PAGES

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two feet wide, and walks on each side twelve or thirteen feet in width. This is the plan of Yonge Street, Toronto, and is generally followed throughout the province; but a roadway thirty feet wide would be ample for many municipalities.

For residential streets—or any street not in the business section—a design which meets with a great deal of favor consists of a roadway 24 feet wide, bordered on each side by a 6-inch concrete curb. Between the curb and the walk is a strip of sod about 6 feet wide; then the sidewalk 5 feet wide; then the remainder of the allowance (9 ft. 6 ins. on a 66-ft. street) is sodded and in appearance added to the depth of the lawns. When streets have been graded and boulevarded in this way, the usual effect is to cause the owners of private property to remove fences, improve their lawns, plant flowers, and make free use of paint. Many residence streets in towns and cities are only 18 or 20 feet from curb to curb and traffic is not inconvenienced. With a narrow roadway the cost of construction is less, maintenance is less, and the appearance of a street is improved by the sodded boulevards.

Selection of Pavements.

There is no "best" material or pavement uniformly adapted to all conditions. The best pavement or road is one which is best suited to the traffic to which it is subjected; which is best laid; and which is chosen with a view to local conditions. A granite block pavement on concrete foundation is the acme of strength and durability, but is utter extravagance on the side street of a village, where a cheap macadam or gravel would suit every need; the best of pavements can be spoiled by using poor materials and inferior workmanship; and stone-concrete, using material brought in by rail, would rarely be considered good judgment if a gravel-concrete pavement, using good local material, could be laid for half the cost. The best pavement is one which gives satisfactory service at least cost—the cost not being first cost alone, but cost after a term of years.

The general treatment of a street and the type of pavement to be laid on it, should depend on varying requirements and conditions, such as,—

(a) The size and wealth of the town or city.

(b) The amount and class of traffic on the street.

(c) The class of street, whether business, residential, etc.

(d) Local materials available for road construction.

Influence of Size and Wealth.

Large cities have greater scope for choice in the matter of pavements than have smaller cities and towns. Wealth is concentrated in large cities, property values are high, and the cost of a pavement is a minor consideration as compared with service. Also, where the amount of paving is great, it is possible to install extensive plants for laying and maintaining certain kinds of pavements, which are impossible in smaller communities. Thus, the use of granite block pavements on heavy concrete foundations is largely confined to wholesale districts or heavily travelled thoroughfares of large cities—subject to the traffic of heavily loaded drays and trucks, and where a quiet pavement is not imperative. In the same way, the extensive plant required to construct and maintain sheet asphalt confines the use of that material to the larger cities.

Traffic.

The amount and class of traffic on a street is an important factor in the selection of a pavement. While roads and pavements disintegrate to some extent by mere exposure to weather, yet the chief cause of destruction is wear under traffic. Many country roads, particularly the main arteries radiating from important towns and cities, carry much more traffic than some city streets. The number of vehicles passing certain points in large cities is very great; thus a 12-hour census of traffic showed over 3,400 vehicles per hour passing Hyde Park Corner in London, England. At the other extreme, some side streets of cities do not carry a dozen vehicles per day, and these only private carriages or delivery wagons. The main county roads adjacent to Toronto have shown a traffic of from 500 to 800 vehicles in ten hours. A traffic of from 100 to 200 vehicles per day is more common adjacent to the smaller cities. To the latter traffic main streets of most villages and towns in Ontario may safely be adjusted.

The growing use of heavy motor trucks is creating a new situation with respect to traffic. The frequent passing of light vehicles causes surface wear; but heavy vehicles shatter the road foundations, particularly when used in the spring when snow is melting and frost is leaving the ground; or in the autumn when the soil is softened after continuous rain. Heavy motor vehicles or heavy vehicles of any kind create a greater need for deep foundations to distribute the wheel load over a greater area of sub-soil.

Class of Street.

Town and city streets may be divided into several well-defined classes:—

(1) Streets of the business section, on which front stores and offices.

(2) Main thoroughfares carrying traffic in and out of the town or to the railway stations, and on which traffic converges.

(3) Important residential streets, not main thoroughfares.

(4) Residential or "side" streets of secondary importance.

The class of street affects the choice and design of a pavement. In a business section, sidewalks are laid to the street line, and the pavement should ordinarily be laid from walk to walk. A pavement is needed which standing horses cannot tear up, and which can be kept clean and free from dust. On a purely residential street, the roadway may be narrowed, the sidewalks may be narrow, sod and trees and a quiet pavement are desirable. On a main thoroughfare, carrying traffic to a station or leading to the country, a wider roadway is needed, and one resistant to wear. Some pavements, such as those of granite block or paving brick, are noisy, and are objectionable on residential streets. Some, such as bituminous surfaces, or concrete, are more easily kept clean than others, and are therefore suitable for retail business blocks; while a limestone macadam, unless oiled, is essentially dusty.

