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CITY PAVING IN CANADA IN 1914

WHAT CANADIAN CITIES SPENT ON ROADS, PAVEMENTS AND SIDEWALKS LAST YEAR—TOTAL MILEAGES TO DATE—ESTIMATES OF 1915 WORK NOT YET DECIDED IN MOST INSTANCES.

FROM information which a large number of Canadian cities, towns and municipalities have submitted to *The Canadian Engineer*, it is very evident that paving in 1914 was, to say the least, little more than "half a crop." The reason is very obvious. The paving season could hardly have been more neatly cut in half by any other means than the effect which the European war had early in August of last year. Of course, a few contracts were continued to completion, or to the end of the season; but their effect upon the aggregate is counteracted by the effect of the financial depression which preceded the outbreak of hostilities. One must remember, however, that the suspension of paving operations was not the result of exhausted resources, but rather due to a general paralysis of all active work in the early stages of the war. The situation in Europe had decidedly more interest for the Canadian public than the needs for better roads and pavements.

The following notes respecting work accomplished by various cities and towns last year will be found of interest:—

Amherst, N.S.—About 1.54 miles of concrete paving was put down in 1914 at a cost of $27,801, or $2.35 per sq. yd., including curb and gutter, grading and foundation. Concrete alone cost $1.90 per sq. yd. The work was done by contract under supervision of Mr. J. E. Parker, town engineer. The town adopted, some time ago, the boulevard system of street arrangement. It is estimated that 1915 work will comprise about $45,000 worth of concrete or bitulithic pavement. No decision, other than that, has been reached.

Assiniboia, Man.—Late in the year a stretch of 54,450 sq. yds. of asphaltic concrete was let by contract and partly constructed, the balance to be completed this year. The price per sq. yd. was $2.47, including grading and foundation. Mr. G. W. Rogers is the municipal engineer.

Berlin, Ont.—At the end of the season the city had a total mileage of 8.18 of pavements, including 4.72 miles of roadway treated with tarvia. A total of 54.62 miles of sidewalks have been laid to date. Work during 1914 included 12,084 sq. yds. of asphaltic concrete laid by contract at $2.53 per sq. yd., inclusive of grading and foundation; 25,416 sq. yds. of asphaltic macadam costing $1.36 (day labor), and 956 sq. yds. of ordinary macadam constructed by day labor at a cost of 69c. About 10,370 sq. yds. of creosoted wood block were laid by contract, the price being $3.10. This made a total of 2.79 miles of pavements laid last year, the expenditure being $121,932.96. The amount spent on curbs and gutters was $13,149.01, and on sidewalks, $14,298.25. Estimates for 1915 work are incomplete, but they include $40,407.15 for pavements and $6,021 for sidewalks. A stretch of 27,867 sq. yds. of asphaltic macadam will be laid. Mr. H. Johnston is city engineer.

Bowmanville, Ont.—The town engineer, Mr. C. F. Gibson, states that nothing has been decided upon for 1915 as yet. There was little or no paving work in 1914.

Charlottetown, P.E.I.—Some 4,000 sq. yds. of waterbound macadam, costing $1 (day labor), constituted new pavement work, while about $1,000 was spent on repairs to existing pavements. Sidewalks costing in all $8,700 were laid. Mileages to date are, of pavement 6; of sidewalks 15. During the coming season about $6,000 will be spent on a new waterbound macadam roadway and about $7,000 on sidewalk construction. Mr. J. P. Nicholson is city engineer.

Edmonton, Alta.—Asphaltic concrete to the extent of 70,105.02 sq. yds.; concrete, 10,683 sq. yds., and sheet asphalt, 4,653.8 sq. yds., were constructed by contract during the year, making an addition of 5.226 miles and bringing the total in the city up to 46.782 miles. Last year's paving cost $286,576.88; curbs and gutters $9,590, and sidewalks $155,484.49. There is a total of 202.267 miles of plank and concrete sidewalk on the city's streets. Mr. A. J. Latornell, the city engineer, advises us that no paving for 1915 has been decided upon as yet.

Fort William, Ont.—Some 2.17 miles of pavements were added last year, bringing the total up to 4.67 miles, the expenditure for 1914 being $154,012 for new pavements, including curbs and gutters, and $2,700 for pavement repairs. Waterbound macadam to the extent of 47,449 sq. yds., costing $1.12; Rocmac amounting to 18,868 sq. yds., costing $1.50, and asphaltic concrete costing $1.95 to $2.10 for 57,798 sq. yds., constituted the contract work, while 603,360 sq. yds. of gravel was laid by day labor at about 35c. per sq. yd. Sidewalk expenditure in 1914 amounted to $25,399, bringing the mileage up to 61.32. No 1915 paving work has been decided upon, according to Mr. R. R. Knight, the city engineer.

Hamilton, Ont.—About 9.7 miles of pavements were added last year, bringing the total up to 41 miles. The amount spent on pavements and gutters was $243,353.95, and on pavement repairs, $12,186. About $145,520 was spent on curbs and sidewalks. Of the latter the city has now about 240 miles.

Last year's paving consisted of the following items: 1,438 sq. yds. of concrete at $1.10; 120,826 sq. yds. of sheet asphalt at 84c.; and 21,351 sq. yds. of asphaltic concrete averaging 76c. (These prices per sq. yd. are exclusive of grading and foundation course.) About 10,326 sq. yds. of creosoted wood block were also laid.

As for 1915 work, no detailed estimate is available as yet. The city will probably construct between 150,000 and 175,000 sq. yds. of pavements, but yardages of different types have not been decided upon, according to Mr. A. F. Macallum, the city engineer.

Kamloops, B.C.—There was no paving done in 1914, and the only road work decided upon for the coming season is the spraying of oil on some 60,000 sq. yds. of earth and gravel road. There are some 5 miles of sidewalks. Mr. Eric G. Kingwell is city engineer.

Kingston, Ont.—Some 10,870 sq. yds. of waterbound macadam, costing 38c., were laid by day labor. The rest of the paving was contract work, and included 7,998.8 sq. yds. of asphaltic concrete, costing $2.35, including grading and a 6-inch concrete base; and 936.8 sq. yds. of concrete in track allowance, consisting of concrete slab 6 in. thick, with a ½-inch limestone cushion under ties and over the whole surface of slab, and then concrete to the top of the 4¼-inch rail. This cost $4.48 per sq. yd., including grading, etc. Sandstone block was also laid in track allowance to the extent of 5,255.5 sq. yds., and cost $5.33, including grading, etc. This also had a 6-inch concrete slab with ½-inch limestone screenings over its surface; then concrete to the base of the rail and sandstone block above it. Pavement mileage now totals 2.616, some .549 mile having been added last year at a cost of $49,459.55. In addition, $1,857.15 was spent on curbs and gutters and $19,950.40 on sidewalks. Mr. R. J. McClelland, city engineer, stated that, at time of writing, council had not decided upon paving work for 1915.

London, Ont.—Last season's paving work included 22,744 sq. yds. of sheet asphalt laid by contract at $1.46, and 20,516 sq. yds. asphaltic concrete, also contract work, at $1.25. Gravel road to the extent of 11,036 sq. yds. and 4,755 sq. yds. of concrete pavements were laid by day labor. There was also a stretch of 6,933 sq. yds. of vitrified brick laid by contract. The above prices for sheet asphalt and asphaltic concrete were inclusive of grade and foundation. London's total paving mileage is now 12.89, an addition of 4.35 miles resulting from 1914 work, at a total cost of $134,029. Pavement repairs amounted to $900. Curbs and gutters involved an expenditure of $13,463.75 and sidewalks, $19,630.75. There are now 160.3 miles of sidewalks in London.

The paving programme for 1915 will eventually amount to $250,000 or over, but exact information is not available as yet. The following yardages have been practically decided upon: Asphaltic concrete (including bitulithic), 54,000; vitrified brick, 5,200; concrete, 9,800, and gravel, 3,200. According to a later report, over $140,000 worth of asphalt will also be laid. The estimate for sidewalks is $20,000. Mr. H. A. Brazier is city engineer.

Moncton, N.B.—The only paving work done last year consisted in the application of tarvia surfacing to about 6,233 sq. yds. of macadam on slag foundation, at a cost of 80c. per sq. yd., or $4,986.40 (day labor). Expenditure on curbs and gutters amounted to $8,125.92 and on sidewalks $33,025.11. There are now 1.25 miles of pavements and 26.71 miles of sidewalks. No 1915 work has yet been decided upon. Mr. J. Edington is city engineer.

Moose Jaw, Sask.—No new pavements were laid. About $1,517.37 was spent on repairs to existing pavements. Curbs and gutters and sidewalks involved an expenditure of $103,691.98. The city has now 4.5 miles of pavements and 40.17 miles of sidewalks. In 1915 it is proposed to construct 16,628 sq. yds. of asphaltic concrete and about 3,000 sq. yds. of sidewalks. Mr. George D. Mackie is city engineer.

New Westminster, B.C.—Mr. J. W. B. Blackman, city engineer, states that 1915 work will cost $67,000 and will include the addition of about half a mile of Hassam paving. No 1914 work was reported.

Oak Bay, B.C.—This municipality, of which Mr. R. Fowler is engineer, laid about 37,800 sq. yds. of 3½-inch tar macadam on a 6-inch Telford base at a cost of 92c. by day labor, thereby increasing its mileage of pavement from 6 to 8½ miles at an expenditure of $35,877. In addition, $24,439 was spent on road and pavement repairs, and $36,402 on new sidewalks, the total length of which now amounts to 17.75 miles. No 1915 work is yet reported.

Ottawa, Ont.—Asphaltic macadam, to the extent of 4,111 sq. yds., was laid by contract at a cost of $1.20. Some 3,500 sq. yds. of Rocmac surfacing was laid by day labor at about $1 per sq. yd. The same price obtained for about 18,000 sq. yds. of tarvia, also laid by day labor. Contract work included 124,530 sq. yds. of sheet asphalt at $1.28; 5,571 sq. yds. of stone block at $2.80, and 22,000 sq. yds. of creosoted wood block at $2.75. The total expenditure on new pavements amounted to some $700,000 and on pavement repairs $33,355.20. Sidewalk expenditure was $82,636.90. The mileage of sidewalks is now 197.32, and of pavements 44.76, about 9.8 miles of the latter having been laid in 1914.

Work for 1915, as at present projected, includes 9,000 sq. yds. of treated wood block, 22,000 sq. yds. of stone block, 100,000 sq. yds. of sheet asphalt, 1,000 sq. yds. Rocmac and 10,000 sq. yds. tarvia, the total estimated cost being $600,000. In addition, $100,000 will be spent on sidewalks. Mr. F. C. Askwith is acting city engineer.

Peterborough, Ont.—Last year's paving was done by contract and included 35,986 sq. yds. of asphalted concrete at $2.15 to $2.19 per yard, and 4,564 sq. yds. of vitrified brick at $2.96 per sq. yd. This added 1.84 miles of pavements last year, bringing the total up to 2.34, at an expenditure of $115,000. New sidewalks cost $12,770, and the total sidewalk mileage is now 67. Pavement estimates for 1915 have not been decided. It is proposed to construct test sections of several types of the lower priced pavements. About $10,000 will be spent on sidewalks. Mr. R. H. Parsons is city engineer.

Portage la Prairie, Man.—The city has about 25 miles of sidewalks, but no pavements. It is unlikely that any will be started this year. Mr. Alex. Taylor is city engineer.

Port Arthur, Ont.—Some 38,536 sq. yds. of waterbound macadam, laid by contract at a cost of 35c. per sq. yd., constituted the new pavement work in 1914. A tarvia surfacing on macadam cost $1,157.95, and some pavement repairs cost $1,177.79. About $15,383 was spent on sidewalks. The total mileage of pavements is now 30 and sidewalks 29. According to the city engineer, Mr. L. M. Jones, no paving work is projected for 1915.

Regina, Sask.—There were 28,525 sq. yds. of asphaltic concrete laid in 1914 at a cost of $3 per sq. yd., exclusive of grading, but including foundation; 26,754 sq. yds. of sheet asphalt at a cost of $2.85 per sq. yd., and 2,203 sq. yds. of stone block at $5.45 per sq. yd. According to a statement made by Mr. F. McArthur, city engineer, the 1915 work has not yet been decided upon.

Saskatoon, Sask.—During 1914 about 4,400 sq. yds. of asphaltic concrete was laid by contract at a cost of $2.90. Other small additions and repairs brought the total pavement expenditure up to $20,481.31, including curbs and gutters. Sidewalk expenditure amounted to $1,353.46. There are now 5.76 miles of pavements in Saskatoon, and 53.82 miles of sidewalks. Mr. Geo. D. Archibald, the city engineer, reports that no 1915 work has been decided upon.

South Vancouver, B.C.—Mr. S. B. Bennett, the engineer to this municipality, states that 10,594 sq. yds. of bitulithic, 1,464 sq. yds. of Lithtar, and 65,372 sq. yds. of treated wood block were laid by contract last year. The wood block cost $3.55 per sq. yd., including grading. About .75 mile of waterbound macadam, varying in width from 15 to 18 ft., was constructed by day labor. The total mileage added last year was 2.73, the cost being $499,858.55, including curbs and gutters. There are now 6.6 miles of pavements. No sidewalks have been laid.

During this season 33,150 sq. yds. of treated wood block will be laid on Main St., 22,420 sq. yds. of bitulithic will be constructed on Victoria Rd., and approximately 2 miles of waterbound macadam will also be built. There are other estimates being prepared, but types have not as yet been fixed. The estimate for improvement on Main St. amounts to $162,360.

Stratford, Ont.—Some 2.04 miles of paving were added last year, making the total 10.2 miles of permanent pavement on a concrete base and 8 miles of waterbound macadam. The sidewalk mileage is 51.6. Both day labor and contract systems were employed in 1914 paving. By the former 670 sq. yds. of waterbound macadam and 12,346 sq. yds. of tar macadam were laid at a cost of 50c. and 56c. respectively. The contract work included 1,939 sq. yds. of Westrumite at $1.30, 7,960 sq. yds. vitrified brick at $1.72, 6,460 sq. yds. of concrete at $1.35 per sq. yd. The amount spent on new pavements in 1914 was $62,368; on pavement repairs, $85; on curbs and gutters, $1,225, and on sidewalks, $11,214.

Estimates for 1915 include $85,284 for pavements and $12,000 for sidewalks. The pavements include 3,125 sq. yds. of Westrumite and 21,260 sq. yds. of tar macadam, both on concrete base. Mr. A. B. Manson is city engineer.

Swift Current, Sask.—Mr. Ward Curlee, city engineer, reports no 1914 paving. This season, however, about 5,000 sq. yds. of Rocmac will be laid. There will also be an expenditure of $15,000 on sidewalk extensions, the mileage of which now amounts to 1.2 miles.

Sydney, N.S.—No paving work was done last year and it is unlikely that any will be done in 1915. About $330 was spent on curbs and gutters, however, and $2,300 on concrete street crossings. There are 5.82 miles of sidewalks, 9.69 miles of macadam, and .24 mile of asphaltic macadam. Mr. Norman K. Hay is city engineer.

Toronto, Ont.—A total of $1,230,049.86 was spent last year on new pavements; $120,059.96 on pavement repairs, and $414,531 on sidewalks. There were 31.1 miles of pavements added, making a total of 298.88 miles. The sidewalk mileage is 695.34. The amount spent for curbs and gutters (laid with pavements) and for curbs (laid with sidewalks) is included in the above items of expenditure. Several curbs were laid under separate contracts, however, in most cases to complete a work. On the construction of these curbs the sum of $16,650 was spent.

