan district during the year. The Goldstream Mine was again operated, supplying a 5-stamp mill. A 10-stamp mill was installed at the Valparaiso Mine. Two adit tunnels were started to intersect an auriferous quartz vein on the Buggy property, near Smugglers Cove. It is reported that the Lon de Van Company intersected an auriferous galena-bearing vein, at a depth of 1,100 feet, on its property located on Georges Inlet.

Prince William Sound.—The Cliff Mine, of the Valdez district, continues to be the only gold-lode property in the Prince William Sound region, which has made a considerable output. In the aggregate, however, considerable ore has been recovered from other properties incidentally to development work. At the Cliff the opening of the fifth level is the most important development of the year. Sinking was done on the Alice property, at Shoup Bay, and preparations made for installing a mill. Development work was also continued on the Mayfield property, about nine miles from Shoup Bay, near the Columbia Glacier, where an ore body has been opened on two levels. At the Ramsay and Ruthford property, east of the Valdez Glacier, a mining plant was installed and considerable development work accomplished, the ore being opened to a depth of 90 feet below the outcrop. There was much prospecting in the northwestern part of Prince William Sound and vicinity, Port Wells, and the adjacent fiords. Accounts from this district indicate that the ores are similar to those of the Valdez region. Considerable development work was accomplished on several properties in this field.

Kenai Peninsula and Willow Creek Districts.—Work was continued on the auriferous lodes of Kenai Peninsula and the Willow Creek district. Three small mills, two on Falls Creek and one on Porcupine Creek, were operated for a part of the year. In addition to these, two arrastres and one prospecting mill were operated in the Moose Pass district. Considerable work was also done on properties on Porcupine Creek, near Seward, and on Palmer Creek, near Sunrise. A gold-lode prospect was opened near Bird Point, on Turnagain Arm, and a small shipment of ore for testing was made. Three mills were operated in the Willow Creek district, and development work was advanced. It is reported that two of these properties are to be consolidated and opened on a large scale. The information at hand indicates that several promising discoveries of auriferous lodes were made in this district during 1912.

Fairbanks District.—Although the output from the Fairbanks placers has decreased, there was far greater activity in lode mining and prospecting than in the previous year. Most of the operations were conducted on a small scale, and the total output of gold was not large, but a very considerable amount of development work was accomplished during the year. In 1912 six stamp mills, aggregating 24 stamps, were operated for a part of the year, and six other mills were being installed in the late summer, and some of these were put into commission before the close of the year. Statistics at hand indicate that the average recovery of free gold from these operations is about $50 a ton. In only two places are the concentrates being saved, though they undoubtedly contain additional gold.

Lode prospecting has continued with increasing activity during the year, and probably more than 200 men were engaged in this work. As a result a number of quartz veins were disclosed, some of which promise well. The notable features of the lodes are their great number, small size, and high tenor. Most of the veins from which free gold can be obtained by panning are composed almost entirely of quartz, with sulphides either absent or present only in subordinate amounts. Stibnite is the most common of the sulphides. Most of the veins have been discovered in two areas—one stretching east and west from Pedro Dome, and the other in the vicinity of Ester Dome. It seems probable, however, that this distribution may be accounted for by the localization of the prospecting rather than by the actual limitations of the distribution of auriferous veins. But few of the richer veins so far discovered are more than one or two feet in width, and the gold is, as a rule, confined to the vein itself. In some places, however, gold has been found in adjacent mineralized country rock. In general the results obtained by the work of the year have been satisfactory. No large veins have been discovered, but a large number of small ones have been found. The development has been largely carried on by local capital, and most of it has been well advised.

Lode Mining in Other Districts.—The influx of prospectors into the Innoko-Iditarod region during the last two years has stimulated the search for lode deposits, but little has yet been accomplished in actual development. In 1912 an auriferous quartz deposit was opened on Gaines Creek and a small mill was installed. This operation has been successful, and is an indication of the possibilities of lode mining. More important is the fact that many other metalliferous veins have been found, and that the geologic conditions are favorable to their occurrence in considerable areas of the Innoko basin and adjacent portions of the Kuskokwim basin.

The Apollo Mine, on Unga Island, continued in 1912 to be the only productive lode mine in South-Western Alaska. Some work was continued on lode prospects in the Iliamna region, notably on the Duryea silver-lead deposit.

There was but little advance in quartz mining during 1912 in Seward Peninsula. Some prospectng was done, as well as assessment work, on a large number of claims. The New Era Mining Company opened a quartz lead near Snow Gulch, where a 4-stamp mill has been installed. Considerable ore was also treated at the Nome custom mill. Plans have also been made to install a stamp on a property located near Bluff, 60 miles east of Nome.