Local Materials.

Local materials should be used as far as practicable to avoid heavy freight charges, and extra cost of handling from the railway cars. Trap rock is a hard, tough stone for road surfaces, and limestone is soft, susceptible to wear. But it will generally be more economical to use a local limestone, and treat it with oil, rather than to import the more durable trap rock by rail. In this the amount of traffic is a factor, and under conditions of heavy traffic, trap rock may be the cheaper in a term of years. Local deposits of gravel may be used in various ways, commencing with the gravel roadway for light traffic, and—if the gravel is suitable—for heavier traffic, oiling it, treating it with asphalt or tar, or using it in the construction of a concrete pavement. The type of surface can be adapted in many ways, to the local materials available.

Materials Used in Pavements.

The materials used in roads and pavements are comparatively few. In their many combinations and adaptations lies the art of roadmaking.

Commencing with the preparation of the earth foundation by drainage and grading, other materials more commonly involved are gravel, sand, stone, clay and shale, wood, asphalt and tar; asphaltic petroleum and creosote oils; also a few chemicals of more occasional use. The principal element of cost in roadmaking and paving is labor. The materials employed, in their original state and location, are of comparatively little value. The cost of pavements is principally dependent on the labor market, and skill in using labor.

The types of roadways and pavements more commonly used in Ontario are as follows:—

Village Streets.

Residential or Side Streets.—Earth, gravel, broken stone.

Business Section.—Broken stone, oiled or with bituminous penetration; concrete.

Through or Main Street.—Gravel; broken stone; broken stone, oiled or with bituminous penetration; broken stone with Telford foundation; concrete.

Town Streets.

Residential Streets.—Earth; gravel; broken stone; broken stone, oiled or with bituminous penetration.

Business Section.—Broken stone, on substantial foundation, oiled or with bituminous penetration or bituminous mixed surface; concrete; vitrified brick on concrete foundation; bituminous surface on concrete foundation; wood block on concrete.

Through or Main Streets.—Broken stone, oiled or bituminous penetration, and with or without Telford or rubble foundation; concrete.

City Streets.

Residential Streets.—Gravel; broken stone, with or without bituminous treatment; concrete; sheet asphalt; or other bituminous surface on concrete foundation; wood block on concrete foundation.

Retail Business or Office Section.—Sheet asphalt or other bituminous surface on concrete foundation; wood block on concrete foundation; vitrified brick on concrete foundation; asphalt block on concrete foundation.

Wholesale Business Section.—Sheet asphalt; wood block or granite setts on heavy concrete foundation.

Street Railway Allowances.—Broken stone; wood block; vitrified brick or granite setts on heavy concrete foundations; concrete.

Street Intersections.

A development in street improvement resulting from automobile traffic is the demand for curves of larger radius at the corner of street intersections. Past practice resulted in a corner that was nearly square, or had a curve varying from 4 to 10 feet radius. This means that the vehicle could not turn into an intersecting street until it had passed the corner. The driver of a car must either shift gear and slow down to a suitable speed for the turn, or else he may take the turn with an abruptness that is a menace to other vehicles as well as pedestrians. A further alternative practiced by many drivers is to swing widely at the turns, a practice which carries them to the wrong side of the roadway and risks accident.

Toronto, Ottawa, Windsor, Stratford, Chatham, and other cities in Ontario are widening and rounding many of their street intersections. The increasing radius of the curves enables an automobile to follow a course parallel to the curb and keep on the right side of the roadway, with greater convenience and safety.

Permanent Grades.

Permanent grades for all streets are one of the important needs of all villages, towns and cities in planning for immediate and future development. The fixing of such grades means that the sidewalks when laid will conform to the ultimate elevation of the roadway or vice-versâ; and that foundations of residences or other structures fronting on the street will be carried to a height to suit the elevation of walks and roadways.

The lack of permanent grades is seen in nearly all towns and villages of the province. Sidewalks have been laid to suit the surface of the ground on one side of the street, and the necessities of the other side of the street have not been considered. When the time comes to improve the roadway, it is found that its necessary grade is not the same as either of the walks. The result is a lack of uniformity that is very unsatisfactory in appearance, with increased difficulties of drainage. The entrance to some houses or stores is too high above the walk; others are below the walk, with drainage from the walk turned into them. Actions for damages are threatened by property owners.

Remedy is always more or less expensive, difficult or impossible. Prevention is the only satisfactory means. To this end, an engineer should be employed to prepare a plan of permanent grades to which all future street improvement and construction of houses on the street, should thereafter conform. Fixed grades are one of the important factors in a scheme of town planning, which make for future economy and satisfactory results.