Asphaltic concrete (including bitulithic) was laid both by contract and day labor, the yardages being 39,659 and 60,179 respectively. The asphaltic concrete cost $1.43 per sq. yd. and the bitulithic $1.59. A total of 38,417 sq. yds. of vitrified brick, costing $2.05, was laid, 27,649 sq. yds. of it by day labor and the balance by contract. Concrete pavement, including a small amount of Dolarway, was laid at a cost of $1.44 per sq. yd. About 8,000 sq. yds. were laid by contract and 24,986 sq. yds. by day labor. Some 3,485 sq. yds. of asphaltic were laid (by day labor) at a cost of $2.10, or $1.01 for surface course only. About 11,200 sq. yds. of Rocmac were laid by day labor and 13,578 were laid by contract, the price being $1.95 per sq. yd., it being an 11-inch consolidated pavement. Sheet asphalt to the extent of 243,733 sq. yds. were laid by contract and 72,961 sq. yds. by day labor, the cost being $1.27. 5,795 sq. yds. of treated wood block were laid at a cost of $3.43, as pavement, and 8,480 sq. yds. were laid in track allowance.

The estimates relative to 1915 paving have not been announced. Mr. R. C. Harris is commissioner of works, and Mr. M. A. Stewart is assistant city engineer in charge of paving.

Vancouver, B.C.—About 98,400 sq. yds. of 2-inch asphaltic concrete on 6-inch concrete base were laid at $2.29 per sq. yd. Vitrified brick block, also on a 6-inch concrete base, cost $3.83 per sq. yd. for 13,958 yards. Concrete, 7 inches thick, to the extent of 10,367 sq. yds., cost $2.01. Bitulithic, 5 inches thick, cost $1.35 and 7,369 sq. yds. were laid. About 1,350 sq. yds. of sheet asphalt, 2 inches thick, with 1-inch binder on a 5-inch concrete base, cost $2.47 per sq. yd. In track allowance work 2,086 sq. yds. of stone block were used, costing $3.75, exclusive of grading and foundation. Some 27,268 sq. yds. of creosoted wood block were laid on 6-inch concrete base; cost, $3.14. Asphaltic concrete consisting of 2-inch top and 1-inch binder was laid to the extent of 7,406 sq. yds., costing $1.65 exclusive of grading and foundation. In all the above items, except the stone block and the last-mentioned asphaltic concrete, the prices given have been inclusive of foundation, but exclusive of grading. All this work was done by contract. Day labor was used to construct 16.701 miles of waterbound macadam, the price being a little over 79½c. per sq. yd. Thus 6.989 miles of pavement (exclusive of macadam) were added in 1914, bringing the total (exclusive of macadam) to 60.431 miles. The mileage of concrete sidewalks is 210.565. Expenditures last year included $85,189.94 on macadam roadways; $24,110.97 on macadam lanes; $1,004.26 on grading for macadam roadway, and $656,077.19 on the other pavements. For pavement repairs in 1914 $10,441.83 was spent, exclusive of macadam work. Expenditure on concrete curbs and gutters amounted to $22,476.05; and on concrete sidewalks, $40,771.96.

At present nothing has been decided about 1915 paving, but according to Mr. F. L. Fellowes, supervising city engineer, the work will be materially curtailed, owing to the financial situation.

Victoria, B.C.—112,300 sq. yds. of sheet asphalt were laid in 1914. The foundation was constructed by day labor and the surface by contract. The light asphalt cost $1.65 and the heavy asphalt $1.97 per sq. yd. The total expenditure on new pavements, repairs, curbs and gutters and sidewalks amounted to $820,000. The total mileage of pavements at present is 71.75, made up as follows:—Asphalt pavement, 53; wood block pavement, 3½; concrete pavement, ¾; macadam pavement, 12½; tar macadam pavement, 1½; vitrified brick pavement, ½; unpaved streets, 119; total mileage of concrete sidewalk, 129; total mileage of boulevards, 58½; total mileage of surface drains, 81½. The total mileage of sidewalks is 129. The paving programme for 1915 has not been definitely decided. Mr. C. H. Rust, city engineer, states that the total expenditure will not likely exceed $350,000, and that sheet asphalt will, in all probability, be the pavement most widely laid. It has already been practically decided to lay 100,000 sq. yds. of it. There may be some bituminous macadam laid also. The estimate for sidewalk work is $25,000.

Welland, Ont.—Last year 6,150 sq. yds. of vitrified brick were laid by contract at a cost of $2.55. Another contract was for 6,280 sq. yds. of wood block, the blocks being 3 inches, with a 20-pound treatment and laid on a 5-inch concrete base. The track allowance portion cost $4.15 and the sides $3 per sq. yd. The total amount spent on new pavements last year was $41,866.33. An additional $500 was spent on macadam road repairs, executed by day labor. The expenditure on sidewalks was $7,972.50. The total mileage of pavements laid to date is 2.45 and of sidewalks, 27.2. For 1915 no estimates for pavements have been decided upon. About $1,500 worth of sidewalk work will be done. Mr. D. T. Black is the city engineer.

Westmount, Que.—According to Mr. P. E. Jarman, city engineer, 1.37 miles of pavements were added in 1914, bringing the total up to 23.22 miles, last year's expenditure on new work being $40,077.30, and on pavement repairs $35,617.41. The new pavements included 5,235 sq. yds. of concrete; 2,316 sq. yds. of tar macadam; 3,700 sq. yds. of Rocmac; 5,168 sq. yds. of stone block, and 13,488 sq. yds. of sheet asphalt. The asphalt was laid by contract, while all other pavements, with the exception of a little stone block, was laid by day labor. Expenditure on sidewalks amounted to $16,676.39, and on curbs and gutters $1,196.70. The sidewalk mileage at present stands at 47.584. The 1915 work has not been decided upon.

Windsor, Ont.—This city spent $18,358.66 on sidewalks in 1914, bringing the total mileage up to approximately 100. There are 35 miles of pavements, 7.8 miles of which were added last year. This included 28,955 sq. yds. of asphalt block at $1.35 f.o.b. factory and 72,577 sq. yds. of concrete at $1.30, exclusive of grading and foundation. Some 11,900 sq. yds. of Dolorway were laid at a cost of 28c. for surfacing. All this work was done under contract. Pavement repairs amounted to $920.70 for labor and $800 for material. No figures are yet to hand respecting 1915 work. It is premised, however, that little work will be done. Mr. M. E. Bryan is the city engineer.

Winnipeg, Man.—The following table gives in detail the mileage of pavements and sidewalks constructed in 1914, and also the total mileages constructed in previous years:—

Type.	Constructed to Dec. 31, 1913.	Constructed during 1914.	Total.
Asphalt plant No. 1 ..	84.747	8.09	92.837
Asphalt plant No. 2 ..	13.484	5.89	19.374
Concrete	1.756	4.26	6.016
Macadam	33.138	0.046	33.184
Granolithic walks	118.659	9.94	128.599
Plank walks	372.139	19.91	392.049

Work during 1915 will include the expenditure of $336,000 on asphalt pavements; $60,000 on granolithic sidewalks; $50,000 on plank sidewalks; $500,000 on street and lane openings; $56,741 on Main St. bridge superstructure, and about $250,000 on Salter St. subway, including approaches. The city engineer is Mr. W. P. Brereton.

Yorkton, Sask.—The town has done no street paving as yet; the sub-soil is of sand and gravel and the streets are kept in good condition by frequent use of the log drag. There are 17½ miles of sidewalks and this construction was so well advanced in 1913 that it was not added to last year, and none is likely to be added this year. Mr. H. Talbot Crosbie is town engineer.

THE CONSTRUCTION OF ROADS IN CITIES.

By Archibald Currie, C.E.,
Former City Engineer of Ottawa, Ont.

IN deciding on the various classes of roadways proposed to be constructed, very careful consideration has to be given to the amount and nature of the traffic on any particular road, with a certain assumption of what it might be in the future. The following descriptions of each type of roadway will be of some interest:—

(1) **Asphalt.**—It is proposed to construct asphalt pavements with concrete base on streets with very heavy traffic, such as will be found near railway freight yards and on streets where street cars are running, except in the track allowance and 18 inches on either side, which should be paved with stone blocks or setts. It has to be understood that asphalt pavement should not be used on grades steeper than 5 per cent. The advantages of this pavement are:—

(a) Ease of traction.

(b) Comparative noiselessness under traffic.

(c) Impervious to water.

(d) Easily cleaned.

(e) Pleasing to the eye.

(f) Suitable to all classes of traffic.

(g) No vibration or concussion in travelling over it.

The defects are:—

(a) Slippery under certain conditions of the atmosphere.

(b) Disintegrates if excessively sprinkled or otherwise subjected to constant moisture, although asphaltum is impervious in either fresh or salt water.

(c) Becomes soft under traffic in extreme heat and presents a wavy surface, and under extreme cold may crack and become friable.

(d) Not adapted to steep grades.

(2) **Asphalt Macadam.**—It is proposed to use this form of construction on streets where the traffic is not quite so heavy as it would be on asphalt pavement, and with the same foundation course, *viz.*, concrete. It may take the place of sheet asphalt on grades steeper than 5 per cent.

The most common type of asphalt macadam roadway is laid on what is known as a Telford base, this base being stones about 8 inches thick laid on edge. The course on top of the concrete or Telford base, whichever is decided upon, is composed of stone from 1¼ to ⅜ in. mixed with bitumen in its melted condition. From 17 to 20 gallons of bitumen will be used to each cubic yard of stone, thus covering completely each particle.

The mixture is then laid on the concrete to a depth, after rolling, of not less than 3 in. Before rolling, a grit course of clean stone screenings is spread over the surface in such quantity as will cover and fill the voids in the surface. The excess of this grit course is then removed and the road swept clean, and over the surface a squeegee coat of bitumen is applied, using about a half gallon per square yard. Over this again is spread the excess of screenings which was previously removed to correct the stickiness of the bitumen. The road is then well rolled until the screenings are bonded with the bitumen of the squeegee coat.

(3) **Asphalt and Stone Blocks.**—This refers to work on streets where street cars are running. Asphalt has

already been dealt with, and, as formerly stated, it is considered necessary to have stone blocks for the full width of the track allowance and 18 in. outside on both sides. While stone blocks are not perfect, owing to surface drainage difficulties, they are preferable to asphalt, and failures in the blocks can be easily and rapidly repaired.

Another form of construction in the track allowance is solid concrete. This has been used with considerable success in Montreal. Particular notice should be taken of the concrete above the slab. This was in the proportion of one of cement, three of sand and five of stone, to pass through a 1½-in. mesh. The top mixture of 2 in. was composed of one of cement to 1½ in. of ¾-in. Banc Rouge screenings.

(4) **Asphalt Macadam and Stone Blocks.**—This is practically the same form of construction as described in (2) and (3), it, of course, being understood about sheet asphalt macadam that it is introduced for vehicular traffic on a grade with a concrete base for heavy traffic, and, as already described, with a Telford base for traffic of a somewhat lighter nature.

(5) **Concrete.**—Concrete for roads is somewhat of a modern idea, but so far it seems to have been very successful, and with proper care, particularly in drainage, there is no apparent reason why construction of this nature should not be successful. It will be necessary to reinforce this concrete, and also have transverse expansion joints about 50 ft. apart. The surface of the road could be painted with some bituminous mixture and afterwards sprinkled with sand, all tending to give a good surface.

(6) **Macadam Tar-Painted.**—This type of roadway will be built on the principles as laid down by that well-known Scotchman, Thomas London Macadam, and not by some of the modernized versions of it. It is considered that many of the residential streets in a city where traffic is light should be macadamized. Where a foundation course is necessary, a Telford base, as already described, should be put in. However, in numerous cases in a city it is not necessary to build a foundation course for years, and all that is required is that the old foundation course be trimmed off to the proper convexity, then stone to pass through a 2-in. ring be laid to a depth of 5 in., then thoroughly blinded with gravel and a little clay, watered and thoroughly rolled. This is admittedly a cheap form of construction and suitable for light traffic in residential districts.

The control and prevention of dust in this class of roads is one which should have very serious and careful consideration, and particularly in view of the automobile traffic which in all likelihood will develop. Dust has always been a feature of macadam roads, being at the same time the result of use and check upon excessive wear. Prior to the introduction of the automobiles, dust was considered as nothing more or less than a nuisance; to-day, however, the existence of macadam roads depends upon the retention of the road dust formed by the wearing of the surface. It has been found from experience that the broad pneumatic tires of heavy automobiles driven at high speed draw out the small particles which bind the material of a macadamized road, with the result that the road soon disintegrates.

Various methods are in use for preventing or reducing dust, amongst which might be mentioned sprinkling with fresh or salt water, a mixture of water and calcium chloride, oil emulsion, impregnating or surfacing with crude oils or coal tar products. The writer has tried all these methods and has come to the conclusion that good tar, properly applied, is the cheapest and best dust preventive, and preservative of macadam roads, being both effective and durable. The quality of the tar is very important. If it is heated too much and refined too far, it becomes brittle and makes black dust, if not sufficiently refined and the light oils taken off, it will disintegrate.

Before tarring a road surface the weather should be warm and the road thoroughly brushed and cleaned. The tar should be heated to its boiling point at convenient positions on the works and should be applied as hot as possible, so that it may flow freely. Immediately upon application, the liquid tar should be brushed so far as necessary to ensure regularity in thickness of the coating.

The quantity of tar required will vary according to the physical conditions of the road, but in the case of a road to be treated with tar for the first time, the quantity should generally be one gallon to coat from five to seven superficial yards.

If the road must be opened for traffic before the tar has set hard, grit or sand should be spread on the surface to prevent the tar from adhering to the wheels of the vehicles, but gritting should be delayed as long as possible, and the quantity of gritting material to be spread should be more than sufficient to prevent the tar from adhering to the wheels. Stone chippings, crushed gravel, coarse sand, or other approved material (free from dust), not larger than will pass through a ¼-in. square mesh, should be used for gritting in quantity not exceeding 1 ton for 300 to 350 superficial yards if grit is used, and 1 ton for 200 to 250 superficial yards if coarse sand is used.

Precautions should be taken to prevent liquid tar passing directly through drainage gratings or outlets.

For the safety of the public, precautions should be taken by lighting, watching and warning.

I have dwelt at considerable length on the question of tarring, but it is one which I consider all-important; not only as a dust preventive but in increasing the life of a road.

(7) **Macadam Tar-Painted and Stone Blocks.**—This construction is meant for residential districts in which street cars are running and ordinary vehicular traffic. Both forms of construction have already been described.

(8) **Macadam Tar-Painted and Granitoid.**—This is another form of construction for residential districts in which street cars are running. Granitoid is merely a concrete roadway with a specially finished surface. The concrete above the foundation course is laid with a very strong mixture of cement with the top ¾ inch laid with only cement and granite or marble screenings, the latter being absolutely free from dust. Particular attention has to be paid to the sub-drainage of the concrete, otherwise there is sure to be trouble and subsequent failure of the work.

This form of construction has been tried successfully in Montreal, Westmount and Maisonneuve.

(9) **Stone Blocks.**—It is considered that stone blocks should be used on streets traversed by extra heavy traffic. The stone for block paving should be specially selected and tested, the requirements being a tough stone which at the same time will not become unduly slippery under horse traffic.

The difficulty with stone block or, in fact, any block paving, is the laying and jointing. The usual custom is to lay the blocks on a cushion of sand, but the opinion is expressed that this is more of a detriment to this type of paving than otherwise. If moisture is to be kept out it would be useful, but as soon as the moisture gets in, the sand starts to run, leaving the blocks suspended in one place and heaved up in another. All this trouble can be greatly overcome by laying and jointing these blocks with a cement grout, but most important of all is having ample sub-drainage.

(10) **Tar Macadam.**—Tar macadam is a comparatively new road material. As a material for footways, it has, in different forms, long been used. In some of the northern towns of England it has been used for roads for some years past, but its increasing employment is mainly due to the development of the motor and cycle traffic, and to the attempts that are being made to cope with the dust problem. The superiority to ordinary macadam is generally acknowledged. Some of its advantages, however, in this respect may be summed up as follows:—

(1) It is less perishable. The metal being coated and partly permeated with a viscous coating of tar, the stone does not absorb water. The surface coat is finer than ordinary macadam and has fewer voids in it, so that water does not penetrate so easily.

(2) It has longer life. The tarry coating, besides preserving the stone from the influence of the weather, largely nullifies the attrition accruing in ordinary macadam. The tar is a better binding than any of those employed. In general, the road is more homogeneous and elastic.