Copper Mining.—The increased copper production of 1912, compared with 1911, is to be credited to the Chitina and Prince William Sound districts. The rise in the price of copper led to much prospecting and deadwork in these as well as in other districts.

The Jumbo and Rush and Brown Mines were the only considerable shippers of copper ore in the Ketchikan district. It appears that the Mount Andrew Mine was idle for most of the year, but plans have been formulated for systematic development. Developments were continued on the It, the Red Wing, the Vittory and the Lhote and Sanford properties, and steps were taken looking to the reopening of the Copper Mountain Mine. Some work was also done on a copper-bearing vein at Sum Dum, in the Juneau district.

The Kennicott-Bonanza Mine is the only one in the Kotsina-Chitina district from which shipments were made in 1912, but a large amount of development work was done on other properties. The concentrator installed in 1911 at the Bonanza Mine was operated during 1912. At the east end of the field work was continued on the Mother Lode, Nikolai, and Westover properties, and also on a property located on an island in the Kennicott Glacier. Prospecting and developing were especially active in the vicinity of Kuskulana River. Here the largest operations were those of the Great Northern Development Company, which completed about 5,000 feet of development work. The Alaska Consolidated Copper Company carried on development work on Nugget Creek and on the Rarus group of claims. The Alaska United Copper Exploration Company continued work on the Blackburn group of claims, located on Porcupine Creek. In addition to the above, a large number of claims were being opened in the Kuskulana region during the summer of 1912. This field is now readily accessible from the railway, and a branch has been surveyed which would permit the shipment of ore.

On Prince William Sound shipments were made by the Ellamar Mining Company, the Threeman Mining Company, the Landlocked Bay Copper Mining Company, and the Beatson Copper Company, located on Latouche Island. In addition to productive properties, there were a large number of claims on which development work was carried on, some of which give promise of soon reaching a shipping stage. A notable advance was that made on the Solomon Gulch property, near Valdez, where a force of men engaged during the year in opening a chalcopyrite ore body.

But little advance was made in copper prospecting in those inland districts, which are far from transportation. About 25 men are said to be carrying on prospecting and assessment work in the White River region, and there are also some in the Nabesna district. Prospectors report the finding of copper ore on Sheep Mountain, in the Matanuska Valley. Some copper ore has also been found on a tributary of the McLaren River, in the headwater region of the Susitna. A little development work was also continued on the copper prospects of the Iliamna region, in South-Western Alaska.

Tin.—The dredge which was installed on Buck Creek last year was operated throughout the open season of 1912. It is currently reported that the output of 1912 is much larger than that of 1911. The Lost River lode-tin property has been bonded, and is now being systematically developed. The results of these operations in 1912 are reported to justify further investments and the installation of a mill. This property promises to become the first productive lode-tin mine in Alaska.

Placer Mining.—The returns from the Alaska placer mines are far from being complete, but the information at hand indicates that the value of the output in 1912 was half a million dollars less than that of the previous year. This decrease in production is due to the fact that the output from the Fairbanks and Innoko-Iditeraod regions was considerably less in 1912 than in 1911. On the other hand, a discovery of rich placer ground was made in the Koyukuk district, and promising finds were made in the Ruby district and the Innoko-Iditerod region. Moreover, the two years' work brought additional proof of the adaptability of the dredge for placer mining in different parts of the territory.

No noteworthy changes took place in the placer mining districts along the Pacific seaboard, which are relatively unimportant. A little mining was done at Juneau, and some larger operations were carried on in the Porcupine district. Beach mining continues to employ a score of men at Yakataga, and probably as many more in South-Western Alaska, notably on Kodiak Island.

The season in the Nizina district was successful, except for the floods which occurred in the latter part of the summer, and caused much damage to the two large plants there installed. The plant on Chititu Creek was, however, put into working order again before the close of the season. Mining continued as in previous years in the Chistochina district, but was considerably less n the Valdez Creek district, chiefly because a large number of claims were under bond to a company which proposed to install a large hydraulic plant.

Hydraulic operations were continued on Kenai Peninsula and at Crow Creek, as in previous years. A dredge installed in 1911 was operated on Kenai River for part of the season of 1912. There was also considerable prospecting in this part of the field for dredging ground.

It is reported that the Yentna district had a very prosperous season. Notable increase in production was made on Dollar Creek, where some high gravels were developed. A few prospectors continue work in the Mulchatna region, west of Lake Clark, but no important discoveries have been made in this field.