Drainage.

Good drainage is a first principle of roadmaking or street construction. This is particularly true in a climate such as that of Canada, where the action of frost is severe. A clear understanding of drainage and its influence on pavements is essential to a skilful handling of the work.

On country highways, open drains at the side of the road are usual for carrying away surface or storm drainage. In many cases it is desirable to supplement open drains with tile under-drains to carry away sub-soil water, or to "lower the water line." Under-drains have a marked effect in keeping the sub-soil of the road free from water, which is particularly necessary in the spring or other wet periods of the year.

Paving can scarcely be considered apart from sewers. Before laying permanent pavements, the probable sewerage requirements of each town, village or city should be carefully considered. To pave streets, then to tear them up to lay sewers, or other under-ground services, is wasteful and short-sighted in the extreme. The town with a good system of sewers has taken the preliminary step toward modern street improvement. If circumstances are such that sanitary sewers will not be required within the life of the roadway or pavement, a village may reasonably install a system of under-drains for storm-water only, usually a vitrified tile drain, of suitable capacity, laid at the edge of the roadway on each side of the street.

The following tables give reference data regarding the types of pavements laid in some of the leading Ontario towns and cities, the areas laid in 1915 and up to the end of 1915, costs per square yard, etc. :—

Table Showing Extent of Paving in the Cities and Towns in Ontario.

Name of City or Town.	Class of Paving.	Class of Street.	Year first laid.	Total Mileage laid to end of 1915.	Total Square Yards laid to end of 1915.	Total Mileage laid in 1915.	Total Square Yards laid in 1915.	Total Cost per Square Yard prior to 1915.	Foundation. Thickness and Kind.	Foundation. Cost per Square Yard, 1915	Surface. Thickness including binder.	Surface. Cost per Square Yard, 1915
Fort William**	Asphaltic Concrete	Business and Residential	1914	2.16	57,798			$2.60	6 in. Concrete		3 inches	
"	Tar Coated Macadam	Residential	1911	5.26	56,117	0.77	9,730	1.32	8 in. Rubble	$0.56	3½ "	$0.65
"	Asphalt Block	Business	1906	1.67	47,383			3.98	8 in. Concrete		4 "	
"	Rocmac	Residential	1911	1.48	24,523			1.55	8 in. Rubble		3 "	
"	Sheet Asphalt	Business	1911	0.59	14,613			3.26	8 in. Concrete		3 "	
"	Bitulithic	Business	1911	0.24	7,466			3.35	8 in. "		2 inches	
"	Tar Filled Macadam	Residential	1913	0.07	724			2.00			3 "	
		Total		11.47	208,624	0.77	9,730					
Windsor	Concrete	Residential	1907	28.74	346,843	1.35	18,986	1.15			7 inches	1.35
"	Asphalt Block	Business and Residential	1903	3.70	113,187	0.13	2,480	2.70	6 in. Concrete	0.70	4 "	1.79
"	Cedar Block	On heavy grades from Wharf	1906	0.53	8,040	0.03	501	1.90	6 in. "	0.70	5 "	1.65
		Total		32.97	468,070	1.51	21,967					
Peterborough	Asphaltic Concrete	Business and Residential	1913	4.21	78,383	1.86	33,920	2.06	5 in. Concrete	0.64	2½ inches	1.30
"	Bitulithic	Business	1914	0.34	2,494			2.24	5 in. "		2¾ "	
"	Concrete	Residential	1912	0.07	975			0.98			6 "	
		Total		4.62	81,852	1.86	33,920					
Kingston*	Asphalt Block	Business and Residential	1911	1.53	25,458			2.75	4 in. Concrete		4 inches	
"	Bituminous Concrete	Residential	1911	1.25	17,800	0.36	3,740	{ 0.90	5 in. Macadam 4 in. Concrete	.... } 0.60 }	3 "	0.72
"	Asphaltic Concrete	Business	1914	0.55	14,200			2.35	6 in. "		3 "	
		Total		3.33	57,458	0.36	3,740					
Kitchener	Tar Filled Macadam	Residential	1910	6.42	85,691	1.70	22,445	{ 1.14 { 1.36	5 in. Macadam 5 in. Concrete	0.55 } 0.80 }	3 inches	0.48
"	Bitulithic	Business and Residential	1910	3.02	60,459			2.41	5 in. "		2½ "	
"	Wood Block	Business	1914	0.44	10,740			3.10	6 in. "		4 "	
"	Concrete	Business	1915	0.20	2,868	0.20	2,868				7 "	1.60
		Total		10.08	159,758	1.90	25,313					
Stratford	Tar Filled Macadam	Residential	1909	4.42	53,151	1.45	18,715	$1.35	5 in. Concrete	$0.70	3 inches	$0.47
"	Westrumite	"	1909	3.56	40,634			2.00	5 in. "		2 "	
"	Asphalt Block	Business	1906	1.05	30,954				6 in. "		4 "	
"	Brick	"	1906	2.12	30,287			2.45	5 in. "		4 "	
"	Concrete	Residential	1914	0.50	6,404			1.30			7 "	
		Total		11.65	161,430	1.45	18,715					
Chatham*	Bitulithic	Business and Residential	1903	5.61	79,708			2.45	5 in. Concrete		2½ inches	
"	Brick	Business and Residential	1903	3.68	56,261			2.50	5 in. "		4 "	
"	Asphalt Block	Business	1903	2.29	37,142			2.60	5 in. "		4 "	
"	Concrete	Residential	1908	2.14	28,185	0.64	8,058	1.20			7 "	1.12
		Total		13.72	201,296	0.64	8,058					
Belleville†	Asphaltic Concrete	Business	1914	0.70	17,660			2.38	5 in. Concrete		3 inches	
"	Rocmac	Residential	1915	0.39	7,233	0.39	7,233		5 in. Macadam	$0.30	4 "	0.70
"	Tar Filled Macadam	Residential	1915	0.17	2,222	0.17	2,222		5 in. "	0.40	3 "	0.60
		Total		1.26	27,115	0.56	9,455					
Sault Ste. Marie‡	Asphaltic Concrete	Business	1913	2.18	38,365			2.27	5 in. Concrete		3 inches	
" "	Concrete	Business and Residential	1914	0.70	14,218	0.62	12,845	1.37			7 "	1.37
" "	Bitulithic	Residential	191[illegible]	0.54	10,766	0.21	4,970	2.40	5 in. "	0.90	2 "	1.50
" "	Brick	"	1912	0.45	9,748	0.09	1,800	2.89	6 in. "	1.10	4 "	2.08
" "	Asphalt Surface, on concrete base	"	1915	0.04	766	0.04	766		7 in. "	1.37	¼ "	0.22
		Total		3.91	73,863	0.96	20,381					