(3) It is practically noiseless.

(4) It preserves a smoother surface than ordinary macadam. The dust is reduced to a minimum so that the cost of scavenging and watering is practically avoided.

(5) The cost of maintenance as regards repairs is less.

Its disadvantage is that of a slightly greater initial cost, but this is compensated for by its longer life. One engineer has complained that the surface is apt to be slippery in frosty weather and others have urged that the surface will become soft and sticky under hot sun. In most cases it is mentioned as suitable for "light traffic" or traffic "not too heavy." From this it might be erroneously inferred that tar macadam is inferior to ordinary macadam, as regards wear. Tar macadam will take heavier traffic than ordinary macadam, but that it can be substituted for the necessary pavements in the streets of big towns and cities is too much to suppose. Its chief purpose will be to supersede ordinary macadam in small county towns and villages, main country roads and suburban and residential quarters of big towns and cities.

The stone most widely recommended for tar macadam is limestone, but iron slag has been found equally good and is of greater strength. Many satisfactory roads have been made with a mixture of limestone and slag. Some of the igneous rocks have been tried, but as a rule these are too compact or crystalline to absorb any appreciable proportion of the tar, which, therefore, remains as a surface coating that easily wears off. A few engineers have, however, employed igneous stone and have been satisfied with the results, so that the question is still open. Derbyshire dolomitized limestone, Kentish rag, and Scarborough grit stone have been largely employed for tar macadam. Mr. Purnell Hooley, who has long studied and experimented with this material, is an advocate of iron slag, and he is the patentee of a specially prepared brand of tar macadam. The question of adding coke-breeze or other fine material to the topping coat is one in dispute. At Harrowgate, 12% of coke-breeze is invariably added and the borough engineer finds the topping coat improved thereby.

The tar requires very careful watching. As previously mentioned, the surface of tar macadam has in some instances become exceedingly sticky and troublesome in hot weather; in some cases so much so that pedestrians' boots have stuck to the road and had to be left there. This is due to (a) the stone not being suitable; (b) the material not being properly prepared, and (c) the tar being defective.

In nine cases out of ten defects in tar macadam may be attributed to the tar. The tar produced by different works varies greatly in quality. The most recent tar-extracting apparatus employed in gas works does not appear to produce such good tar as formerly, and the brand of coal used also has a bearing on the subject. Unfortunately, the difference between poor and good tar cannot be established by chemical analysis at present; samples of both appear chemically the same. The advice given by one well-known engineer is to find a gas works producing good tar, and use only the tar produced there.

The tar macadam is laid on the roadway in three grades, over a good foundation, which is always shaped up to the proper convexity. The aggregate of the surface is composed of broken stone obtained in the vicinity; 60% broken to a size of 2½ in., about 30% 2½ in. to 1¼ in., and 10% ¾ in. to ½ in., for closing up interstices. The last-named size is kept separate and used during rolling operations. The tar macadam, after being spread and levelled, is rolled into a smooth surface, but not rolled to the same extent as an ordinary waterbound macadam road. A 10-ton roller is used for this work, as better results are obtained than when using a heavy roller. After the roadway has been open for several weeks, a coating of tar is applied to the surface of the road and covered with stone chippings or sand, not larger than will pass through a ¼-inch mesh.

Engineers differ considerably about the preparation of materials and no standardization is at present possible. Heating the stone dries it and renders it in a better condition to absorb tar. On the other hand, it is contended that artificial drying is detrimental and that it is better to dry the stone by storage under cover. It is doubtful whether the latter method can be effectual for, though the stone is preserved from actual wetting, it will, in wet weather, absorb the moisture from the air.

As to the necessity of boiling the tar, there should be little doubt. Tar varies very much in the amount of volatile matter present and careful boiling for two or three hours will render the consistence more stable and the material more tenacious. If the tar is poor, a little pitch can be added to enrich it. The boiling, however, must never be carried too far or the residue will be brittle. Considerable care must be exercised with the boiling. In preference to boiling, some engineers store their tar for some months before use, and in this case it is kept in concrete or iron tanks set below the level of the ground and fitted with valves, to permit the escape of volatile gas. The tar should, in this case, be drawn from the bottom of the tank, and a pump must therefore be fitted to effect this.

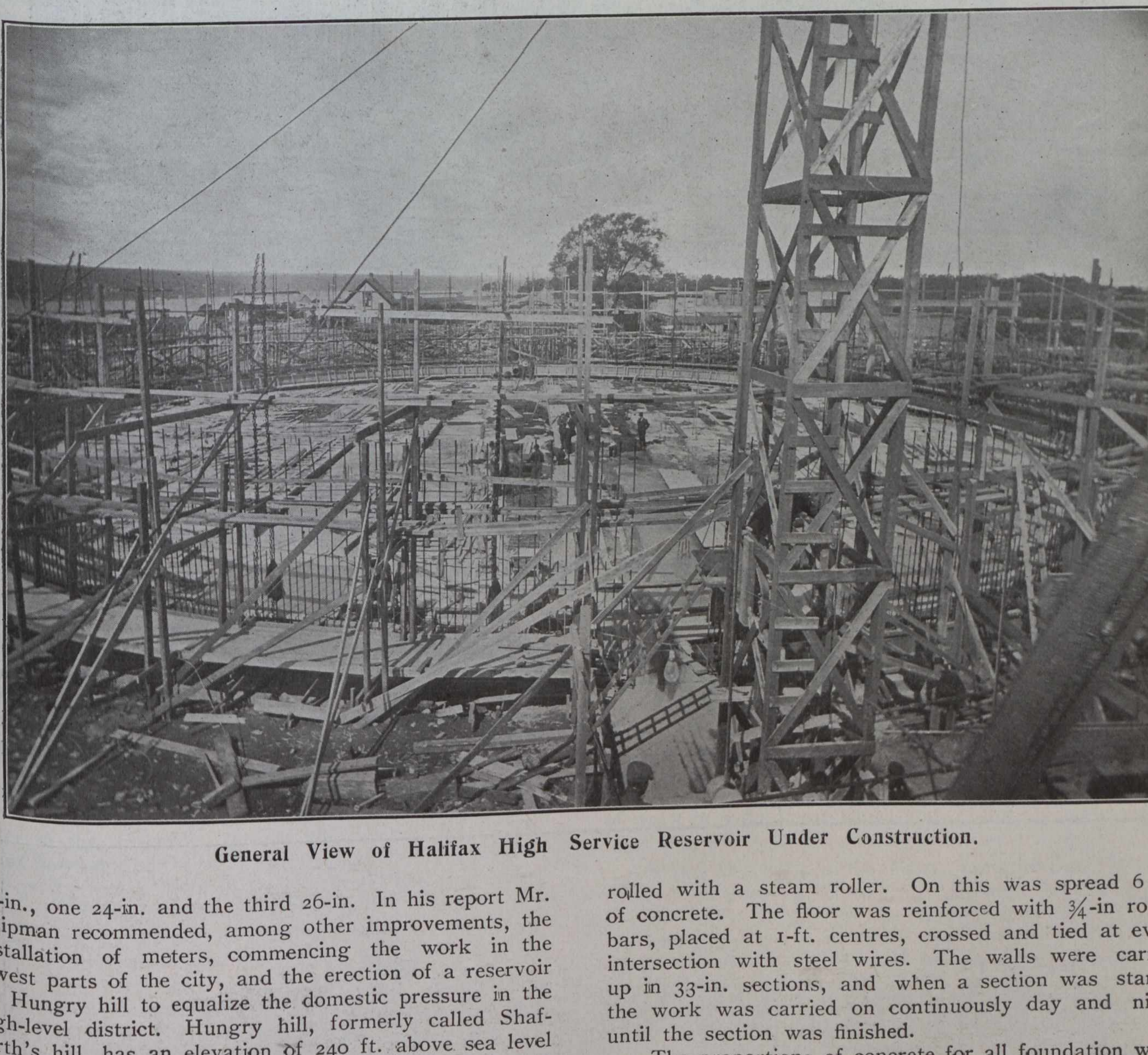
Maintenance consists in keeping a roadway as nearly as practical in the same condition as it was when originally made. The repair of a roadway is the work rendered necessary to bring it to its original condition after it has become deteriorated by neglect to maintain it. There is a wide distinction between the two operations; the former keeps the road always in good condition, while the latter makes it so only occasionally.

NEW HIGH SERVICE RESERVOIR, HALIFAX, N.S.

GENERAL FEATURES OF DESIGN AND CONSTRUCTION OF NEW 3¼-MILLION-GALLON REINFORCED CONCRETE RESERVOIR

By Lieut. Thos. W. J. Lynch, C.E.,
City Engineer's Staff, Halifax.

IN February, 1905, the City Council engaged the services of Willis Chipman, C.E., Civil and Sanitary Engineer, Toronto, to examine the waterworks system of the City of Halifax and to make recommendations towards the betterment of the same. The first step, undertaken before his report was sent to the Council, was to have the three main conduits supplying the city metered. Three Venturi meters, each with recording apparatus, were ordered in August, 1905, one 14-in., one 24-in. and the third 26-in. In his report Mr. Chipman recommended, among other improvements, the installation of meters, commencing the work in the lowest parts of the city, and the erection of a reservoir on Hungry hill to equalize the domestic pressure in the high-level district. Hungry hill, formerly called Shafforth's hill, has an elevation of 240 ft. above sea level and is the highest point in the city. The city commenced the construction of this reservoir in the spring of 1913, but owing to the frost making its appearance in October operations were discontinued and the work did not start up again till April, 1914, when F. A. Morley, concrete engineer, of Sydney, N.S., became superintendent.



General View of Halifax High Service Reservoir Under Construction.

The walls are 36 in. at bottom and run to 18 in. at the top. The height of the walls is approximately 29 ft. The diameter of the reservoir is 160 ft. It is built to hold 3,250,000 gals.

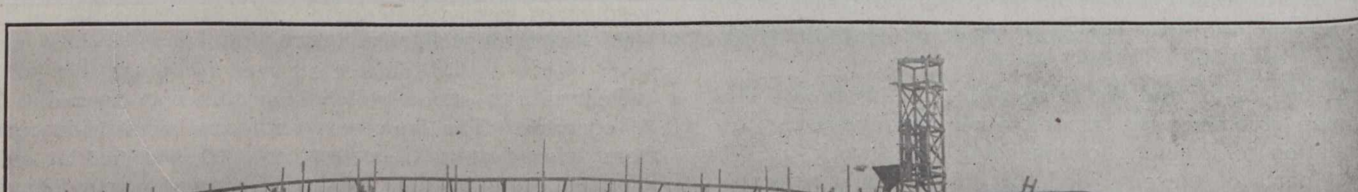
Extreme care had to be taken in constructing the reservoir floors. After the excavation had been completed any soft spots were dug out to hard bottom, filled with broken stone and thoroughly tamped. On this two 6-in. courses of broken stone were laid and thoroughly rolled with a steam roller. On this was spread 6 in. of concrete. The floor was reinforced with ¾-in round bars, placed at 1-ft. centres, crossed and tied at every intersection with steel wires. The walls were carried up in 33-in. sections, and when a section was started the work was carried on continuously day and night until the section was finished.

The proportions of concrete for all foundation work and the lower six inches of the floor is one part cement, two parts sand and four parts gravel or broken stone. The bottom courses of the walls, 1:1:2 to a height of ten feet. Above that height the walls are 1:1½:3. The floor layer consists of two courses of concrete, each six inches thick, the lower made of 1:2:4 and the upper one 1:1½:3 concrete, reinforced. The concrete for the floor and walls contains 5 lbs. hydrated lime for every 100 lbs. of cement. The ultimate tensile strength of the steel rods and bars used as reinforcing runs from 60,000 to 70,000 lbs. per sq. in., with an elastic limit of 30,000 lbs. and an elongation of at least 20 per cent.

The horizontal reinforcement consists of round bars, varying from 1¼ to 5¾-in. in diameter, supported on vertical uprights, with brackets to hold the bars, as shown in one of the illustrations. The vertical reinforcement consists of ¾-in. twisted bars, spaced in the lower half of the reservoir at 12-in. centres and in the upper half at 24-in. centres. The top surface of each course was finished level, and no irregular, wavy or sloping lines were permitted to show in the face of the concrete work. The walls of the gate-house were built in a similar manner.

Floor Construction Showing Reinforcement.

After the walls were built the columns were poured. There are altogether 54 columns, each 1½ ft. square, reinforced with ¾-in. hooped rods. The girders, which vary from 18 in. by 16 in. to 16 in. by 12 in., and the beams, varying from 16 in. by 16 in. to 8 in. by 8 in., were then poured, and the slabs, 4 in. thick, were put on, the latter reinforced by ⅝-in. rod iron, tied at intersections with steel wire. As each course had set a



Exterior View of Reservoir, Showing Method of Construction.

stiff wire surface brush was used and the surface kept wet (until the next course was ready) by covering it with wet bagging or canvas. Before laying the next course the surface of the finished course was thoroughly cleaned and brushed and then well wet down with a mixture of neat cement grout thoroughly brushed in. The new concrete was deposited before this was set. A steel dam was embedded in the top of each section and accurately placed, a 1½-in. V-shaped groove being left in the top of each course, formed by embedding a mould therein, and leaving the same until the concrete had taken its initial set. A splice-plate 6 in. long was used and riveted with six rivets in joining the ends of the steel dam.

The gate-house is reached by a reinforced concrete stairway, with a balcony in front. Both the stairway and balcony are enclosed by a 2 in. pipe railing. The gate-house is 28 ft. by 16 ft. The whole building is of reinforced concrete, the roof being covered with Lamon's artificial cement shingles, grey in color, laid diamond-pattern, overlapping 3¼ in., fastened with galvanized

Reservoir Outlet.

nails and copper rivets. A gutter of 16-oz. copper is fitted all around building, with usual conductor. The inflow pipe is a 20-in. and the outflow a 15-in. These are connected with the high water service. The gate-house is built with connections for another reservoir, which is to be built on the north side of the plant, and contains three chambers for the present plant and one for the proposed extension. There is a floating valve for shutting off the supply, and in case this does not operate the overflow valve does the work. The water can also be shut off by hand. The inflow comes through an automatic regulating valve, which closes the pipe when the water in the reservoir reaches the desired level. The water flows out of the reservoir through the check-valve, and as the water falls in the reservoir the regulating valve automatically opens, allowing water to enter.

During the course of construction work about 150 men have been employed, there being both day and night shifts. The work has been executed by the Standard Construction Company, and they have erected, in the opinion of experts, one of the finest reservoirs in Canada at a cost to the city of $56,000.

The original survey in connection with the land required for this undertaking was made by the writer. Mr. H. W. Johnston, C.E., Assistant City Engineer, was the designing and structural engineer, while F. W. W. Doane, C.E., City Engineer, supervised the design and construction.

METHODS OF CONSTRUCTION MANAGEMENT.

MACHINERY in many industries has been developed to a point where the limitation of mechanics prevents further marked advances. The next important step must obviously be in the line of management methods. This development is being given particular attention with already notable results. In the same way the attitude of construction engineers and contractors during the past decade has been undergoing a marked change. They are realizing generally that something quite radical must be undertaken in the introduction of economies in operation in order to balance the increase in wages of skilled and unskilled labor and the rising prices of materials. This phase of construction methods demand daily more and more attention, and a paper on construction management, presented to the Western Society of Civil Engineers by Sanford E. Thompson and Wm. O. Lichtner, deals with the subject in such an instructive way that the following extracts from it will undoubtedly be found of value.

Improvements in construction methods involve: (1) Introduction of improved machinery where machinery is economical; (2) introduction of improved methods of handling labor and machinery and standardizing their methods; (3) reduction in waste of material; (4) elimination of unnecessary operations of the workmen; (5) relieving the skilled worker of duties which the unskilled man can do; (6) increasing the productive capacity of each man.