Yukon Basin.—The Fairbanks district continues to lead in the production of placer gold. The new discoveries in this field were principally those on creeks which have already yielded some gold. The most important was on Eva Creek. The work of the year has also considerably increased the area known to be underlain by workable gravels in the Chatanika Flats, near the mouth of Dome and Cleary Creeks. Additional gold-bearing gravels are said to have been found on Fairbanks Creek. The Fairbanks Creek dredge was operated throughout much of the open season. The gold produced at Fairbanks came chiefly from Goldstream Creek, the lower parts of Dome and Cleary Creeks, and Ester, Eva, and Fairbanks Creeks. It is estimated that between 130 and 140 different plants were operated, and that from 900 to 1,500 men were employed. Summer operations were much in excess of those of the winter.

In the Circle district the placer gold was taken chiefly from the mines of Mastoden, Deadwood, Eagle, Mammoth, Switch, and Independence Creeks. It is estimated that about 27 mines were worked during the winter and 32 in the summer of 1912, employing from 60 to 100 men in the winter and from 145 to 175 in the summer. A dredge installed on Mastoden Creek was operated during the summer of 1912. Hydraulic plants were operated on Mammoth, Mastoden, and Eagle Creeks.

The Fortymile district had a successful season. Three dredges were operated there during the summer. It is estimated that about 25 mines were operated in the winter of 1912, and about 50 during the summer. Many of these were, however, only small plants.

It is reported that the Koyukuk district had a very successful season in 1912, but details are lacking at this writing. A large amount of gold is said to have been taken from the newly discovered deep placers of Hammond Creek, and this production may have been sufficient to more than double the output of the district, compared with previous years.

Though the current reports from the Ruby Creek district have been rather discouraging, yet it seems certain that this district will become a gold producer of some importance. In 1912 operations were practically confined to six creeks, all lying within a small area about 25 miles south of the town of Ruby, on the Yukon. The creeks on which productive mining has been carried on are Long Creek, Upper Long Creek, Bear Pup, Midnight Creek, Glenn Gulch, and Trail Creek. About 150 men were employed in this district on 30 claims, and the value of the gold production was probably in excess of $150,000.

About 24 claims, located on five creeks and employing 140 men, were worked in the Innoko district during 1912. No new discoveries were made. In the Iditarod district Otter and Flat Creeks continue to be the most important producers of placer gold. Work was also done on Chicken, Willow, and Happy Creeks, and a little mining was carried on about Moore Creek, located about 30 miles farther east. A dredge was installed on the upper part of Flat Creek during the winter of 1912, and was operated for the latter part of the open season. It is estimated that 34 mines were operated in the Iditarod district in 1912. These were distributed on six creeks, and employed about 650 men. Of these plants one is a dredge, eighteen are equipped with steam machinery, and the rest are operated by manual methods.

During the summer of 1912 gold was discovered on Fox Gulch, a tributary of Cripple Creek, 30 miles north-east of Ophir, which created considerable local excitement. About a hundred men are said to be prospecting in this field. It is reported also that some workable placers were found on Mud River, a north-westerly tributary of the Innoko.

Prospecting continued in the Aniuk River basin, where gold was found in 1911. A small amount of productive mining was done in this region in 1912. Nothing of importance has developed in the Goodnews Bay region, where several claims, however, were operated in 1912.

Gold Dredging on Seward Peninsula.—There was no abatement in dredge installation on Seward Peninsula in 1912. It is reported that during the year 39 dredges were completed or in process of erection. The dredge season began in May, but most of the machines were not operated until the first steamers brought in the dredge crews, about June 15. Information at hand indicates that by August some 30 dredges were in operation, and that a number of others were started before the close of the season. Dredging continued until about the middle of October. It is a significant fact that these dredges are widely distributed over the peninsula, some being operated or under construction in every district which has yielded placer gold. This brings the final proof that profitable dredging ground is by no means confined to the vicinity of Nome, to the Solomon River valley, or to the vicinity of Council, as at first believed. The limitations on profitable dredging seem to be controlled rather by the cost of transportation, and especially of fuel, than by the physical condition of the gold-bearing gravels. Another significant item is that, in spite of the drought of the early part of the summer, and the fact that the value of the winter clean-up was only $400,000, the production of gold for the season was nearly the same as that of the previous year. This indicates that a large part of the gold production came from dredging operations which were not seriously hampered by small water supply. It is fair to assume, therefore, that the production of placer gold from the peninsula has passed its minimum for many years to come.

EFFECT OF ELECTRIC CURRENT ON CONCRETE.*

During the last few years attention has been called to the possibility of damage to reinforced concrete structures by stray currents from electric railways and other power sources. The laboratory experiments of Toch, Knudson and Langsdorf, in 1906 and 1907, showed quite clearly that under certain circumstances the passage of electric current from the reinforcing material out into the concrete gave rise not only to serious corrosion of the reinforcing material but also to cracking and disintegration of the surrounding concrete. Since then numerous laboratory experiments have been carried out by various investigators, all tending to confirm the earlier observations in regard to the destruction of the concrete, but giving rise to numerous conflicting theories as to the cause of the phenomena observed.