Cost includes grading. ***Kingston. In 1915, 5,000 sq. yds. water bound macadam built, oil treated. ***Chatham.** 2,212 sq. yds. concrete on lanes in 1915. †23,000 sq. yds. oil bound macadam built in 1915 besides above-mentioned paving. ‡Minimum width of 1915 pavements, 30 ft. between curbs. One concrete pavement received a surface treatment of hot bituminous material and trap rock screenings.

Name of City or Town.	Class of Paving.	Class of Street.	Year first laid.	Total Mileage laid to end of 1915.	Total Square Yards laid to end of 1915.	Total Mileage laid in 1915.	Total Square Yards laid in 1915.	Total Cost per Square Yard prior to 1915.	Foundation. Thickness and Kind.	Foundation. Cost per Square Yard, 1915	Surface. Thickness including binder.	Surface. Cost per Square Yard, 1915
Niagara Falls	Brick	Business	1904	1.32	24,531	0.18	4,096		6 in. Concrete	$0.83	4 inches	$1.77
“	Concrete	Residential	1911	0.53	9,629	0.22	3,109	$1.47			7 “	1.38
“	Westrumite	Residential	1909	0.35	6,680				5 in. “		2 “	
		Total		2.20	40,840	0.40	7,205					
Sarnia*	Asphalt Block	Business and Residential	1905	2.75	50,900			2.30	5 in. Concrete		4 inches	
“	Brick	Business	1904	0.27	27,080			2.19	6 in. “		4 “	
“	Concrete	Main Artery to the city	1913	1.12	10,571			1.09			7 “	
“	Wood Block	Business	1909	0.33	7,800			2.47	6 in. “		4 “	
		Total		4.47	96,351							
Galt	Tar Filled Macadam	Residential	1911	1.24	18,417			2.05	6 in. Macadam		3 inches	
“	Bitulithic	Semi-Business	1914	0.20	3,780			2.21	8 in. “		2½ “	
		Total		1.44	22,197							
Woodstock†	Tar Filled Macadam	Residential	1907	0.77	14,200			0.55	3 in. Macadam		3 inches	
“	Brick	Business	1903	0.40	11,283			2.00	6 in. “		4 “	
		Total		1.77	25,483							
Port Arthur	Bitulithic	Residential	1910	1.12	31,367			$2.75	5 in. Concrete		2 inches	
“	Sheet Asphalt	Business	1910	1.41	30,956			2.37	5 in. “		3 “	
“	Rocmac	Residential	1910	2.44	30,000			1.25	5 in. Macadam		3 “	
“	Asphalt Block	Business	1908	1.15	29,542			3.00	5 in. Concrete		4 “	
“	Asphaltic Concrete	Residential	1912	0.60	15,530			2.40	5 in. “		2 “	
		Total		6.72	137,395							
St. Catharines*	Bitulithic	Residential	1913	6.06	96,000	0.84	11,800	2.33	5 in. Concrete		2½ inches	$2.29
“	Asphalitc Concrete	Semi-Business and Residential	1913	2.84	42,000			2.20	5 in. “		2 “	
“	Asphalt Block	Semi-Business and Residential	1906	2.37	37,600			2.42	5 in. “		4 “	
“	Brick	Industrial	1906	1.10	26,410	0.07	892	2.48	5 in. “		4 “	2.35