Following along the lines of development in factory operations, it is now being realized that the same principles, which we may term scientific methods of management, are applicable to construction work. These have been put to the test in a number of cases and the results have proved conclusively the applicability of scientific methods to construction operations. In making so sweeping a statement as this it is recognized that no cut-and-dried scheme can be applied to every piece of construction work. Just as in factory work, the methods of attack and the processes to be followed vary with the character of the work. But the general principles of planning the work, standardization of operations, and training of the men, are adaptable to any kind of work provided either the job is of long duration or the construction company (as is almost always the case) is handling similar work right along, so that an organization once developed can be transferred from job to job.

The most convincing proof of the value of any plan is the fact that it has been carried out successfully. As a result of actual experience in construction work, it has been proved that scientific methods of construction are: Low unit costs; high wages to the workmen; completion of work in a minimum time; and, uniformly high quality of work.

When the work is planned out and handled systematically, we may say scientifically, greater skill and effort is required on the part of the management, and the question naturally arises whether the results produced are simply smoother working of the labor mechanism, or whether, on the other hand, it actually pays in dollars and cents. As an illustration of actual results, two or three cases may be cited before taking up the details of the methods.

In concrete construction work it is frequently stated and is a known fact that the cost of the form work is the determining factor whether a profit or a loss is incurred by the contractor. Taking actual unit costs under ordinary methods in comparison with similar unit costs under scientific methods of constructing reinforced concrete buildings of typical design of beam and girder construction, we find as follows:

Operations—	Cost of labor under ordinary methods.
"Making" form work	1¾c. per sq. ft.*
"Erect and strip" form work....	6c. per sq. ft.
Bend, assemble and place reinforcing steel	$7.50 per ton

Operations—	Cost of labor under scientific methods.
"Making" form work	1c. to 1½c. per sq. ft.
"Erect and strip" form work....	4c. per sq. ft.
Bend, assemble and place reinforcing steel	$4.90 per ton

*This is a figure lower than the majority of the construction companies ever get even under very favorable conditions.

The figures in both cases include job expenses but not general overhead.

On one job under scientific methods the "making" of the form work for a 6-story concrete building, 200 ft. by 600 ft., was done at practically one-half the cost of exactly the same work by the same company under the old methods; and this notwithstanding that they had made a detail study of their costs for several years to reduce them as low as possible. This saving was due directly to the application of scientific management methods.

In the work of common laborers, such as trenching and backfilling for sewers and water pipe, large reductions in cost have also been effected. For example, in a case where the digging was of an exceptionally hard and varied character, being a very stiff tenacious clay, the following results were obtained:

Operation—	Unit cost— No task work.	Unit cost—With partial task work.
Excavation	48.0c. per cu. yd.	34.8c. per cu. yd.
Pipelaying	11.1c. per lin. ft.	4.5c. per lin. ft.
Backfilling	34.6c. per cu. yd.	10.6c. per cu. yd.

These results have not been due, as might be thought at first sight, to requiring the workman to do two or three times the amount of work he formally accomplished, but in a large degree to thorough planning of the work in advance, studying the actual details of the work, and teaching men how to perform their tasks in the easiest possible manner.

The savings, then, were obtained not by merely hustling the work nor in any degree by slighting it, but to the much more essential features of:

(*a*) Economical design and layout of construction operations.

(*b*) Laying out in advance the method of handling the work to reduce to a minimum the quantity of construction material.

(*c*) Selection of the best tools and materials.

(*d*) Arranging the processes to simplify the work, and teaching the men how to do it in the best way.

(*e*) Designing in advance the amount of work to be done by each man.

(*f*) Giving the men a definite money incentive to encourage them to do a large day's work.

(*g*) Eliminating the time ordinarily lost by workmen, such as waiting for orders, waiting for foreman to lay out the work, waiting for materials, looking up tools, using improper tools.

The authors, after observing that the general principles that may be applied to construction were similar to those which had proved satisfactory in shop management, go on to analyze the duties involved in the latter as outlined by Frederick W. Taylor in his "Principles of Scientific Management."

Cost keeping has been developed recently by contractors to a marked degree and the advantages of knowing what each part of the work is costing from day to day is apparent in providing an opportunity to follow up the heads of the various branches where costs are running high. This, however, is really the limit of its effectiveness since a mere record of costs does not in any way show how to handle the work in a less expensive manner.

The aim of scientific management is to find the best and cheapest way to accomplish a piece of work and provide means for doing it in this fashion.

Formerly much construction and even shop work were carried on with no detail structural drawings and many of the directions were given by word of mouth. Nowadays a question as to whether or not the making of designs or construction drawings reduces the cost of work, would be considered absurd since the economical advantages of the drafting room are obvious. Yet we frequently handle construction work in a most haphazard way with no definite plan and no definite arrangement of men and materials except as the occasion requires from day to day or from hour to hour.

To handle work systematically it is necessary to: (1) Plan the work in advance; (2) determine the best methods to employ in construction; (3) lay out individual or gang work for the various men; (4) train the men to accomplish their duties in the best and shortest way; (5) provide an incentive so that each man will be glad to do a full day's work without being driven to it.

Many construction companies are carrying out a part of these principles, but few are developing all of them with anything like the effectiveness possible.

To illustrate in detail the methods that have proved successful, we may take the construction of a reinforced concrete building. To still further confine the description and give more details of the work, we will consider simply the making of the form work. In taking this special case, however, it is recognized that the same principles have been found by experience to apply to various other types of engineering construction, both in private contract and municipal work. As a matter of fact, the fundamental principles are identical with the principles required in shop work.

In discussing the phases of the work, emphasis is placed on methods that are in whole or in part comparatively new rather than those which are basic in all work regardless of the method of management adopted. These newer methods involve special construction designs, planning and routing the work, standardizing methods, and a study of time in which each small element of the work should be done.

In any construction company the duties of the engineer, aside from his relation to financial interests, may be two-fold: (*a*) Duties involving the structural design and engineering features of the construction; (*b*) engineering which relates specifically to the construction plant and the methods of handling the details of the construction work.

Instead of both of these functions devolving on one man, the chief engineer, the duties in a large construction company can best be separated, the chief engineer handling what may be termed civil engineering while the treatment of the construction organization and methods in full detail requires the services of a new man termed the "production engineer." It must be understood that his services do not entail an extra cost to the job because his duties actually replace the work usually done by men less competent to perform the high class of work required, and result in improvements in methods and cutting down the number of employees so as to save a far greater amount than the salary of this officer. In a company handling a small amount of work one man may serve both functions. In another case a member of the construction company may act as chief engineer.

Design.—Under scientific methods of management the work of the designing engineer is increased because in order to properly lay out the work he must prepare detail drawings or sketches for the concrete, the reinforcing steel, and the form work. In other kinds of construction similar detail designs have been found economical. For example, in house construction complete framing plans should be made. It is appreciated that many construction companies follow such methods to a limited extent, but it is the object of this paper to show how these may be extended with economy of cost. A more extended discussion of the details of certain features of this work is taken up further on in this paper.

The making up of all material lists follows the making of these detail sketches, the lists being worked up in such a manner that they can be used not only for ordering materials but for checking their receipt upon the job. In addition to this work, the designing engineer must, with the advice of the job superintendent, actually design on paper the plant which is to be built for handling the construction.

These various features of design, that is, all of those that relate to the method of work, handling of materials, and listing the materials, are under the supervision of the new production engineer.

Planning and Routing.—One of the most important features under the new type of management is what is termed the "routing" of the work, which is also under the supervision of the production engineer. This involves planning out in detail and in writing all work connected with the construction of the building just as we plan the structural design and for a similar purpose, usually to save time of the workman and insure a higher quality of work. This means planning just how each part of the work is to be done, in what sequence the various parts of the work will follow each other, the size of gangs of different trades required from day to day to get the work done in schedule time, and the schedules for ordering materials so as to have them on hand when required. After the work has all been planned, graph charts are made for the home office and for the job, designed so that the home office and the superintendent can see at a glance just how far ahead or behind a job is at any time.

It takes time to plan out the work in detail and may even slightly delay starting the actual construction, but it pays in the long run, for when the work does start it will go along far more quickly and at a much less cost than if it had been done by ordinary methods. Experience has proved what a short-sighted and costly policy is that sometimes followed by construction companies, which requires the superintendent and some workmen to be on a job 24 hours after the contract is signed to indicate their goodwill to finish the work in the minimum length of time.

As the name indicates, the route man directs the movements of all materials of which the structure is to be made in minute detail, so that they shall be delivered at the right place with a single handling and the minimum of expense. In order to do this he must be a practical construction man of experience, who possesses the ability to visualize the job from beginning to end and to record this in such a manner that the superintendent and field force can carry out the details as planned. The location of the jobs with reference to the home office and their size determines whether all the routing can be done by one route man at the home office or whether only the main details shall be handled there and the other details consigned to a job route man. In the case discussed the job is assumed to be handled direct by the route man at the home office.

The route man first visits the job with the job superintendent, assuming that the production engineer and designing engineer are already familiar with the project, and by a careful study of the surroundings decides on the location of the job office, mill saws, stock piles, tool sheds, track sidings for railroad cars, location of concrete mixers, and any other necessary things which will need ground space. He then works up a ground plan on a fairly large size scale, showing the location of all features of the plant. This preliminary planning saves considerable money over the old plan of waiting for materials to arrive on the job before considering the placing of it.

Take, for example, the locating of the lumber piles. The route man receives from the designing engineer the schedule of the lumber to be used in the form work. From this list he lays out the piles of lumber, separating each thickness, width, and length, and designates on the ground plan where each pile is to be placed so that when the lumber arrives on the job every stick of lumber is carried direct from the car or the wagon to its proper place and located as conveniently to the saw-mill as practicable. When a stick 1½ in. by 8 in. by 12 ft. long is wanted it will be found in a certain pile. This saves much re-handling of lumber and a lot of lost time hunting for a piece of a certain size, to say nothing of the loss of material and time cutting up large stock because suitable small stock is buried under it.

The kind and quantity of equipment on any particular job is generally determined by the available equipment owned by the company, but it often pays to rent or buy a certain equipment in order to get the work done more quickly or at a cheaper cost. For instance, it is usually found to be a paying proposition to install a power-driven circular saw on any job using considerable form work, because of the saving in time and lumber. A consideration of such matters involves also the best methods of operating.

From the details furnished by the designing engineer, the route man plans the work and has the necessary material issued and operation tickets made out, as described further on in this paper. In this way the material lists gotten out by the designing engineer are all checked before the job is started. The route sheets and graphical charts next made up are the key to the successful carrying on of the work in accordance with the route man's plans.

The route man sends to the job superintendent the field plan showing the location of the job office, mill saw, stock piles, etc., so that he can do all preliminary work while the route man is arranging the routing. The superintendent gets together his organization of foremen, job-order-of-work men, office and engineering force. The plans, route sheets, graph chart and tickets are sent to the job as soon as finished. These must be studied carefully by the job superintendent and he must enforce the work in every detail according to schedule. This does not, as might appear at first thought, take the individuality away from the superintendent, but simply relieves him of much detail which can better be handled by the route man in the office. The route man, of course, must keep in close touch with the superintendent and avail himself of his experience in all matters while the plans are maturing. Having planned the work, it is absolutely necessary for the job superintendent to follow instructions explicitly, otherwise confusion will arise.

It is evident that the duties of the job superintendent under the new methods are somewhat changed, in fact the title "superintendent" might well be changed. He is not given free hand as when he was allowed to run the job pretty much according to his own notions. Formerly, so long as his costs were within the original estimate he was not taken to task. This practice is not fair; in fact, one may cite case after case where the superintendent has been commended for some good costs he has obtained and then reprimanded for high costs on some other job which were due not to his methods of management but to the estimator figuring the cost on the first job too high, while on the second job he did not allow enough for the special construction or difference in design. Under the newer methods of management such features as the design of the form work is standardized and separated into units so that the cost of the labor on one job is accurately comparable with that on another job.

The job superintendent is responsible for the correctness of the work. He is the construction company's representative who deals with the owner and architect and settles all small differences which arise on every job.

Although the description of methods applies chiefly to reinforced concrete building construction, the principles, as has been emphasized already, are applicable to nearly every kind of construction work. Sometimes, although this must be avoided if possible, the work must be distributed to gangs instead of individuals or pairs of men. In some classes of work, such as earthwork, the routing may be of a very simple nature, and stress must be laid on the standardization of tools or the measurement of material or both. In other cases, such as pipelaying, the training of the men is of the greatest importance.

Whatever the class of construction, it must be recognized at the start that results cannot be obtained in a minute, nor can they be obtained without a considerable initial expense. An organization must be developed, men must be trained to properly handle the work, and the management, that is, the members of the company, the superintendent and the foremen, must be brought to realize that a proportionally large number of office men, "non-sweaters" as they have been called, means a great diminution in unit cost, provided these office men are engaged in work which is really productive by eliminating labor on the part of the skilled and unskilled workmen. The actual reductions in costs through scientific methods, which are cited at the beginning of the paper, simply represent what may be normally expected under ordinary conditions.

Applications for approval of diversion of St. Croix River waters have been filed by the St. Croix Water Power Co., and the Sprague's Falls Manufacturing Co., Limited, and transmitted to the International Joint Commission of the United States and Canada.

STUDIES IN ROAD CONSTRUCTION.

(Continued from last Issue.)

BRIDGES AND ABUTMENTS. By A. Sedgwick, Assistant Engineer, Ontario Office of Public Roads.

The author cautioned municipalities against reliance upon safety at low cost only, in the building of bridges. Besides assurance that it has a safe carrying capacity, the question of durability of design and materials enters. Modern framed structures consist of a number of separate parts or members, each of which has a special function to fulfil. The first function of the specifications is to ensure that the separate members composing the structure will be so designed that they will fulfil their requirements with such uniform efficiency that the whole structure will have a reasonable life commensurate with its initial cost without a series of unnecessary and costly repairs as the years go on.

Ordinary timber bridges built by municipalities in former years were generally built with one idea in mind, namely, to withstand the action of decay. The stresses existing in the various pieces or members were seldom investigated, the only effort made being to make the members of such size as experience showed would carry all probable loads and in addition would be large enough to resist decay for a reasonable length of time.

The second function of a bridge specification is to provide a uniform basis on which a municipality can invite tenders from contractors to build the bridge.

Since it is impossible for councillors and other municipal officers to judge of the merits of a steel bridge in the same way as they could with timber bridges, it is, therefore, necessary in order to secure the best results, to employ the services of a competent engineer, experienced in bridge work. The result of the engineer's efforts may not always be apparent at first to the unpractised eye and perhaps this is the reason why municipalities are slow to adopt his services; but it should be borne in mind that the results he obtains will largely be shown in the superior life of the bridge and may not be manifest until the end of the bridge's life is reached, many years after it has been built and paid for, and consequently no longer in the public's mind. Of course, the engineer's work would ordinarily also show itself in a neater and more workmanlike appearance of the structure. And last, but not least, an experienced engineer may do much to keep the municipality free from unnecessary and unprofitable lawsuits.

The engineer having been engaged by the municipality, his first duty is to inspect the site of the proposed bridge and make a survey of the same. It will then be generally necessary to make a careful inquiry into the the nature of the stream and its surroundings, so as to determine the length of span required. So much has the country been denuded of timber, that in many districts and localities the watercourses are subject to freshets of ever-increasing intensity and frequency. In view of the present and probable future conditions, the engineer may or may not find it necessary to adopt a longer span than the old structure. In rare instances, a shorter span may be adopted with safety, thus resulting in the saving of a considerable sum of money, but this step should not be attempted except on the most reliable evidence obtainable. In any case, great care must be exercised in reaching a conclusion in this respect. If the engineer has lived in the locality for an extended period, his experience will do much towards effecting the decision he arrives at; but if not, he must rely largely on the evidence of the native residents and a close scrutiny of the surrounding country and of bridges existing above and below the one in question.

The engineer will next satisfy himself as to the nature of the soil upon which the abutments and piers, if any, will be founded and the nature of the current so far as it may effect the safety of the foundations. Finally, he will make note of the available deposits of gravel or stone and the accessibility of the site from the railway station.