Following the early demonstrations of the possibility of damage to concrete by electric current, reports of serious damage to certain concrete buildings, bridges, etc., have been circulated from time to time, and considerable apprehension has been aroused in some quarters that great damage may be in progress due to this cause. The subject was brought directly before the U.S. Bureau of Standards by numerous letters of inquiry from engineers, contractors and corporations, requesting information in regard to the probable extent of the damage and the most feasible methods of preventing it. Although a good deal of work has been done showing that under certain conditions, readily produced in the laboratory, blocks of reinforced concrete could be completely destroyed by electric current, there remained a wide diversity of opinion as to the cause of the phenomena observed. Recognizing the great practical importance of the subject, and acting in response to requests from numerous sources, the Bureau of Standards has since the summer of 1910 been conducting a thorough investigation of the cause and extent of damage to concrete by electric current and the best methods of mitigating the trouble under practical conditions.

The investigation has been conducted along the following lines:

(1) Laboratory studies of the cause and nature of the phenomena caused by the passage of electric currents through concrete.

(2) Observation in the field with the view of establishing definitely the probable extent of the danger in practice and the circumstances under which trouble is most likely to occur.

(3) A study of the various possible means of mitigating trouble from this sourse, leading to specific recommendations based thereon.

The reports of previous investigators that the passage of current from an iron anode into normal concrete caused destruction by cracking were only partly confirmed. This effect did not occur in most of the specimens tested when the potential gradient was less than about 15 volts over a distance of 3 in. or about 60 volts per foot of anode.

Among the numerous theories that have been advanced for the cracking, the one which attributes it to oxidation of the iron anode following electrolytic corrosion has been fully established. The oxides formed occupy 2.2 times as great a volume as the original iron, and the pressure resulting from this increase of volume causes the block to crack open. The mechanical pressure developed at the iron anode surface by corrosion of the iron has been found to reach values as high as 4,700 lb. per square inch, a value more than sufficient to account for the observed phenomena of cracking. Metals which do not form insoluble products of corrosion and all non-corrodable anodes never cause cracking of the concrete as a result of the passage of an electric current.

Suggestions of some engineers that copper-coated steel, or aluminum, be used as reinforcing material have been shown to be impracticable, since the copper coating is readily destroyed and the aluminum is attacked by the alkali in the concrete.

The corrosion of iron anodes in normal concrete is very slight at temperatures below about 50 deg. Cent. The lack of corrosion of the iron at temperatures below about 50 deg. is due to the inhibiting effect of the hydrated lime, $Ca(OH)_2$, in the concrete. For any fixed temperature the amount of corrosion for a given number of ampere hours is independent of the current strength.

The rapid destruction of anode specimens at voltages from 60 to 100 volts or more is made possible mainly by the heating effect of the current, which raises the temperature above the limit mentioned above. If the specimen be artificially cooled no appreciable corrosion occurs and no cracking results.

In the specimen tested the potential gradient necessary to produce a temperature rise to 50 deg. Cent., with consequent corrosion, was about 60 volts per foot. For air-dried concrete it is much higher. This shows that under actual conditions corrosion from stray currents may be expected only under special or extreme conditions.

Since the passivity of iron in concrete is due chiefly to the calcium hydrate present it appears probable that old structures, in which the hydrate has been largely converted into the carbonate, will be more susceptible to the effect of electric current than the comparatively new concrete with which the foregoing experiments have been made. The increase in the corrosion would, however, be partly offset by the increase in the resistance of the older concrete.

The addition of a small amount of salt to concrete, as is frequently done to prevent freezing while setting, has a twofold effect. First, it greatly increases the initial conductivity of the concrete, thus allowing more current to flow, and, second, it destroys the passive condition of the iron at ordinary temperatures, thus multiplying by many hundreds of times the rate of corrosion and consequent deterioration of the concrete. Salt should, therefore, never be used in structures that may be subjected to electrolytic action. Further, reinforced concrete structures built in contact with sea

*Abstract of paper delivered before National Association of Cement Users, Pittsburg, December 10th-13th, 1912, by Mr. E. B. Rosa, Assistant Director; Mr. Burton McCollum, Associate Physicist, and Mr. O. S. Peters, Assistant Physicist, U.S. Bureau of Standards.

water or in salt marshes are very susceptible to trouble from electrolysis.