“	Rocmac	Main Arteries to the city	1913	2.20	14,227	0.44	5,220	1.60	5 in. Rubble		3 “	1.25
“	Westrumite	Residential	1913	0.34	4,800			2.00	5 in. Concrete		2 “	
“	Wood Block	Bridge Floor	1915	0.27	4,643	0.27	4,643		6½ in. “		3 “	3.33
		Total		15.18	225,680	1.62	22,555					
St. Thomas	Brick	Business	1898	2.75	52,300			1.90	5 in. Macadam		4 inches	
“	Westrumite	Residential	1911	1.45	24,640			1.96	5 in. Concrete		2 “	
“	Concrete	“	1913	1.00	18,187	0.17	2,600	1.30			7 “	1.35
“	Tar Filled Macadam	“	1913	0.80	11,880			1.20	5 in. Macadam		3 “	
		Total		6.00	107,007	0.17	2,600					
Toronto	Sheet Asphalt	Business and Residential	1888	217.71	3,373,148	16.28	300,876	...... $2.25	5 in. Concrete 6 in. “ 8 in. “	$0.82 0.98 1.30	3 inches	$1.20
“	Bitulithic	Residential	1903	49.63	728,949	4.06	67,014	2.70	6 in. “	0.98	2 “	1.60
“	Brick	Business and Residential	1893	31.56	580,526	2.06	45,319	3.40	6 in. “	0.98	4 “	2.05
“	Asphaltic Concrete	Residential	1912	8.40	136,738	0.54	7,856	2.60	6 in. “	0.98	3 “	1.36
“	Asphalt Block	Business	1903	6.28	92,767			3.45	6 in. “		3 “	
“	Stone Block	Business	1884	1.56	84,053							
“	Rocmac	Residential	1912	4.56	60,162	1.59	19,621	1.90	8 in. Rubble	0.70	3 “	1.00
“	Tar Filled Macadam	Residential	1913	3.09	50,000						3 “	
“	Concrete	Residential	1905	6.03	46,000	2.47	22,000				6 “	1.54
“	Cedar Block	Business	1881	2.90	40,000							
“	Wood Block	Business	1907	1.05	20,000	0.05	5,543		8 in. Concrete	1.30	4 “	3.30
“	Dolarway	Residential	1913	0.69	8,658			1.65	6 in. “		⅛ “	
		Total		333.46	5,221,001	27.05	468,229					
Ottawa*	Sheet Asphalt	Business and Residential	1895	41.89	790,536	5.71	97,150	2.20 2.60	6 in. Concrete 8 in. “	1.20 1.60	2¾ inches	1.10
“	Tar Macadam	Business	1902	4.95	86,703			1.35	6 in. Macadam		3 “	
“	Tar Filled Macadam	Residential	1913	2.68	43,995	1.03	16,300	1.75	8 in. Telford 6 in. Concrete	0.80 1.10	5 “ 4 “	0.80 0.55
“	Wood Block	Business	1908	1.21	27,642			3.85	8 in. “		4 “	
“	Stone Block	“	1907	0.36	7,083				6 in. “		4 “	
“	Bitulithic	“	1905	0.62	6,300			1.40	6 in. Macadam		2 “	
“	Rocmac	Residential	1914	0.34	5,377	0.22	3,225	1.82	8 in. Telford	0.75	3½ “	1.00
“	Asphaltic Concrete	Business	1914	0.06	1,130				6 in. Concrete		3 “	
		Total		52.11	968,766	6.96	116,675					

***Sarnia.** No work since 1913. †4,120 sq. yds. concrete on lanes. ***St. Catharines.** Costs include grading. Concrete in lanes, 1,076 sq. yds. ***Ottawa.** Track allowance, 1915 work, 17,000 sq. yds. stone, 7,700 sq. yds. wood block.