Mr. Sedgwick then outlines the various steps the engineer takes in proceeding with the designs of the proposed bridge, such as the calculation of dead and live loads, abutment reactions, bearing plate loads, selection of style, computation of stresses in the various members and their subsequent design. The completion of plans and specifications is followed by the invitation for and consideration of tenders for the construction of the bridge. The detailed plans of the successful tenderer should be carefully scrutinized and approved by the engineer before the steel work is fabricated. Special attention should be given to the exactitude of connections,—a matter frequently slighted. An example was given by the author to show how efficiency may readily be sacrificed by faulty design. He goes on to state:—

The strength of the bridge truss as a whole is only equal to that of its weakest part, and the life of the bridge is directly proportional to its strength. If, then, its probable life is reduced 10%, the bridge has cost 10% too much. As a first-class engineer's services can usually be obtained for 5% of the cost, it does not require much figuring to see that money would be saved in the end by employing the best expert advice obtainable.

Coming to the design of the abutments and wing-walls, the engineer meets with a variety of problems. Two types of abutments are now in common use, namely, plain concrete and reinforced concrete, but even with plain concrete work it is considered good practice to use steel reinforcement where the wingwalls join the abutment proper, there being a tendency on the part of the wingwall to break away from the abutment at this point.

For abutments of ordinary height and where good gravel is easily obtainable at a moderate price, plain concrete is most often employed, it being simpler to use, requires less expert inspection, and costs about the same as reinforced concrete work. Abutments constructed with reinforced concrete, however, require much less concrete and consequently much less cement and gravel than in the former case, so that where gravel is scarce and has to be hauled long distances or where the abutment is of unusual height it may be found advisable for the sake of economy to use this style of construction in preference to the other.

The abutments of a bridge must fulfil two functions: (1) To support the ends of the bridge, and (2) to act as a retaining wall to hold back the earth fill forming the approach to the bridge.

The pressure of the earth filling on the back of the abutment wall cannot be computed with mathematical exactitude, but from the results of experience the general rule is to make the thickness of the wall not less than four-tenths of the height and extend the footings on all sides far enough to keep the pressure on the foundation within safe limits. It has been said that nine-tenths of all the recorded failures of retaining walls were due to defective foundations. It will be seen that since the earth filling has a tendency to tip the abutment over, the pressure on the toe of the wall will be more or less greater than that on the heel. This pressure will depend on the height and width of the wall and also on the character of the earth filling. It will be further increased by the weight of the wall and the weight of the bridge superstructure. It will also be seen that the bearing power of the different soils varies between very wide limits.

On account of the conditions just mentioned, it must be admitted that in order to secure an economical as well as a safe structure considerable experience and judgment must be exercised by the engineer entrusted with the problem. The writer has seen bridge abutments built and designed by so-called practical men that had sufficient excess concrete in them to have paid for an expert engineer's services several times over. And the work could not even then be vouched for as safe, as subsequent events sometimes prove. On the other hand, there are abutments built by the same class of men that are so flimsy that though they may still be standing up, they, like the superstructure, cannot be considered safe, and in any case will naturally show the effects of decay and disintegration much sooner than a more substantial structure.

CULVERTS. By R. M. Smith, B.Sc., Assistant Engineer, Ontario Office of Public Highways.

The culvert, an artificial channel under or through an embankment, together with the highway bridge, formed, in design, methods of construction, supervision and economic features, one of the most interesting factors in highway engineering. Owing to the frequency with which it occurs, it was from the point of view of both construction and maintenance, worthy of careful attention. The author pointed to a common fault, *viz.*, the insufficient width of roadway that is to be found in culverts and bridges of short spans.

With construction and materials, the author deals as follows:—

Culverts are being made of these materials: Timber, clay, cast iron, corrugated metal, stone, concrete and brick. The selection of materials depends upon: Cost, availability of material, freight charges, cost of hauling, cost of construction, location of culvert. A round cross-section culvert discharges more when flowing full than any other section. Three to four feet diameter is large; culverts are rarely used above this. When the flow requires a greater opening two pipe culverts are used; or box or arch construction put in. Culverts must be designed: (1) To support the weight of material which covers them, also the superimposed load; (2) to stand severe expansion forces, caused by water freezing within, due to pipes becoming blocked.

It is hard to determine the load a culvert may be called upon to carry; cast iron, corrugated metal or vitrified clay have been used with sufficient varying conditions to prove that they will resist successfully any load they are liable to receive, provided they are properly placed. The design of reinforced concrete pipe, box and arch culverts, should be carefully prepared so that they will support the load they must carry.

Culverts constructed of any material should be laid to good foundation. The material of which a foundation is composed should be examined, since excessive stresses are caused by settlement which the culvert is not designed to take. They should be laid true to line and grade.

At outlet, culvert should be nearly flush with ground level. If set too high, water falling from end will undermine the tile. Rapid grades have the same effect, these defects being overcome by paving or placing cobble stone at both ends of culvert and more particularly at outlet. Diameter of pipe should be sufficient to carry maximum flow likely to occur in terms of years.

Pipe culverts firmly bedded on the foundation and when of bell and spigot type, places should be cut to receive projection. If soil furnishes a poor support pipes should be bedded in layer of concrete or broken stone, backfilling for pipe culverts should be composed of a selected material, firm gravel or compact sand best, free from large stone. Great care should be taken that material is properly rammed around and under the pipe. A headwall should generally be constructed at both ends of pipe as this tends to shorten pipe. Sometimes, however, it is found advisable or more economical in case of culverts of large size to construct wing walls, either straight or flared. Concrete and stone masonry are used in headwall. Cheapness, durability, and the fact that concrete is readily moulded to any form desired renders it a very satisfactory material for this purpose. Bottom of headwall should be carried 18 inches or more below bottom of pipe to prevent washing out.

When box or arch culverts are being constructed and a poor soil is encountered it is possible to spread the footing so as to lessen the pressure on the foundation or to carry them deeper to a firmer bearing. If there is liable to be any danger from scour, the bottom of culvert should be paved, hand-placed rubble may also assist very much in lessening effect of water. If this danger is not present the stream bed may be made to serve as the invert. Headwalls should be constructed for box and arch culverts.

Vitrified pipe used for culvert should be best quality salt-glazed pipe of double strength type, with socket joints. Pipe is made in 2-foot lengths, 12 to 36 inches in diameter. The pipe is laid in trench, socket end toward inlet, should have 15 inches of material above highest point and joints should be filled with Portland cement 1:3 mixture. Under light traffic conditions, in highway work this pipe makes a fairly satisfactory culvert, but it is not advisable to use same when other material can be obtained, as life of pipe is generally short.

Cast iron pipe with bell and spigot joints have been used for some time; the pipe is generally used when lack of covering makes it necessary to put top of pipe close to surface, and where water will stand during freezing weather. This will stand practically any weight, the disadvantages are that it is expensive even in small sizes, becoming prohibitive in large. Twelve feet is standard length, but it is made in shorter lengths.

Culverts of corrugated metal tubing are being built throughout the province, but the first construction of this class is of too recent a date to enable us to determine the life of these culverts. It is claimed by manufacturers that they will last 20 years, but this remains to be proven.

Corrugated metal pipe is made in any length desirable, ranging in multiples of 2 feet up to 36 feet, or can be obtained in nest sections which may be bolted together in the field. Its weight is about one-twentieth that of cast iron, consequently easily handled and transported. The nest sections are of particular advantage in this respect. Care should be taken to select pipe made of proper material.

Wrought iron is superior to steel as far as its non-corrosive properties are concerned and hence pipes made of iron generally have a longer life. The non-uniformity of results obtained have been due almost entirely to the different kinds of material used in manufacture.

The advantages of corrugated metal pipe are that it can be laid within 6 inches of grade and may be used where soil is such that it is impossible to maintain a foundation under stone or concrete. If washed out, it can be replaced with little or no damage. The objections are: it is said to lose some of the galvanizing material when being rolled, and liable to rust. In the larger sizes it has been quite frequently known to flatten at the top. When culverts are being built in small sizes, corrugated metal is considered by some engineers to be superior to concrete pipe.

Brick culverts are sometimes used in arch culverts and end walls, but possess no advantage over concrete either in cost or durability, and should not be built unless bricks are close at hand and it is inconvenient to get material for concrete. Faced brick must be used, ¼-inch joint with cement mortar 1 to 3; 515 bricks to cubic yard.

Stone laid up in Portland cement mortar makes a very lasting and satisfactory culvert, when good, sound stone is at hand and crushed stone or gravel hard to obtain. It is well to build culverts and end walls of cement rubble masonry. Abutments and wing walls for bridges are also built of this material. Walls should be at least 18 inches thick at top and bottom, about 4/10 total height, should be constructed of large stone, dressed to even face, free from clay seams, built in layers of alternative headers and stretchers. Walls should be carried to sufficient depth to be unaffected by frost. Below 4-ft. span, culverts can be topped by flag; larger than this should be arched, but this may have one disadvantage in causing an abrupt rise in road, or necessitating long approaches. Reinforced concrete top does away with arch, makes good culvert and eliminates the bump in road. Steel of all kinds has been successfully used as reinforcing for these culverts.

Concrete pipes may be cast and laid as any other form of pipe. In Ontario, pipes are cast previous to laying and are made in lengths of 2½ feet with thickness varying from 2 to 6 inches, depending upon diameter. Circular culverts up to three feet are commonly made of concrete tile. If properly made and laid they are very durable, and, when suitable material is available, of low cost. The points that must be considered are:—

(1) Concrete properly mixed.

(2) Cement of good quality.

(3) Thickness of concrete proportional to diameter.

(4) Sufficient covering of earth when laid.

(5) Culverts not to be short, and especially at road intersections; better to make length full width of road allowance.

(6) Tile should be placed with reasonable care.

(7) Good fall on a regular grade to free outlet in such a way that water will not stand in them.

(8) Tile laid with socket end up-stream and joints made tight with cement mortar. Water gets in, freezing, etc., culvert gets out of line.

(9) Ends should be protected with stone or concrete headwalls to prevent water finding its way along pipe.

(10) Concave bed excavated for pipe to rest in securing even bedding. Without which heavy load in passing over before culvert has settled is liable to break or burst tile. Tile cannot be used for very shallow culverts; advisable to have the thickness of earth above tile equal to diameter of tile.

A mixture of cement, sand and crushed stone in proportion 1:1½:3 is probably considered ahead of cement, sand and pit gravel, 1:1½:3, but the advantages of one over the other seems so slight that the available material governs construction.

Concrete culverts may be built either plain or reinforced. When large works are being constructed series of cement tests should be made to determine strength. However, on culverts it is generally impracticable to apply these tests on account of lack of apparatus.

In treatment of concrete arch culverts, forms should be dressed and fit closely, concrete well spaded against forms to eliminate air holes. Surface should be part of concrete itself, plastering does not remedy defects. Sometimes concrete is surfaced with 1-inch coat of 2 : 1 mixture. This is done by placing 1-inch lumber against forms and removing the boards as concrete is partially set, then filling in space between form and weaker cement with strong mixture. It is contended, however, that if concrete is properly spaded against forms the coarse aggregate goes to centre and a stronger mixture actually remains against the forms.

For heavy work, walls, piers and abutments, a proportion of 1 : 3 : 6, and for culvert tops, bridge floors and other reinforced concrete, 1 : 2 : 4, are considered good mixtures.

When the wall is fairly thick the amount of concrete may be minimized by placing large stone in wall, embedded in concrete, the diameter of stone in no case to be greater than half the thickness of wall, and none should appear on face. For culvert tops, bridge floors and other reinforced work, when concrete is subject to greater strain than in abutments and piers, it is important that concrete be made stronger. Gravel should be screened, and all stone larger than 2-inch diameter rejected. In reinforced concrete culvert tops, arrangements should be made to lay entire top in one day if possible, and if not, to finish each day's work with a slab the full thickness of floor and completely spanning the distance between abutments.

The amount of water to be used demands attention. It is dangerous to mix too dry, the prevailing practice is to mix concrete very wet. Although in this state it does not gain strength as soon as when mixed dry, it is easier to handle, requires less tamping and eventually becomes as strong as drier mixture. It is better to mix concrete by batch mixer rather than by hand. However, in ordinary highway work mixers are not always available.

It is not advisable to lay concrete in freezing weather. This can be done successfully, but it is necessary to heat all materials and even then it is risky and expensive. No culvert or bridge construction should be started in severe weather if it can possibly be avoided.

Where concrete culverts have been properly built and carried to firm foundations no heaving has occurred. In nearly every case where frost cracks or heaving has taken place the cause has been traced to building too late in the fall, water getting under concrete floor, etc.

The time of setting depends principally upon the brand of cement, the amount of water used in the mixture, and the temperature. In very hot weather care should be taken that concrete does not dry out before setting. It is well to sprinkle with water occasionally. On large jobs where it is desirous to use as little lumber as possible for forming, the forms are removed from walls in as short a time as 48 hours or even less in special instances. On highway work this is not often necessary and forms should be left on the wall for about twice that time. It is rather difficult to make any set rule for reinforced concrete, but the forms should not be removed until the concrete is thoroughly set. This is generally considered to require from 7 to 14 days. From experiments conducted by the writer on reinforced and plain concrete the concrete stood the greatest tension and compression test after 27 days' setting, consequently the heaviest loads should not be allowed on the structure until one month after placing concrete.

(To be continued.)

WATER PURIFICATION AT ST. CATHARINES, ONT., BY LIQUID CHLORINE.

SINCE 1878 the water supply of the city of St. Catharines has been drawn from the Welland Canal. Increase of population during recent years, coupled with the canal changes now under way, has made necessary some means of protection against pollution of the supply. The superintendent of waterworks, Mr. Alex. Milne, was instructed in January of last year to report on accepted methods of sterilization, and in a recent article in "Engineering and Contracting" he outlines the distinctive features of the liquid chlorine installation recommended by him and adopted by the water commission, with the approval of the Provincial Board of Health.

It is stated that the recommendation involved the acceptance of the proposal of the Electro Bleaching Gas Co. of New York, including a 36-in. Venturi meter and complete automatic apparatus for the control and regulation of the liquid chlorine; the company guaranteeing the efficiency and accuracy of the whole apparatus and furnishing a guarantee bond covering the agreement. Active work on the excavation for the concrete meter and valve chamber was commenced on May 26, the work being done

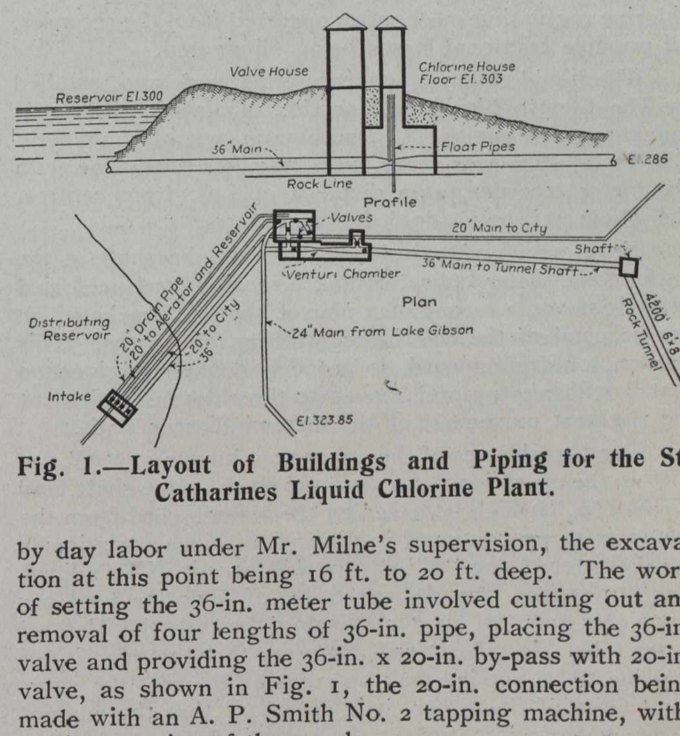


Fig. 1.—Layout of Buildings and Piping for the St. Catharines Liquid Chlorine Plant.

by day labor under Mr. Milne's supervision, the excavation at this point being 16 ft. to 20 ft. deep. The work of setting the 36-in. meter tube involved cutting out and removal of four lengths of 36-in. pipe, placing the 36-in. valve and providing the 36-in. x 20-in. by-pass with 20-in. valve, as shown in Fig. 1, the 20-in. connection being made with an A. P. Smith No. 2 tapping machine, without interruption of the supply.