Specimens of normal concrete carrying currents increase their resistance an hundredfold or more in the course of a few weeks, which fact still further lessens danger of trouble. The rise of resistance is in general due to the precipitation of calcium carbonate within the pores of the concrete, thus plugging them up. A slight amount of salt prevents this precipitation and consequent rise of resistance, thus still further emphasizing the detrimental effect of the presence of salt.

Contrary to the observations of previous investigators, a distinct softening of the concrete near the cathode was observed. This begins at the cathode surface and slowly spreads outward, in some cases ¼ in. or more. After exposures to the air this softened layer becomes very hard again, but remains brittle and friable. This softening effect causes practically complete destruction of the bond between the reinforcing material and the concrete, reducing it to a few per cent. of its normal value. Unlike the anode effect, which becomes serious in normal concrete only on comparatively high voltages, the cathode effect developes at all voltages, the rate being roughly proportional to the voltage in a given specimen. For this reason it may frequently occur in practice, and is, therefore, a more serious matter practically than the anode effect about which so much has been heard.

The softening of the concrete at the cathode is due chiefly to the gradual concentration of sodium and potassium near the cathode by the passage of electric current. The alkali in time becomes sufficiently strong to attack the cement. This action can be increased or diminished by varying the sodium and potassium content of the cement.

Observations have shown that the softening of the concrete only takes place very close to the cathode, the main body of the concrete remaining perfectly sound without loss of strength. Because of this effect the method of protecting reinforced concrete buildings by connecting the reinforcing material as a cathode to a battery or booster would be much more dangerous than no protection at all.

The only effect which an electric current has on unreinforced concrete is to cause a migration of the water soluble elements. Consequently, in the absence of electrodes, the ultimate effect of current flow on the physical properties of the concrete is not materially different from that of flow water seepage, which also removes the water soluble elements. Non-reinforced concrete buildings are therefore immune from trouble due to stray earth currents.

Conditions do arise in practice which will cause damage from stray currents, but the danger from this source has been greatly overestimated in many quarters. While precautions are necessary under certain conditions, there is no cause for widespread alarm. Waterproofing reinforced concrete would greatly increase its resistance and diminish accordingly the danger from the anode or cathode effects. Waterproofing to prevent electrolysis is, however, a much more difficult matter than waterproofing to maintain a moderate degree of dryness, because of the much higher degree of waterproofing required in the former case. It has been found that practically all of the waterproofing agents now on the market that are intended to be mixed with the concrete are of little value as preventives of electrolysis. Waterproofing membranes, however, when applied to the surface can be made much more effective and may have considerable effect in preventing the entry of earth currents into the concrete.

Painting or otherwise coating iron with an alkali resisting metal preservative before embedding it in concrete may serve to minimize the dangers of electrolysis, but no such coating has been found that does not prevent the formation of the bond between the concrete and iron when the concrete sets. In order to insure safety from electrolysis potential gradients must be kept much lower in structures exposed to the action of salt waters, pickling baths and all solutions of chlorides, sulphates, nitrates or carbonates.

All electric power circuits within the building should be kept free from grounds directly on a portion of the building itself. If the power supply comes from a central station the local circuits should be periodically disconnected and tested for grounds and incipient defects in the insulation. In isolated plants ground detectors should be installed and the system kept free from grounds at all times.

All pipe lines entering concrete buildings should, if possible, be provided with insulating joints outside the building. If a pipe line passes through a building and continues beyond, one or more insulating joints should be placed on both sides of the building. If the potential drop around the insulated section is 8 or 10 volts or more, the insulated portion should be shunted by means of a copper cable. The grounding of electric conduits to water pipes and ground plates is in general not to be recommended in the case of concrete structures.

Lead-covered cables entering such buildings should be insulated from the concrete. Wooden or other non-metallic supports which prevent actual contact between the cable and the concrete will give sufficient insulation for this purpose. Such insulation of the lead-covered cable is desirable for the protection of the cable as well as the building.

In making a diagnosis of the cause of damage in any particular case the fact that a fairly large voltage reading may be obtained somewhere about the structure should not be taken as sufficient evidence that the trouble is due to electrolysis. The distance between the points and particularly the character of the intervening medium are of much greater importance than the mere magnitude of the voltage reading. As a precautionary measure, however, all potential readings about a reinforced concrete structure should be kept as low as possible.

SPECIFICATION FOR CEMENT TOP FLOORS.

This specification is for laying hard-finish cement top floors on new rough concrete, either paling or slabs supported by forms.