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Picton	Tar Filled Macadam	Business	1910	1.00	25,813			$0.90	4 in. Macadam		3 inches	
"	Rocmac	Residential	1914	0.12	2,600			1.00	4 in. "		3 "	
		Total		1.12	28,413							
Dunnville	Tar Filled Macadam	Business and Residential	1915	0.90	17,523	0.90	17,523		5 in. Concrete	$0.95	2 inches	0.35
Aylmer	Concrete	Business and Residential	1913	1.75	30,914			1.49			7 inches	
"	Brick	Business	1911	0.25	7,463			2.29	5 in. Concrete		4 "	
		Total		2.00	38,377							
Seaforth	Asphalt Block	Business	1906	0.33	9,830			2.55	5 in. Concrete		4 inches	
Brockville	Sheet Asphalt	Business	1912	1.02	21,741			$2.10	5 in. Concrete		3 inches	
"	Tar Filled Macadam	Residential	1913	0.76	14,443	0.70	10,813		6 in. Macadam	$0.61	3 "	$0.60
"	Rocmac	Residential	1914	0.67	11,663				6 in. "		4 "	
"	Granite Block	Business	1913	0.03	860			3.40	6 in. Concrete		6 "	
		Total		2.48	48,707	0.70	10,813					
Oshawa*	Concrete	Business	1913	2.52	26,375	0.51	8,973	0.90			6½ inches	1.00
"	Bitulithic	Residential	1912	0.85	15,203			2.45	5 in. Concrete		3 "	
"	Asphalt Block	Business	1911	0.63	9,533			2.49	5 in. "		4 "	
		Total		4.00	51,111	0.51	8,973					
Welland	Brick	Business and Residential	1912	2.17	48,680			2.55	6 in. Concrete	1.00	4 inches	1.55
"	Wood Block	Residential	1914	0.28	6,098			3.00	5 in. "	1.00	4 "	2.00
		Total		2.45	54,778							
Lindsay	Asphaltic Concrete	Business	1914	2.21	40,740			2.00	5 in. Concrete		2½ inches	
"	Asphalt Block	Semi-Business	1910	0.40	6,950			2.75	5 in. "		4 "	
		Total		2.61	47,690							
Cornwall	Tar Filled Macadam		1912	0.10	1,338			0.60			4 inches	
Walkerville†	Concrete	Business	1908	10.23	106,367	0.12	1,814	1.28			7 inches	1.25
"	Cedar Block	Business	1892	4.73	67,751			1.32	5 in. Concrete		5 "	
"	Asphalt Block	Residential	1904	2.77	39,135	0.23	2,731	2.28	5 in. "		4 "	1.96
"	Bitulithic	Business	1904	0.48	14,230			2.17	5 in. "		2 "	
		Total		18.21	227,483	0.35	4,545					
Ingersoll**	Brick	Business	1915	0.57	13,460	0.57	13,460		5 in. Concrete		4 inches	2.09
"	Concrete	Residential	1915	0.26	4,100	0.26	4,100				7 "	1.50
		Total		0.83	17,560	0.83	17,560					
Hamilton	Sheet Asphalt	Business and Residential	1894	39.42	658,975	6.14	90,108	$1.60	6 in. Concrete	$0.65	3½ inches	$0.93
"	Asphaltic Concrete	Residential	1912	5.64	85,466	0.80	11,397	1.70	6 in. "	0.65	3 "	0.92
"	Wood Block	Business and Residential	1909	2.07	35,730	0.11	2,304	3.15	5 in. "	0.57	4 "	2.30
"	Brick	Business	1905	0.39	4,593	0.05	414	2.80	5 in. "	0.59	4 "	1.85
"	Concrete	Residential	1914	0.24	2,728	0.07	1,064	1.15			6 "	0.83
"	Granite Block	Business	1913	0.11	1,541			4.67	6 in. "		4 "	
		Total		47.87	789,033	7.17	105,287					
London	Asphaltic Concrete	Business and Residential	1902	12.39	196,632	4.30	87,096	2.28	6 in. Concrete	1.00	3 inches	1.33
"	Brick	Business	1904	1.68	26,631	0.17	3,050	2.75	6 in. "	1.00	4 "	1.70
"	Bitulithic	Residential	1902	1.48	24,427			2.25	8 in. Macadam			
"	Concrete	Residential	1912	1.06	14,984	0.35	4,928	1.58			7½ "	1.62
"	Asphalt Block	Business	1903	0.30	5,330			2.65	6 in. Concrete			
		Total		16.91	268,004	4.82	95,074					
Brantford	Bitulithic	Business and Residential	1908	2.98	50,128			2.73	6 in. Concrete		3 inches	
"	Westrumite	Residential	1908	2.02	33,847			1.84	5 in. "		2 "	
"	Concrete	Residential	1910	0.49	8,190			1.30			7 "	
"	†Tar Macadam	Residential	1913	0.60	8,000			0.40	6 in. "		3 "	
"	†Asphaltic Concrete	Residential	1913	0.64	6,512			1.28	6 in. "		3 "	
"	Asphalt Block	Bridge Floor	1912	0.05	870			2.50	5 in. "		4 "	
"	Warrenite	Business	1909	0.05	685			1.78	5 in. "		2 "	
		Total		6.83	108,232							