All concrete was of 1 : 6 mixture, using clean, sharp pit gravel, mixed wet, and liberal quantities of clean, sharp angled limestone spawls. The cross walls of the chlorine house are supported on steel beams, resting on the chamber walls, the whole being continued as a unit up to elevation 303 (local datum) as shown on profile of Fig. 1. The concrete floor of the chlorine house and the roof of the chamber are reinforced with 4-in. (65-lb.) steel rails and expanded metal.

The superstructure is of double-hollow concrete blocks, strapped on the interior and lined with Beaver board. Power, light and heat for the plant is obtained from 120-volt, 66-cycle current.

The general design of piping and valves at the intake crib and valve house is as shown in Fig. 1 and furnishes an ideal combination of feeds, which may be used combined or independently from three separate intakes if so desired, in event of trouble or the unwatering of either. The placing of the 36-in. and 20-in. valves at the by-pass below the Venturi meter gives the advantage of operating either or both mains without disturbing the chlorination treatment.

From this point the supply is conveyed to the city by two mains, the 20-in. shown on the plan is reduced to 16-in. at the foot of the escarpment and enters the distribution system at the extreme westerly end. The 36-in. is laid to the shaft of the tunnel as shown, the tunnel being 6 x 8 ft. in section for a distance of 4,200 ft. to a concrete bulkhead where it connects to a 24-in. cast iron main laid to and across the centre of the distribution, a distance of 21,000 ft., thus affording ample time for complete chlorination before the supply reaches the consumer.

The 36-in. Venturi meter is the product of the Builders' Iron Foundry of Providence, R.I. It is designed especially for the rather unusual local conditions, the recording apparatus being the float-operated type "M" register, indicator-recorder, the indicator and recorder being in Imperial gallons, while the register is shown in cubic feet.

The recorder is placed directly over the float pipes, thereby obtaining the best possible results in operation, not only of the meter recording apparatus but also of the chlorine regulating mechanism operated from the recorder, all possible frictional losses being eliminated.

The liquid chlorine apparatus was made and installed by The Electro Bleaching Gas Co., of New York, and is known as their model "C," automatic type of equipment. The installation was made on a parallel centre line with the meter recorder, at a distance of 3 ft. from centres, the whole unit being described as follows:

From an aluminum sheave fitted to the shaft at the back of the meter indicator dial, a tension cord is carried at a right angle to one of a pair of sheaves bracketed on the pedestal of the chlorine controlling apparatus. This tension, or driving cord, is properly counterweighted so that it will take up and convey to the chlorine equipment the slightest movement of the meter indicator shaft.

The two sheaves of the apparatus, known as "A" and "B" in the operations, are mounted on the same shaft, and sheave "A," which is driven by the tension cord from the meter, is so proportioned in dimension that a variation in the diameter of the "B" sheave will permit of an adjustment to secure any desired rate of chlorine feed per 1,000,000 gals. of water passing through the Venturi meter tube. In other words, in order that the quantity of chlorine to be applied may be adjusted to meet the varying quality of the water, it is necessary that the amount of movement originating at the meter indicator and transmitted by the tension cord shall be increased or diminished to secure the desired action on the chlorine controlling valve. This is the purpose of the "B" sheave, and it is therefore of such design that it can readily be removed and replaced by sheaves of larger or smaller diameter, as the case may warrant.

From this "B" sheave another properly balanced cord passes over a small, loose guide pulley, mounted on the electric mechanism box. This cord is connected to one part of an electric contact carriage or switch device. This entire mechanism is unique and of decidedly interesting design and correspondingly difficult to describe. The function of this switch is to make, break, and reverse the current passing to a small motor, which operates indirectly through a series of gears, the valve controlling the delivery of the chlorine gas. This switch, or contact carriage, is made of two separate parts; one part may be termed the "floating" section, being connected to the tension cord from the "B" sheave, as previously mentioned, and the other part is mounted on a vertical screw shaft actuated or driven from the motor.

The operation of this switch may be briefly stated as follows: The floating portion is moved vertically, a proportional fraction of the total movement originating at the meter indicator. At the inception of this movement, contact is made with the second portion of the carriage, so that the circuit is closed on the motor. As the motor operates, the screw shaft revolves, moving the section portion of the contact carriage vertically up or down, as the case may be, until its contact with the floating portion is broken, and the power circuit opened. This, therefore, stops the motor as soon as the movement of the meter indicator ceases.

The chlorine control valve is actuated by the motor through this same vertical screw shaft by universal joint connected shaft driving bevel back gearing connected by a spur to a pinion on the spindle of the diaphragm regulating valve, this latter being the immediate control of the gas passing to the absorption tower.

As all operations and adjustments of the mechanism start from zero, the large pinion on the valve spindle has been calibrated to indicate on its face from zero the percentage of valve opening, thus enabling the operator to check the momentary flow of chlorine as given on a table furnished by the manufacturer of the equipment. An additional check is provided by the "rate of flow" gauge mounted on the left which indicates the flow of chlorine in ounces per hour. At the upper right of the frame is the chlorine cylinder pressure gauge, on the indicator of which is fitted a circuit closing arm, from the contact points of which are carried wires to a large alarm gong, in the caretaker's residence nearby, operated by 2 dry cells which gives a very positive alarm when the cylinder pressure reaches the low point for which it is set.

From the cylinders the chlorine passes through the controlling apparatus to the absorption tower, discharging near its base, the tower being filled with broken pumice stone and receiving a continuous flow of water from a ¾-in. pipe fitted at its top to provide complete absorption of the chlorine, the chlorinated solution being thence carried by gravity to the 36-in. main below, discharging at the axis of the pipe. The absorption tower and all pipes and fittings in contact with the chlorine or solution are made of vulcanized rubber.

Electric current enters the building at the right of the apparatus to a switchboard, 120 volts, 66-cycle, and for the operation of the apparatus is transformed to 10 volts single phase by means of a Viking pony transformer wired through the contact carriage to the motor, the operation of the electrical apparatus being entirely automatic, on the movement of the temporary rate of flow recorder. In event of line or other electrical troubles the apparatus may be operated temporarily by a battery of six dry cells, for which provision is made. In addition to these it is the intention of the writer to install a small direct-current generator, driven by a Pelton or similar water wheel in the basement of the adjoining valve house, giving an independent triple source of power, reducing to a minimum the danger of shut-downs from power sources.

The plant was placed in operation on August 10, 1914, and with the exception of some slight adjustments to tension cords, etc., has required no attention, and has been highly satisfactory.

Desired results are being obtained from the application of 1.65 lbs. of chlorine per million Imperial gallons of water.

Editorial

TIME FOR A CHANGE IN MUNICIPAL GOVERNMENT.

An engineer's first duty to his client is to tell him the truth, no matter where it may lead or how unpalatable it may be.

Engineering and engineering economics are subject to natural law, which cannot be altered to suit the whims of human nature.

The most serious disgrace that comes to an engineer is to conceal, pervert or distort natural and economic law, either to please a client or temporarily advance his own interests, and so ultimately lead his client into difficulties.

An experienced engineer of standing ranks as a confidential professional adviser, feeling keenly his responsibilities. His integrity and conscientiousness, when properly established, should be appreciated and upheld by his client.

Engineers, while not infallible or superhuman, are more apt than laymen to be right in their findings on engineering facts and economic truth connected with engineering matters.

These five self-evident truths pretty well define the proper understanding that must exist between the public and engineering advisers. Abuse of any one of them creates a condition detrimental to public welfare. That they are abused there is little question. That the laymen are, with few exceptions, the abusers, there is little question. That the few exceptions can generally be traced to political or personal influence of laymen is equally true.

The public, through its representative officials, its councillors, its politicians, and its newspapers, administers delay and defeat to some of its needful aims, thereby vitally affecting public welfare, by its frequent attempts to conceal, distort, suppress or overawe the carefully prepared opinions of experienced engineers reporting on public questions for the public interest. And that is not all. It belittles the ability and undermines the reputation of these same engineers, whom it had previously taken into its service, because of their ability, reputation and standing in the profession.

Many instances of this regrettable practice are to be found in the annals of municipal development. Consulting engineers and municipal engineers have woes in common in this respect. The former may have his carefully prepared report thrown aside without courteous consideration; the latter may be removed from office at any moment, all on account of the caprice of a man, a board, or an electorate.

It is somewhat remarkable that the general public has not realized the folly of permitting its elected representatives to spend money on engineering investigation, only to shelve and side track the reports should they not conform, as stated, to "the whims of public nature" which in most instances, means the whims of one or more of these elected representatives.

Besides, what better indication of municipal shortsightedness could we ever expect to see than the present prevalent practice of discharging, in a wholesale manner, the municipal engineers, by whom only the water supply, roads and streets, sewerage system, etc., of the municipality can be maintained in efficient condition and prevented from deterioration? At a time of depression, when money for municipal expenditure is so difficult to negotiate, a council sees where it can save an engineer's salary and assures its electors that "money saved is money earned," while the municipal improvements are left to depreciate by being expected to take care of themselves.

There is nothing new to relate respecting the antiquated service the public gets from its present system of municipal government. *The Canadian Engineer* has advocated a more general acceptance in Canada of the commission form of government. It has done so with the full knowledge that practically all of us are so thoroughly imbued with the idea that politics is rotten and that it cannot be kept out of municipal affairs, that we are inclined to believe that the betterment of the position of the municipal engineer is a hopeless task. But commission government of municipal affairs is an important step towards the principle of non-partisan nominations and elections. If we follow this principle carefully and try to shun those that have every indication of failure, decided improvement will be the result.

Of course there are other principles, besides non-partisanship. The city of Dayton, for instance, is trying to follow the merit system, though a real merit system can not be fully in force until there is sufficient demand for skilled municipal employees to warrant men in preparing themselves for such positions. Ohio and some of the western States are trying a third principle, that of home rule. Home rule will not be safe until it is impossible for a man, who cannot do what he wishes with the city government, to go to the legislature and procure a change of the city charter which will give him the authority he wants in spite of the desires of the people of the city. But the commission form of municipal government, properly established, does not depend for success upon any such contingencies. It is worthy, to say the least, of more consideration in Canada.

LIQUIDATION OF A NOTABLE FIRM.

The recent announcement by Mr. W. H. C. Mussen that he had been forced to place the firm of Mussens, Limited, in voluntary liquidation, was a distinct shock to the engineering and contracting fraternity in Canada. The cause appears to have been over-stocking of machinery, considering present trade conditions, and the difficulty of collecting outstanding accounts. Mr. Mussen estimates the assets at $550,000 and the liabilities at $300,000, and states that he placed the company in liquidation merely in order to prevent the assets having to be sacrificed.

He claims that the liquidation will prove to be merely an enforced extension of credit, and that he will be able to pay dollar for dollar if he is permitted by the Court to carry on business in the usual manner, and sell the stock to the best advantage when opportunities are offered by the requirements of the market.

Mussens Limited have been one of the four or five largest and best known contractors' supply houses in Canada. We believe that they have always done business in a square, fair manner, with courtesy to customer and competitor alike, and we genuinely regret the step which it appears to have been necessary to take. Should the Court permit the business to be carried on under Mr. Mussen's direction, we have every confidence that the creditors will lose little or nothing eventually.

ENGINEERS' LIBRARY

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

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BOOK REVIEWS.

The Gas Turbine. By Norman Davey. Published by Constable & Company, Limited, Leicester Square, London, W.C. First edition, 1914. xiv. + 248 pages with index; 100 illustrations; size, 5½ x 8½ ins.; cloth. Price, $3.75 net.

Ever since the successful introduction of the steam turbine a similar machine operating on gaseous fuel has been the subject of more or less speculation, theoretical investigation, and to some extent experiment. At first glance, such a machine seems both possible and wholly desirable, but closer scrutiny reveals such tremendous difficulties in the way of its development that its practical realization seems as far off as ever. For this reason the interest in the gas turbine has remained academic, and its literature meagre indeed, although an operative machine of 300 h.p. was built in 1903. It is interesting, then, to note that the present book is the first to appear in any language dealing with the gas turbine in a complete manner. The only other book in English on the general problem of such machines was published in 1910 and consisted only of a collection of articles on the subject gathered from various sources.

The author has divided his work into two parts, Book I., dealing with the theory of the gas turbine, and Book II., describing the actual machine and accessory apparatus so far as they have been developed.

The theory of the turbine is presented for cycles in which heat is added at constant pressure, constant volume, and an intermediate cycle in which neither of these conditions prevail, but taking in heat under thermodynamic conditions varying between them. (Actual machines have been constructed to operate on all of these cycles.) Considerable space is also devoted to the consideration of the mixed fluid turbine using gas and steam. After the manner of Clerk, the author seems to be disposed to teach by practice as well as precept and has invented a turbine of the mixed fluid type which appears to have greater possibilities than any machine so far built, but as no tests have been made with it, its performance is a matter of conjecture. At any rate, the author gives it the benefit of any doubt that may exist as to probable efficiency. In the discussion of the theory good use is made of the temperature-entrophy diagram adding thereby to the lucidity of the text. Objection may be taken to a departure from the common definition of "efficiency ratio" on the pretext of avoiding confusion, and to the assumption that "specific heats" are constant—points, however, which do not materially affect the value of the book.

The second part is descriptive of the various parts comprising the gas turbine plant, such as, producer, furnace, turbine wheel, cooling, governing, regenerators, condensers, pumps, etc. A chapter is devoted to practical limitations, followed by a summary of efficiencies and a comparison of types, a history of the gas turbine and an account of the recent experimental work that has been done up to the present.

In spite of the author's enthusiasm, the book leaves the impression that the gas turbine is still an experiment unconcluded. The analogy between it and its prototype, the steam turbine, from which encouragement is derived, is slight. The economy of the latter flows from properties peculiar to steam that are absent entirely in gases such as air. High efficiencies of compression and expansion of gases are quite possible in theory, but owing to the limitations of structural materials, are at present unattainable in the turbine. All speculation as to the future aside, however, the present book is welcome as a step in the right direction. It sets before the reader a very fair statement of the case and brings together a mass of material previously in scattered form. It presents very clearly the nature of the difficulties to be overcome and constitutes a new base from which the problem may be attacked; as well as being a very interesting and suggestive work for those whose interest lies in the direction of thermodynamic development.

Poor's Analyses (first series). Published by Poor's Railroad Manual Co., New York. First edition, 1915. 8½ x 11 ins., flexible leather.

This book contains analyses of the operations of 41 corporations, railroad, public utility, and industrial, in such a way that estimates of the value of the securities can be readily made. It is compiled from analyses published weekly during 1914. It contains facts only, without expression of opinion or deductions as to values. It makes a useful reference book.

Metal Statistics, 1915. Published by the American Metal Market Company, New York. Eighth edition. 344 pp., 4 x 6 ins., cloth.

The 1915 edition is very complete in its information respecting the ferrous and non-ferrous metal fields, for buyers and sellers, as well as plant managers and engineers. Its value is further enhanced by statistics relating to the production of coal, petroleum and cement, data not included in previous editions. Monthly averages of prices of iron and steel and metals are included.

The Design of Steam Boilers and Pressure Vessels. By Professors Haven and Swett, Massachussetts Institute, Boston. Published by John Wiley and Sons, New York City; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1915. 416 pages; illustrated; 6x9 ins.; cloth. Price, $3.00 net.

This book forms an interesting addition to the books on boiler design, and was written by men who have had considerable experience in teaching such work, so that the matter is well put and illustrated by clear working drawings of many details.

Chapter I. deals with general principles, in which terms are explained, types of boilers are described and various details are taken up. A discussion of various materials used is also given.