Finish to be mixed one part of cement to two parts crushed trap rock or hard gravel screening, which will pass through a half-inch sieve, and from which the fine dust has been removed. This is to be thoroughly mixed in a mixing box or by machine mixer, with an amount of water to produce a plastic but not a sloppy consistency; spread on the under-concrete before either the finish or the under-concrete has had time to set, floated with a wooden float to a true level, and then lightly troweled with a steel trowel as soon as possible to bring it to proper level, and smooth the top slightly. This will give a finish which is pebbly. It will not be dead smooth or slick like a sand finish.

After the finish has been troweled and has set sufficiently so that the covering will not mar the surface, it should be covered with sawdust, sand, cloths, or any other material which will hold water on it continuously. In building reinforced concrete work difficulty will be caused by the sand and sawdust blowing about the work, filling the forms, and generally getting in the way. In working around a textile mill there is usually plenty of old bagging, and in a paper mill there is usually plenty of old felts which can be borrowed for the purpose of preventing this.

The finish shoud be kept soaking wet for at least a week, or, better, for ten days. After two days it is possible to put up studs and do miscellaneous work on top of the new finish, provided it is not allowed to dry out.

COAST TO COAST.

Victoria, B.C.—The amount expended by the Dominion Government in dredging in the harbor of Victoria totals $84,194.21.

Calgary, Alta.—Up to Christmas, ninety-five applications had been received by the municipal authorities for the position of city engineer.

Calgary, Alta.—Permission is to be asked from the provincial government to allow Calgary to issue debentures payable in fifty years for certain purposes which include purchases of real estate, concrete structures and buildings which will come under the first-class regulations.

Ottawa, Ont.—The Department of Customs has issued an order prohibiting the importation from the New England States of forest plant products, including logs, tan bark, posts, poles, railway ties, cord wood and lumber, unless accompanied by a certificate from the United States Department of Agriculture that such products are free from the gypsy moth.

Berlin, Ont.—The report of the year's operation of the street railway shows a credit balance of $6,031.11, after taking off the debenture and interest payment. Ten per cent. was written off for depreciation on machinery, 5 per cent. on rolling stock, and 3 per cent. on trackage. This leaves a net profit of $910.58. Of that amount Waterloo is entitled to $227.64 and Berlin $682.94.

Winnipeg, Man.—According to the report just issued by the chief engineer of the Grand Trunk Pacific Railroad, on the work accomplished for the past year, construction has been undertaken on 563 miles of main line, and on 688 miles of branch lines, making a total of 1,251 miles of line on which clearing, grading, and track-laying have been done. Track has been laid on 128 miles of main line, and on 331 miles of branch lines, making a total of 459 miles of railway completed exclusive of second tracks and sidings.

Montreal, Que.—Owing to the many cases wherein expert engineering advice is required as regards level crossings, the elevation of tracks, and the construction of tunnels, the Board of Control of Montreal had under consideration recently the advisability of engaging an expert engineer for that purpose. The matter was deferred till the beginning of January, when it is most likely favorable action will be taken. Another reason for the engagement of a special engineer is that the regular staff of engineers at the city hall have practically no time to take up such work, as they have all and more than they can accomplish in keeping up with the demands for new municipal public works. Every season the city has important cases to be argued out before the Railway Commission, involving large sums of money and experience has taught the municipal authorities that the promoters have the best technical advice available. The corporation will now proceed to secure the services of an engineer who will undertake such work as the board may direct him to look after.

PRINCE RUPERT HARBOR.

It will take probably ten years to complete the work planned for the improvement of Prince Rupert harbor. Under instructions from the Grand Trunk Pacific Railway, Engineer Virgil B. Bogue has had his staff working here for several months, in preparation for making this a model harbor with its fourteen miles of length, thirty miles of water front, and a mean depth of 60 feet, without a rock or bar to interfere with navigation. Mr. Bogue plans to add civilization to its natural advantages and make a subharbor of fresh water 40 square miles in area. Between the island on which Prince Rupert is located and the main land is a large salt water lake with narrow passages at each end. Part of the general plan of harbor improvement is to put locks at the passage ways and to convert the lake into a fresh water harbor fed by mountain streams, and at high tide level. The whole water front is being laid out to accommodate berths for the big ocean liners, shipyards, fishing plants, lumber yards, saw mills, ore docks, elevators, warehouses, and other industries. The plans are sufficiently comprehensive to accommodate all the requirements of a city of several hundred thousand people.

FORESTRY AT TORONTO UNIVERSITY.

The Faculty of Forestry, University of Toronto, which graduated twelve students last year, has in the registration for the present academic year filled up its ranks to the number of 44, two old students who had interrupted their course returning and 17 new ones being registered. The graduating class has ten names, the first year of the four-year course eight names, the second year ten, and the third year five, besides eight in the six-year course in various years, and three occasional students.