*There are 14,650 sq. yds. track allowance paved; 3,840 asphalt block, 5,410 brick, 5,400 concrete. †In 1915, 4,050 sq. yds. concrete used for lanes.
**Brick cost includes foundation.

TORONTO SEWERS PRIOR TO 1867.

Following are some of the oldest sewers in Canada, all built prior to Confederation. This list was furnished to *The Canadian Engineer* through the courtesy of R. C. Harris, Commissioner of Works, and W. R. Worthington, Engineer of Sewers, of the city of Toronto. It is a complete list of all of the Toronto sewers laid prior to 1867. Some of these sewers are still in service, in whole or in part, but many of them have been entirely reconstructed owing to the greater carrying capacities needed:

Year built.	Location.
1840	Pearl St., Simcoe St. to east end.
1843	Adelaide St., York St. to Bay St.
1843	York St., Front St. to King St.
1844	John St., King St. to Wellington St.
1844	Peter St., Front St. to Queen St.
1844	Queen St., Peter St. to Spadina Ave.
1844	Wellington St., Church St. to Yonge St.
1844	Wellington St., Peter St. to Simcoe St.
1845	Wellington St., York St. to Simcoe St.
1845	Adelaide St., York St. to Simcoe St.
1845	Bay St., King St. to Adelaide St.
1845	Richmond St., Church St. to Yonge St.
1849	Duke St., Sherbourne St. to George St.
1851	Mutual St., Gerrard St. to Wilton Ave.
1855	Agnes St., Yonge St. to Terauley St.
1855	Albert St., Yonge St. to James St.
1855	Albert St., Elizabeth St. to James St.
1855	Bathurst St., Front St. to Queen St.
1855	Berkeley St., Queen St. to Sydenham St.
1855	Centre Ave., Armory St. to Elm St.
1855	Chestnut St., Queen St. to Elm St.
1855	Duchess St., Ontario St. to 140' W. Parliament St.
1855	Front St., Don River to Trinity St.
1855	Front St., Peter St. to Spadina Ave.
1855	John St., Front St. to Wellington St.
1855	John St., Queen St. to Stephanie St.
1855	James St., Queen St. to Louisa St.
1855	Osgoode St., Chestnut St. westerly.
1855	Queen St., Jarvis St. to Victoria St.
1855	Richmond St., York St. to Simcoe St.
1855	Simcoe St., 180' N. of Esplanade to Caer Howell.
1855	Sydenham St., Ontario St. to Berkeley St.
1855	Terauley St., Queen St. to Elm St.
1855	Victoria St., Adelaide St. to Gould St.
1856	Shuter St., Yonge St. to Bond St.
1856	Victoria St., Gerrard St. to Gould St.
1856	Carlton St., Church St. westerly.
1856	Centre Ave., Chestnut Place to Elm St.
1856	Duke St., Parliament St. to Berkeley St.
1856	Queen St., Simcoe St. to John St.
1858	Jarvis St., King St. to north of Shuter St.
1858	Parliament St., Front St. to King St.
1859	Elizabeth St., Agnes St. to College St.
1859	Foster Ave., Elizabeth St. to 145' east.
1859	George St., King St. to Queen St.
1859	Mutual St., Shuter St. to Wilton Ave.
1861	Gerrard St., Yonge St. to Jarvis St.
1861	Jarvis St., Wilton Ave. to north of Shuter St.
1861	Wilton Ave., Dalhousie St. to Jarvis St.

The cost of the report on the Montreal aqueduct made for the city of Montreal by consulting engineers H. E. Vautelet, J. B. McRae and Arthur St. Laurent was approximately $20,000.

FIELD MARSHAL HAIG'S TRIBUTE TO THE WORK OF THE ENGINEER AT THE FRONT.