Chapter II. discusses the stresses set up in the different parts of the boiler, and gives formulas for computing the thickness of the shell, tubes, heads, flat stayed surfaces, manhole plates, etc. In Chapter III. the riveted joint is very fully considered, all details of rivets, caulking, etc., receiving attention. After a complete treatment of the principles underlying the design of the joint, and the deduction of the necessary formulae, a complete set of drawings and tables, covering every practical form of joint is given, from which the complete details of the joint may be at once taken in a given case without calculation.

Chapter IV. deals with such matters as water consumption, grate surface, stay tubes, steam space, staying, etc., and the remaining chapters, V., VI., VII. and VIII., takes up the application of the principles already given to the design of four very common classes of boilers to a given specification in each case

The book is a very good one for the designer, and will be found of considerable value to anyone interested in such work. The drawings are well made and clear.

Land Drainage: A Treatise on the Design and Construction of Open and Closed Drains. By J. L. Parsons. Published by Myron C. Clark Publishing Co., Chicago. First edition, 1915. 165 pages; 22 tables; 32 illustrations; 6x9 ins.; cloth. Price, $1.50.

Land drainage problems are oftentimes of no small dimension. Existing literature respecting design, construction, maintenance and general administration of drainage enterprises is of a very general nature and sadly lacking in many respects. The author adds considerable to what valuable information there is available for drainage engineers and contractors, as well as for land owners, drainage district officials and young and inexperienced engineering students.

Considering the scope which the book has, the information contained in it is concise and well arranged, as shown by the following chapter headings: Preliminary Drainage Surveys; Design of Tile Drains; Tile Drain Outlet Walls and Inlets; Design and Maintenance of Open Drains; Plans, Reports and Records; The Estimate of Costs of Drainage Systems; The Preparation and Enforcement of Drainage Specifications; The Division of Costs of Drainage Systems; and The Quality and Inspection of Drain Tile.

Although the work is not technical (except for the presentation of a few tile size formulas, yardage computations, earth pressures, etc.) there is a great deal of useful information therein for the irrigation and drainage engineer, and it is a question whether he can find a work that presents in a more readily available shape the practical information which it is necessary for him to have.

High and Low Tension Switch-Gear Design. By A. G. Collis, A.M.I.E.E. Published by D. Van Nostrand and Sons, New York. First edition, 1913. 218 pages; 94 illustrations; 5½x9 ins.; cloth.

This book records researches in connection with various circuit breaking and protective apparatus.

The author states that "the major portion of this contribution is expressly intended as an introduction to the main elements of design, which will be more abstracted by further publications on the individual subjects involved." He intimates that it is practically impossible to treat the various designs mathematically and further presents the matter in such a manner that essentials may be easily understood.

It is pointed out that switch-gear has not developed correspondingly with the development of electrical transmission, this being scarcely realized at this date.

A number of oscillograph records are interesting.

The book is divided into two sections; the first deals with alternating current and the second with direct current switch-gear. The author has expressed difficulty with this section as it becomes necessary in both sections to refer to both A.C and D.C. gear.

No mention is made of iron pipe or structural steel frame work nor of tank type switch gear for high transmission system.

Chapter II. deals with the rating of oil circuit breakers, and other characteristics and tests are dealt with, while in the same chapter the matter of overpotential surges, etc., is treated less extensively.

On page 38 the author claims that he has succeeded in designing a new switch and a new di-electric which can be graded so as to prevent any predetermined rise of current with the same gradient for potential rise.

Chapter V., Part 2, deals with paralleling of D.C. machines, circuit breakers and test on same, and with fuses.

The last chapter deals with general electric subjects as self-induction, power factor, synchronous motors, etc.

In an appendix the British Board of Trade Regulations are re-printed.

As suggested in the preface, the book deals with all switch-gear matters in a more or less general way, leaving a number of detailed problems to be dealt with later. The book will be quite useful to those interested in switch-gear.

Descriptive Geometry for Students in Engineering Science and Architecture. By Henry F. Armstrong, McGill University. Published by John Wiley and Sons, Inc., New York City; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1915. 128 pages; 114 illustrations; 6¾ x 10 ins.; cloth. Price, $2.00 net.

This book should prove to be a very satisfactory text on the subject of descriptive geometry, as it explains very clearly and fully all the essential features of the subject. It deals entirely with theoretical problems, no attempt being made to apply the principles involved to actual engineering problems. A feature of the book which should be noted is that the first quadrant projection is used exclusively, although the modern tendency in engineering practice is to use the third quadrant projection.

PUBLICATIONS RECEIVED.

Probable Effect of War on U.S. Ceramic Industries. By A. S. Watts, U.S. Bureau of Mines. 15 pp.; 6x9 ins.

Department of Railways and Canals, Canada.—Annual Report for year ending March 31st, 1914. It contains reports on Government railways, including N.T.R., and Quebec bridge, canals, locks, railway subsidies, etc.

Explosions of Gas and Coal Dust.—Circular 21, U.S. Bureau of Mines. 24 pp.; 6x9 ins. Some notes, prepared by Mr. G. S. Rice on what a miner can do to prevent such explosions.

Cotton Warehouses and Terminal, New Orleans, La. General illustrated description of design and construction of this plant with annual capacity of 2,000,000 bales. Issued by Ford, Bacon and Davis, engineers. New York.

Department of the Interior.—Annual Report for year ending March 31st, 1914. Vol. 1. It covers Dominion lands, immigration, surveys, astronomy, and Dominion parks. Vol. 2 will cover forestry, irrigation and water power.

Telegraph Statistics.—Report for 1914, Department of Railways and Canals, Canada, giving organization, earnings, operating expenses, equipment and other statistical information concerning all corporations operating telegraph lines in Canada.

5,000 Facts About Canada.—1915 edition of this useful booklet, compiled by Frank Yeigh, Toronto. It covers agriculture, area, banking, census, immigration, mining, manufacturing, trade, etc. The Canadian Facts Publishing Co., Toronto. Price, 25c.

Timiskaming and Northern Ontario Railway Commission.—13th annual report (for year ending October 31st, 1914). It contains reports of chief engineer and the departments of motive power and cars, roads, bridges, buildings, traffic, telegraph, etc.

Physical Properties of Metal Cobalt.—Part 2 of Report by H. T. Kalmus, B.Sc., Ph.D., and C. Harper, B.A. Published by Mines Branch, Department of Mines. 70 pp.; illustrated. It deals with researches on Cobalt and its alloys conducted at Queen's University for the Mines Branch.

Hand Firing Soft Coal Under Power Plant Boilers.—By Henry Kreisinger. Technical Paper 80, U.S. Bureau of Mines. 83 pp.; 6x9 ins. Description of methods of firing, discussion of combustion and heat losses, and simple instructions toward greater efficiency, make this a most useful publication for fuel engineers and men employed in steam power plants.

Highway Bonds.—By L. I. Hewes and J. W. Glover, U.S. Office of Public Roads. 136 pp.; 6x9 ins.; illustrated. Issued as Bulletin No. 136, U.S. Department of Agriculture, Washington. A compilation of data and an analysis of economic features affecting construction and maintenance of highways financed by bond issues, and the theory of highway calculations.

Investigation of Flow Through 4-inch Submerged Orifices and Tubes.—By L. R. Balch, C.E. Published by Engineering Experiment Station, University of Wisconsin. Bulletin No. 700. 31 pp.; illustrated; 6x9 ins. Price, 25c. It contains results of experimental work carried out under the direction of Daniel W. Mean, Professor of Hydraulic and Sanitary Engineering.

Minister of Public Works.—Annual Report for year ending March 31st, 1914, relative to works under his control. Vol. 1. It contains reports of deputy minister, accountant, chief architect, chief engineer, general superintendent of telegraphs, collector of revenues, and miscellaneous. (Vol. 2 will deal with geodetic levelling.) The chief engineer's report covers the construction and repairs of wharves, piers, breakwaters, dams, etc.; improvement of harbors and rivers; construction of graving docks; slides, booms; interprovincial bridges, etc., etc.

Flow Over Weirs With Imperfect Contractions.—By G. J. Davis, Jr., Dean of Engineering, University of Alabama. Bulletin No. 699, Engineering Experiment Station, University of Wisconsin. 73 pp.; illustrated; 6x9 ins. It outlines description of experimental apparatus, methods of experimentation, gauging, calibration, discussion of results and tables of data.

Sewage Disposal Systems in Canada.—By T. Aird Murray and T. Lowes, consulting engineers, Toronto. Published by the authors, 1915. 44 pp.; 8x11 ins.; fully illustrated. Price $1.00. It outlines recent developments in sewage disposal and describes the disposal works at Lethbridge, Alta.; Weston, Ont.; Mount Dennis, Ont.; Whitby, Ont.; Dundas, Ont., and Carleton Place, Ont. It contains sections devoted to a discussion of the distribution of sewage over percolating filters and outlines types of 7-inch sedimentation tanks, with notes on the alteration of an ordinary septic tank into a 2-story tank.

CATALOGUES RECEIVED.

Small Motors.—Six-page leaflet describing type A R single-phase motor. Illustrated. Issued by Westinghouse Electric and Manufacturing Co.

Cableways on Filtration Work.—A bulletin issued by the Canadian Allis-Chalmers, Limited, Toronto, describing use of Lidgerwood cables in the construction of several large filtration plants.

Sorge-Cochrane Hot Process System of Water Softening.—A 20-page pamphlet issued by the Harrison Safety Boiler Works, Philadelphia, and relating to recent developments in the conversion of hard water into soft.

Steam Turbine Drive for Rolling Mills.—A 22-page illustrated pamphlet distributed by the De Laval Steam Turbine Co., Trenton, N.J., containing detailed information respecting the installation, operation and results in several important mills.

Armstrong-Whitworth of Canada, Limited.—128-page, illustrated catalogue of high-speed twist drills, cutters, reamers, riveters, dies, taps, punches, etc., with interesting notes on carbon steel, feeds and speeds, steel treatment, etc. Head office, Montreal.

Water Purification.—A booklet of 80 pages, illustrated, relating to mechanical filtration and water softening plants. It reproduces extracts from a number of recent valuable papers on the subject, and illustrates numerous installations for cities, towns, public institutions, industrial works, etc.

Testing V-Notch Meters.—A 48-page, illustrated booklet issued by the Harrison Safety Boiler Works, Philadelphia, describing exhaustive investigation of the properties of the V-Notch weir, the Cochrane Meter Testing Plant and meter equipment. The paper by James Barr, B.Sc., entitled "Experiments Upon the Flow of Water Over Triangular Notches" is reprinted therein from London "Engineering."

Fluxphalte.—An interesting illustrated booklet issued by the Asphalt and Supply Co., Limited, Montreal, relative to their asphalt macadam binder, "Fluxphalte," which is a very heavy road oil just being introduced into Canada, although used extensively in Mexico and England, as is also Rodol, which is a lighter asphaltic oil or dust preventative. It contains illustrations of roads that have been treated with Fluxphalte, and of special flapper machines which are loaned to municipalities for applying it.

GOOD ROADS CONVENTION AT TORONTO

INTERESTING EXHIBITS OF MATERIALS AND MACHINERY FOR ROAD MAKING —PROMINENT ENGINEERS AND CONTRACTORS DELIVERING PAPERS AND TAKING PART IN DISCUSSIONS—SESSIONS IN CONVOCATION HALL THIS WEEK.

"THERE is no longer any question as to the need for good roads," declared Lieutenant-Governor Hendrie last Monday afternoon at the opening of Second Canadian and International Good Roads Convention and Exhibition at Toronto. "The problems that confront us are those of finance, of construction and of maintenance."

The Material Exhibits are Interesting.

And the engineers and contractors who are attending the Convention to the number of several hundred, are finding considerable help in these problems, both from the excellent papers that are being read and from the highly educative exhibits. The interest is divided between the papers and the exhibits. Lively discussions are bringing out many excellent points. The exhibits outnumber those at last year's convention, and are in general of a more interesting character. Both material and machinery firms are well represented, and the exhibits are worth careful study by every man in attendance at the Show.

Machinery Exhibits are Under Canvas.

The material exhibits are in the large drafting room in the rear of Convocation Hall, two views of which are given herewith. The machinery exhibit is in a large tent adjoining Convocation Hall, and is of a most complete character. A general view of a portion of this tent is also given on this page.

At the opening session, besides the Lieutenant-Governor, the following delivered addresses: Mayor Thos. Church, of Toronto; Sir Edmund Walker; Hon. Finlay McDiarmid, Minister of Public Works for Ontario; B. Michaud, Deputy Minister of Roads for Quebec; J. A. Sanderson, president of the Ontario Good Roads Association; and N. W. Rowell, K.C., of Toronto. U. H. Dandurand, of Montreal, presided in the absence through illness of the president, W. A. McLean.

Morning, afternoon and evening sessions on Tuesday, yesterday and to-day were devoted to technical papers and discussions, full report of which will appear in next week's issue of *The Canadian Engineer*.

Another View of Convocation Hall.

To-morrow morning's session will close the Convention, with the exception of a business session of the Dominion Good Roads Association to-morrow afternoon.

The following are a few notes regarding the exhibits and those who took active part in making them of interest to the delegates:—

City of Toronto.—Colored cross-sections of various types of pavements and photographs of the Bloor Street Viaduct, Bathurst Street grade reduction and of various types of pavements in Toronto. In charge of Murray Stewart, roadways engineer.

Hugh Cameron & Company.—Photographs of Waterous road-making machinery, shown by Hugh Cameron, R. B. Cameron and Frank Ransome.

Technical and Motoring Papers.—Six or seven Canadian journals that appeal to road makers or to users of roads, especially motorists, had interesting exhibits arranged.

Ideal Incinerator & Contracting Company.—Splendid model of incinerator was exhibited by Mr. de Sherbinin.

Baines & Peckover.—W. M. David and Frank Evans exhibited roadway reinforcing and contractors' supplies.

Alfred Rogers.—Attractive booth arranged to exhibit Saugeen, Hanover and Pyramid brands of cement. In charge of J. Lavelle, J. Wright and John Kelly.

Canadian Crushed Stone Company.—Mr. Watson was in charge of exhibit of various grades of crushed limestone.

Canadian Fairbanks-Morse Company. — Literature was distributed and views shown of full line of road machinery. No exhibit was made of the machinery, but W. F. Brownrigg offered to give a shrapnel shell to every delegate who would go to the factory with him to inspect the road machinery on exhibit there.

Ontario Trap Rock Company.—Exhibit of trap rock shown by J. W. M. Cousins.

Lecky & Collis.—W. S. Lecky exhibited models of cube concrete mixers and of the road machinery built by the American Road Machine Company and the hoisting engines built by the Doty Engine Works.

Fibred Asphalt Paving Company.—Samples of fibred asphalt were shown by Mr. Stevenson.

Trussed Concrete Steel Company.—H. J. Stambaugh and F. E. Aytoun showed Kahn reinforcing for roads, and also curb bars and concrete road joints.

Canadian Equipment Company.—Photographs of Bucyrus revolving shovels and of the general line of road machinery built by the Western Wheeled Scraper Company were shown by John G. Beck.

Dunn Wire-Cut-Lug Brick Company.—Carnations were distributed freely from this booth by Frank Goodman, the Canadian representative, and F. Townsend, the engineer of the company. Samples of brick and views of brick streets were shown.

Canadian Ingot Iron & Culvert Company.—Corrugated iron culverts built of Armco ingot iron were exhibited by James Moore and Fred Brearley.

Rocmac Roads, Limited.—Numerous views of Rocmac roads were shown by M. J. Allen, John Sears and several of the engineers who are connected with the United States branches of the company.

Asphalt and Supply Company.—An interesting exhibit of sections of various kinds of bituminous pavements and mastic. Samples of different grades of road oils and asphalts were shown, as well as views of streets and roads, and also a flapper machine for spraying "Fluxphalte" road dressing. W. A. Morris and A. d'Estiambre were in charge.

Ontario Asphalt Block Co.—An elaborately arranged exhibit in miniature of an ideally laid out asphalt block street, with grass plots, concrete sidewalk, lighting posts and other features complete. In charge of J. F. Reid and H. E. Warden.