Most of the graduates found employment with the Forestry Branch of the Dominion Department of the Interior, and a few with the Canadian Pacific Railway Company.

The call for foresters, owing to the sudden organization of the British Columbia Forest Branch, has been so urgent that the Dominion Branch has not been able to retain all its men, and a number have joined the new department. The market for foresters has been brisk, with consequent raises in salaries to an unusual level for young men, and altogether a hopeful development for employment is anticipated.

There have been no essential changes in the curriculum as followed hitherto, except that the practice camp has been held at the beginning of the session instead of at the end.

An unusually satisfactory location for the camp was found at Frank's Bay, Lake Nipissing, Ontario, where an old depot of the John B. Smith and Sons Lumber Company was at the disposal of the fifteen students who attended the camp, with two instructors, and a virgin stand of red pine (limits of the Strong Lumber Company), to be logged this winter, together with other types, gave excellent opportunity for practice work in forest survey, and gathering data for working plan, studying detail of types, constructing growth tables, etc.

The work was carried out according to careful plans, and has been so complete and satisfactory with regard to red pine growth studies that it is expected to publish the results.

VICTORIA'S OFFICIALS REPLY TO UNDERWRITERS.

Water Commissioner Rust and Fire Chief Davis, of Victoria, find that so far as the water situation in the city at present is concerned, the recent statements of Mr. Page, secretary of Vancouver Island Fire Underwriters, were about right, and they admit that there is a shortage of water, which shortage will be more acute during the coming summer; in fact, until water is obtained from Sooke lake. But the water commissioner is now preparing a report which will deal with the best means of augmenting the supply pending the completion of the Sooke lake development work, and this report will shortly be before the council.

They correct Mr. Page's statement that the fire department has been in the practice of connecting fire engines to the salt water hydrants. It was only done on one occasion, about two years ago, but the standing order now is that this must not occur. Also, relative to the department's telephone service, the department lines are operated under a separate exchange system in headquarters station, with a private wire for fire alarms only. Further, Mr. Page's suggestion that a fire alarm wire to the North Dairy Farm pumping station is required has been adopted, and the line is about completed.

The officials' report also states that it is the intention of the water commissioner not to construct any more four-inch mains except occasionally on streets whereon there are a number of houses and in the outskirts of the city.

In answer to a question, Fire Chief Davis stated that for the past two months the pressure available for fire fighting purposes in Victoria West has been good. At the Victoria West fire hall, which is about the highest point in that section, the pressure has been maintained at from fifty-five to sixty pounds and has not been less, while on the low level the pressures range from ninety to ninety-five pounds, and have run as high as 105 pounds. This improvement has occurred since the Esquimalt Water Works Company installed its new main to Goldstream. About two months ago while repairs to the pipe line were being made, the supply was gradually reduced during the day, with the result that the pressure had been reduced to about twenty-five pounds.

ST. LAURENT AND MOUNT ROYAL FRANCHISES.

An ending somewhat characteristic of present-day developments has taken place in the case of the franchise for the public service of the municipality of St. Laurent and the disagreement between that municipality and the new Model City of the Canadian Northern Railway. It may be recalled that the Franco-Belgian Syndicate some time since obtained the franchise for the supply of water for the town but refused to post the deposit of $20,000, being no doubt desirous of obtaining the franchises for all the public services. Later, the council granted franchises for water supply, lighting and street railway service to the company, the conditions being that the franchise was for twenty-five years, work on the waterworks and on lighting to be commenced within thirty days of notice from the council, and the railway to be commenced within six months of the adoption of the by-law now before the legislature at Quebec.

The Franco-Belgian Syndicate only had a capital of $100,000, but was applying to the Dominion Government for an increase to $2,000,000, and the representatives of the company claimed they had lots of French and Belgian capital behind them and were well able to post their $50,000 deposit.

It was a little significant that the Montreal Tramways Co. was not making a very strong agitation against the granting of the franchise, so far as known. When the matter came up before the Quebec legislature, it developed that the Franco-Belgian Syndicate had turned over its franchise for street car service to the Montreal Tramways Company and its lighting franchise to the Montreal Public Service Corporation. These concerns are those with which Mr. E. A. Robert, M.L.A., is particularly interested and which are included as subsidiaries in the Montreal Tramways and Power Company. It was suggested that Mr. Robert should not vote in the matter when it came up at Quebec, but the point was not pressed for the reason that the government had a large majority in any case.