Philip Carey Co.—Model strips of wood block, concrete and brick pavements shown, illustrating the use of Elastite paving joint. Robt. Purves in charge.

Creosoted Block Paving Co.—Large models of creosoted wood block laid on creosoted plank as bridge flooring, and of creosoted block with pitch filler on concrete foundation for street paving. Lug block and views of pavements were also shown by J. L. Boyd.

Imperial Oil Co.—Samples of various grades of Standard Mexican road oils and asphalts distributed by G. G. Underhill and W. B. Irwin. Numerous views of roads and streets were shown, and a particularly fine view of the large works at Sarnia, Ont.

Canada Cement Co.—Views of concrete roads were shown. A feature that attracted considerable attention was a beautiful rustic fence which was made of concrete. Information regarding cement was given by J. F. Rhodes, C. C. Lapierre, W. A. Toohey, F. A. Robertson, C. P. Botsford and Leo Charpentier.

Canadian Clay Products Bureau.—Benjamin Brooks, engineer of the International Clay Products Bureau, gave information regarding vitrified clay pipe for culverts. An elaborate culvert constructed of clay pipe and brick was exhibited in the booth.

Paterson Manufacturing Co.—B. E. Smith and J. B. Duntley showed views of streets and roads built with Tarvia, and showed samples of Tarvia A, Tarvia B and Tarvia X.

Province of Ontario.—Interesting models of different kinds of roads were exhibited, showing sections of the roadways and the various steps in construction of same.

Wettlaufer Bros.—An extended line of contractors' machinery was on exhibit, including rock crushers, tile machines, hoists, concrete mixers, etc. Special interest was aroused by the new combination road roller and paver. W. E. and John L. Wettlaufer were in charge.

J. I. Case Threshing Machine Co.—A. H. Alfsen, the newly appointed manager for Canada, demonstrated a crushing and screening outfit, a road roller and a grader.

Sawyer-Massey Company.—One of the most complete exhibits, and that which occupied the most space. There were shown wheel scrapers, dump wagon, road roller, crushing and screening plant, portable gasoline engine, stone and gravel spreader wagon, drag scrapers, combination tank wagon and sprinkler, plows, portable boiler, graders, etc. M. J. Allen and A. J. Mumford were in charge.

Petrolgas Safety Burners.—Exhibit of safety burners by H. D. Sutherland.

Albion Motor Car Company.—There was exhibited a motor road roller made by Barford & Perkins, of Peterborough, England.

McLaughlin-Buick Company.—A convenient type of automobile for engineers and contractors was shown.

SURVEYS ACT AMENDMENT.

A bill, introduced by Mr. G. Howard Ferguson, M.P.P., is now before the Ontario Legislature to amend the Surveys Act by adding a clause relating to the marking of angles on lots or on laying out new streets, to the calculation of bearings on plans of subdivisions and to the materials of which monuments should consist. The section which Mr. Ferguson proposes is to be known as Section 47, and is as follows:—

Every angle in the exterior boundary of a subdivision plan of an original lot or part of an original lot or of any subdivision plan laying out a new street shall be marked by monuments, and all bearings on every such plan shall be calculated from one course in the said boundary to be designated on the plan as the governing line, and the course of the said governing line shall be determined by astronomical observation or other satisfactory method, such monuments to be composed of,

(a) Stone or reinforced concrete, 4 inches square at the top, 8 inches square at the base, and 4 feet 6 inches in length; or

(b) Iron bar 1 inch square and 5 feet long.

PERSONAL.

R. B. HAMILTON, formerly of Winnipeg, has been appointed superintendent of the Municipal Electric Railway of Saskatoon, Sask.

B. W. WAUGH, B.A.Sc., has just returned to Ottawa after completing a base line survey at Port Nelson, Hudson Bay, for the Dominion Department of the Interior.

C. J. PHOENIX, formerly of the sales department staff of the Steel Company of Canada, at Hamilton, has accepted a position with the Algoma Steel Corporation at Sault Ste. Marie.

C. H. TAYLOR gave a talk on Tuesday last at a meeting of the Toronto Branch of the University of Toronto Engineering Alumni Association, his subject being the hydraulic air compressor, of which he is the inventor.

ALLAN PURVIS, formerly in charge of the Vancouver division of the Canadian Pacific Railway, succeeds Mr. Robert King as superintendent of its London division. Mr. King, it is reported, will be assigned to the superintendency of the company's Montreal division. He was formerly superintendent at Woodstock, N.B.

C. J. SMITH, for a number of years general traffic manager of the old Canada Atlantic Railway, and general manager for ten years of the Richelieu and Ontario Navigation Co., has been appointed manager and secretary of the Montreal Warehousing Co., a subsidiary corporation of the Grand Trunk Railway System.

T. T. BLACK, engineer in charge for Messrs. Quinlan and Robertson, contractors for the Don section of the Bloor St. viaduct, gave an interesting talk relative to its construction at a well-attended luncheon of the Toronto Branch of the Canadian Society of Civil Engineers on March 25th. Mr. J. R. W. Ambrose presided.

H. A. BAYFIELD, former superintendent of Government dredges in British Columbia, has been appointed by the Dominion Government to the position of principal assistant engineer at Fort Nelson, terminus of the Hudson Bay Railway. Mr. Bayfield is a graduate of McGill University. He has been identified with the Intercolonial and Great Northern Railways, and for some time was mechanical superintendent of the Montreal harbor works. He is a member of the Canadian Society of Civil Engineers, the Institute of Mechanical Engineers of Great Britain, and the American Society of Mechanical Engineers.

OBITUARY.

The death occurred last week in Toronto of R. Shelwood Elmsley. He had been engaged in engineering work in Canada since 1894 and was a member of the Canadian Society of Civil Engineers. He was a graduate of the Royal Engineering College, England.

Following closely upon the announcement last week of the death of Norman Lawless, a young Canadian engineer in service at the front, the sad report has been received of the death of Lieut. F. C. Andrews, who was killed in action in northern France on the 16th inst. Mr. Andrews was also a University of Toronto man, having taken a course in mining engineering. Prior to his departure for the front, he was in the employ of the Canadian Copper Co., at Copper Cliff, Ont.

ENGINEERS' CLUB, HAMILTON.

At a meeting last week to establish an architects' and engineers' club in the city of Hamilton, the following officers were elected: Mr. E. P. Coleman, pres.; Walter Stewart, 1st vice-pres.; J. J. McKay, 2nd vice-pres.; E. Frank Kelly, sec.-treas., and Lawrence Munro, president of the Ontario Architects' Association, Hamilton Chapter, director. It is expected that club rooms will be built next winter. A large number of technically trained engineers are resident in the city, and it is felt that the club will fill a long-felt need.

OTTAWA BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

At a luncheon on March 4th, H. A. Powell, Esq., K.C., of St. John, N.B., delivered an address on "Railroad Construction and the Public" to the members of the Ottawa Branch. Mr. Powell is in close touch with engineering matters in Canada, being a member of the International Joint Commission of Canada and the United States.

At an evening meeting on March 18th, Mr. Joseph Race, city bacteriologist, gave an illustrated paper on slow sand filtration of water supply. The meeting was largely attended and an interesting discussion followed the presentation.

SASKATOON ENGINEERS.

A meeting of engineering students was held a few weeks ago in Saskatoon for the formation of an engineering society in connection with the faculty of engineering at the university. The officers of the society are: Hon. president, G. J. McKenzie, C.E.; hon. vice-president, John P. Oliver, B.A.Sc.; president, F. T. McPherson; vice-president, H. S. Smith; secretary-treasurer, James Murray; other members of the executive are R. J. Haney, A. E. Stewart, and Spencer Ball.

At the meeting it was also decided to apply for affiliation with the Canadian Society of Civil Engineers.

COMING MEETINGS.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—Annual meeting to be held at the Iowa State College, Ames, Iowa, June 22nd to 25th, 1915. Secretary, F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—Second Annual Convention, Toronto, March 22 to 26, 1915. Secretary, Geo. A. McNamee, Dominion Good Roads Association, Montreal.

TORONTO ELECTRICAL SHOW.—The second annual exhibition, to be held in the Arena, Toronto, April 12th to 17th. Secretary, Mr. E. M. Wilcox, 62 Temperance Street, Toronto.

AMERICAN WATERWORKS ASSOCIATION.—The 35th annual convention, to be held in Cincinnati, Ohio, May 10th to 14th, 1915. Secretary, J. M. Diven, 47 State Street, Troy, N.Y.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

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

23319—February 20—Approving plan "A," showing character of work of Smith Patterson Drain under tracks of M.C.RR., St. Clair Div. (bridge 38.26), Tp. Brooke, Co. Lambton, Ontario.

23320—February 22—Approving location Edmonton, Dunvegan and B.C. Ry., through Tp. 78, Rgs. 6 and 10, W. 6 M., Alta., mileage 359.416 to 385.00.

23321—February 22—Approving location Edmonton, Dunvegan and B.C. Ry., through Tps. 78 and 79, Rgs. 10 and 13, W. 6 M., Alta., mileage 385.00 to mileage 410.45.

23322—February 20—Rescinding Orders No. 16181, dated March 26th, 1912, and No. 17763, dated October 16th, 1912, in so far as they authorize railway to be constructed across Iberville and De Fleurimont Sts., city of Montreal; and authorizing Lachine, Jacques-Cartier and Maisonneuve Ry. (Applicant Company) to cross Iberville St. by means of bridge 50′ in width, carrying highway in straight line over Ry.; bridge be so constructed as to serve De Fleurimont St. as well. Refusing application to divert Comte St.; Order No. 16181 be amended to provide for construction of bridge, 40′ wide, for vehicular and pedestrian traffic only, over Comte St. Rescinding Order No. 16181, in so far as it authorizes level crossing at Poupart St., with leave to Applicant Co., to divert Poupart St. along east side of right of way into Comte St., or, at its option, to construct bridge carrying said street over railway.

23323—February 22—Approving resolution passed by G.N. Express Co., at meeting held in St. Paul, Minn., on Feb. 10th, 1915, authorizing Ronald Stewart, Vice-Pres. and Gen'l Mgr., of Co., to prepare, make, and publish rates, charges, tariffs and schedules for transportation of property by Co., over its lines in Canada.

23324—February 22—Dismissing application of C.P.R. for authority to remove regular agent at Lavant Station, Ontario, and to appoint a caretaker in his place.

23325—February 22—Granting leave to C.N.R., pending further Order, to discontinue services of its agents at Lavoy, Alta.; Devlin Station, Ont.; Homewood, Man.; Ridpath, Sask.; Brunkild Sta., Man.; Rosebank, Man.; Underhill, Man.; St. Gregor, Sask., Neelin, Man.; and Warren, Man.; subject to condition that caretaker be appointed at each to see they are kept clean and heated for accommodation of passengers on arrival and departure of trains, and care for L.C.L. freight and express matter.

23326—February 22—Dismissing applications of C.N.R. to remove agents at Mafeking; St. Laurent; Cardale Sta.; Decker Sta.; Woodnorth Sta.; and Fairfax Sta., Manitoba; Mikado Sta.; D'Arcy; Norquay St.; Beadle; Weldon; Waseca Sta.; Pinkham; Willmar; and Brooking Sta., Saskatchewan; Minburn Station, Alberta; and Sleeman Station, Ontario.

23327—February 22—Granting leave, pending further Order, to C.P.R., to discontinue services of agents at Purple Springs, Alta.; Beverly Station, Sask.; and Tilley Station, Alta.; subject to condition that caretaker be appointed at each.

23328—February 22—Relieving G.T.P. Branch Lines Co. from erecting and maintaining fences along certain portions of Regina Boundary Branch, mileage 0 to 155, Sask.

23329—February 22—Approving revised location of C.P.R. Weyburn-Stirling Branch from mileage 316.63 to 358.31, being from point in Sec. 25-3-1, W. 4 M., to point in Sec. 12-6-7, W. 4 M., Alta.

23330—February 22—Rescinding Order No. 15911, dated Feb. 5th, 1912; and authorizing C.P.R. to construct road diversion in N.E. ¼ Sec. 13-18-17, W. 3 M., Sask.; and construct, by means of a grade crossing, its Swift Current North Westerly Branch Line across said diversion, at mileage 21.03.

23331—February 22—Granting leave, pending further Order, to C.P.R., to discontinue services of agents at Appin Sta., Ont.; Brechin Sta., Ont.; and Bethany Sta., Ont.; subject to condition that caretaker be appointed at each station; authority herein granted as to Bethany Station be subject to condition that Bethany Jct., be made a billing point.

23332—February 23—Directing that C.P.R. and Western Canada Power Co., jointly publish and file supplements to C.P.R. Co.'s Special Joint Tariffs, C.R.C. Nos. W-1615 and 1806; also C.R.C. Nos. W-1790, 1812, and 2000, being respectively, Transcontinental Freight Bureau's Nos. S.R. 1019, 17-A, and 18-B, providing joint rates from Stoltze Manufacturing Co.'s mill to destinations shown in said tariffs, via Ruskin, B.C., which shall not exceed rates from Ruskin to same destinations by more than 2c. per 100 lbs.; Western Canada Power Co., to receive 3c. per 100 lbs., as its proportion of joint rates so made. Rescinding Order No. 23213, dated January 26th, 1915, made herein.

23333—February 23—Authorizing C.P.R. to construct extension to spur for British Sand & Gravel Co., on Lots 138 and 139, Con. St. Martin, Parish of St. Felix de Valois, Co. Joliette, Que.

23334—February 24—Approving proposed location C.N. Alta. Ry. Co.'s Combined Station and Section House at Bliss, Alberta.

23335—February 23—Approving proposed location C.N.R. Standard Freight and Passenger Shelter at Anerley, Saskatchewan.

23336—February 24—Approving proposed location C.N. Alta. Ry. Co.'s Combined Station and Section House at Bedson, Alberta.

23337—February 24—Approving proposed location C.N. Alta. Ry. Co.'s Combined Station and Section House at Darwall, Alta.

23338—February 23—Approving location C.N. Alta. Ry. Co.'s Combined Station and Section House at Obed, Alta.

23339—February 23—Approving location C.N. Alta. Ry. Co.'s Combined Station and Section House at Mount Geikie, Alta.

23340—February 23—Approving location Can. Nor. Alta. Ry. Co.'s Combined Station and Section House at Scrivan, Alberta.

23341, 23342, 23343, 23344, 23345—February 23—Granting leave, until further Order, to C.P.R., to remove agents at following stations:—Jeanette Station, Ont.; Chelsea, Que.; West Montrose Station, Ont.; McAlpin, Ont.; and Grasshill Station, Ont., subject to condition that caretakers be appointed to see that stations are kept clean and heated for accommodation of passengers on arrival and departure of trains, and care for L.C.L. freight and express matter.

23346—February 22—Granting leave, pending further Order, to C.N.R., to discontinue services of its agents at,—Beaver, Man.; Hawick Station, Alta.; Berton, Man.; Ladysmith, Man.; Chandler, Sask.; and Banning Station, Ont., subject to and upon condition that stations be kept clean and heated for accommodation of passengers.

23347—February 24—Authorizing Rural Municipality of Swift Current No. 137, at its own expense, to construct highway over C.P.R. on centre line running through Sec. 9-15-15, W. 3 M., Sask. After construction, Municipality consenting, Rly Co., may close portion of original road allowance north of N.E. ¼ Sec. 9-15-15, W. 3 M., within limits of its right-of-way.

23348—February 24—Approving location C.P.R. station at Govenlock, Sask., in N.W. ¼ of Sec. 23-3-29, W. 3 M., mileage 307.5, on Weyburn-Stirling Branch Line; station to be in accordance with C.P.R. Standard Structural Plan A2.

23349—February 24—Approving proposed location Can. Nor. Alta. Ry. Co.'s Combined Station and Section House at Brule, Alberta.

23350—February 24—Approving proposed location Can. Nor. Alta. Ry. Co.'s combined Station and Section House at Henry House, Alta.

23351—February 23—Approving agreement entered into between Bell Telephone Co. of Canada and Sunderland Telephone Co., Limited, dated February 8th, 1915.