In the above connection, also, the legislature sanctioned a twenty-five year franchise for the Montreal Tramways Co. for the street car service for the Canadian Northern Railway "Model City," the name of which town was changed at the same sitting of the legislature to "Mount Royal." Also, at the same meeting, a fifteen-year franchise was given the Montreal Public Service Corporation for the lighting of the streets of Mount Royal. The counsel for the Montreal Light, Heat and Power Co. was on hand to object to this on various grounds, among which was the fact that no one yet lived in Mount Royal. He claimed that it was a shame that this company should get the exclusive franchise in this manner when there were so many other companies in the field. The answer made to this remark by the friends of the bill was that the Montreal Light, Heat and Power Co. should have thought of this when they were getting their privileges in 1901 and that if they were prepared to give up their exclusive franchises the other companies were prepared to do the same.

As a result of the final revision made by the private bills committee of the legislative assembly, the Montreal Tramways Company, and allied interests, abandoned their exclusive franchise for the construction of a water works system in the parish of St. Laurent, and retained the exclusive franchises for the tramways service, and the supply of electric light and power. These franchises are for the period of twenty-five years each. The protests of the electors of the parish of St. Laurent and the vote they had taken against the water works privilege being limited to one company, were not commented on in any way.

The legal representative of the company, Mr. Rinfret, moved that the reference to the water works by-law, which the bill asked to be sanctioned with the two other by-laws, be omitted, and this was followed by the further amendment, also included in the bill of Mount Royal in favor of the protection of vested rights.

Honorable Mr. de Varennes, chairman of the committee, inquired whether the representative of the parish of St. Laurent consented to the change, and Mr. Jasmine nodded consent.

The Vancouver board of trade is taking up matters of material benefit to the province as a whole, one of which is the question of securing actual settlers for the land. There has been criticism of the manner in which the land resources of the province have been administered, and the board of trade committee have had the matter under consideration for months. The substance of its report is that care should be taken to exclude the speculator, to encourage the settler and to help the man who would till the soil, practical assistance being given by the government.

PERSONAL.

R. A. ROSS, consulting engineer, of Montreal, has been engaged by the city of Calgary to make a report on the local power and light situation.

H. A. BAYFIELD, government superintendent of dredging in British Columbia, has been relieved of his duties by the Minister of Public Works.

ALEXANDER POTTER, consulting engineer, New York, has changed his address from 114 Liberty Street to 50 Church Street, New York City.

H. BARBER has resigned from the Hydro-Electric Department of the city of Hamilton to take a position with the Toronto Hydro-Electric Commission. Mr. Barber is a graduate of the Toronto University in Electrical Engineering.

JOSEPH D. EVANS, who has been chief engineer of the Montreal Tramways Company since June, 1911, will sever his connection with that company on January 1, and become construction manager of the Electric Bond and Share Company, of New York, one of the largest builders and operators of public utilities on the continent.

J. W. TYRRELL, one of the first graduates of the School of Practical Science, has formed a new consulting engineering firm in Hamilton, Ont. The members of the firm are J. W. Tyrrell, John E. Jackson and Oliver E. Blandy, and the work taken up will be civil engineering, and Ontario and Dominion land surveys. The offices are in the Hamilton Provident and Loan Company.

W. P. NEAR, B.A.Sc., has been appointed city engineer of St. Catharines, to take the place of Mr. R. D. Brown, whose resignation was noted in these columns some weeks ago. Mr. Near was born in St. Mary's, Ont. He was educated in the High School there, and later graduated in civil engineering from the University of Toronto. He worked on boundary surveys in Alaska, and later spent a year on the Temiskaming and Northern Ontario Railway. The year 1905 witnessed the eclipse expedition to Labrador and Mr. Near was a member of the party. Three and a half years ago he joined the main drainage department as a member of the Toronto city engineering staff.

COMING MEETINGS.

AMERICAN WOOD PRESERVERS' ASSOCIATION.—Ninth Annual Convention will be held at Chicago. Jan. 21-23, 1913. Secy-Treasurer, F. J. Angier, Mount Royal Station, B. & O. R. R., Baltimore, Md.

AMERICAN INSTITUTE OF CONSULTING ENGINEERS.—Annual Meeting, January 14th, 1912, will be held at The Engineers Club, 32 West Fortieth Street, New York, N.Y. Secretary, Eugene W. Stern, 103 Park Avenue, New York.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—Annual Meeting will be held on Jan. 28th, 29th, and 30th, 1913, at the Society's new headquarters, 176 Mansfield St., Montreal. Secretary, C. H. McLeod.

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

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

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

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary, Professor C. H. McLeod.

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

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

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

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving: Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright Secretary, Mr. Hugh B. Fergusson, 911 Rogers Building, Vancouver, B.C. Headquarters: McGill University College, Vancouver.

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

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

MUNICIPAL ASSOCIATIONS

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

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

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

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

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

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

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

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

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

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

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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