Recently there has appeared in various newspaper dispatches eloquent testimony of the work of the engineer at the front, all of them thoroughly deserved. Following these reports it is particularly gratifying to read the statement by Field Marshal Haig, covering operations from December 18th, 1916, to the present offensive. He pays the following tribute to the work of the engineers:—

"The prospect of a more general resumption of open fighting can be regarded with great confidence. The systematic destruction of roads, bridges and railways made unprecedented demands on the Royal Engineers, who were already heavily burdened by the work entailed in the preparations for the spring offensive. Our steady progress in the face of great difficulties is the best testimony to the energy and thoroughness with which those demands were met. The bridging of the Somme at Brie is an example of the nature of the obstacles which we encountered, and the rapidity of their removal. In this instance six gaps had to be bridged across the river, where it is of considerable width and where the current flows swiftly. The work was commenced on the morning of March 18, and by 10 p.m. the infantry bridges were completed; by 5 a.m., March 20, a medium-type bridge for horse transport and cavalry was completed, and by 2 p.m. of the 28th heavy bridges, capable of taking all forms of traffic, had replaced the lighter type.

"Throughout the winter the transport problems were most serious, both in the battle area and behind the lines, and on the rapid solution of these success or failure necessarily largely depended. At the close of last year's campaign the steady growth of our armies and the rapid expansion of our material resources had already taxed the roads and railways to the utmost. With winter conditions deteriorating the roads, the difficulty of maintaining them became almost overwhelming.

"An increase of railway facilities of every type and on a large scale therefore became imperatively and urgently necessary. Great quantities of material and rolling stock were required immediately, while subsequently our wants in that regard were considerably augmented by a large program of new construction in the area of the enemy's withdrawal. The task of obtaining the amount of railway material required and the carrying out of the work of construction at the rate which our plans rendered necessary, besides providing labor and material for the repair of roads, was one of the greatest difficulties. Its successful accomplishment reflects the highest credit on the transportation service, of whose efficiency and energy I cannot speak too highly."

A recent report submitted to the Winnipeg Grain Exchange by United States capitalists outlined a scheme for a through railway route from the United States to Petrograd by way of Canada. The scheme has been considered for some time, and negotiations with the railways and governments which will be involved in the project will be opened in the near future. The plan provides for a standard railway line, connecting United States roads through British Columbia and Alaska with Behring Strait and a line from the Siberian coast to the Trans-Siberian Railway. Large ferries would carry freight and passenger cars across the 56-mile-wide strait. Negotiations have been opened with the Russian Government to improve the Trans-Siberian Railway into a modern road instead of a primitive stretch of track overburdened by war transportations. The United States commission to Russia will take up that phase of the proposed line with the new Russian Government.

TRENCHING MACHINE WORK.*

By William W. Brush,

Deputy Chief Engineer, Bureau of Water Supply, Department of Water Supply, Gas and Electricity, New York.

IN 1909-1910 the city of New York installed between Valley Stream and Amityville, Long Island (a distance of 83,800 feet) a 72-inch lock-bar 7/16-inch steel pipe as a portion of its Brooklyn conduit, system. The contract, which was dated November 6th, 1908, was awarded to the T. A. Gillespie Co., and the total estimated cost for all the work, which included culverts, valve chambers, valves and other appurtenances, was $1,879,390.

That portion of Long Island traversed by the pipe is an almost level sandy plain, there being only a few feet difference in elevation between the small valleys and the low, intervening ridges. The material to be excavated was sand, with some gravel and a light sandy top soil. A right-of-way, in general 200 feet in width, with few cross-roads, gave opportunity for the use of any excavating system.

The contractors used practically every known method in excavating the trench, including hand, horse and scraper, clam-shell buckets, steam shovels and the Austen trenching machine. The trenching machine was used for the greater part of the work. It could be, and was, operated from the shallowest trench section up to a maximum depth of about ten feet, the limiting depth being determined by the resultant width of trench, it being necessary to have a secure track foundation on each side of the trench on which the machine travelled, and by which it was supported. Where the depth of the trench was greater than 10 feet, the contractor removed a portion of the material by other methods and then used the trenching machine.

In a section where the average depth of cut was 8 feet, and the work was performed during a period of one month, data are available on which accurate determination of the cost of excavation by this method can be worked out.

Two machines were regularly employed, working in tandem, one machine removing approximately half the material and the other machine completing the trench. This method was considered to give maximum rate of progress. The contractors were desirous of completing the work as rapidly as possible, and the methods adopted were based, first, on progress, and second, on unit cost.

The two machines used were not owned by the T. A. Gillespie Co., but were rented from the F. C. Austin Drainage Excavator Co. at a yearly rental of $8,500 and $9,300, respectively. This rental was based on the total yardage excavated by either machine being 100,000 cubic yards or less, all over and above 100,000 cubic yards being paid for at the rate of $0.055 cents per cubic yard. The machines were worked in tandem for the greater part of the work, and in many cases for the 24 hours in each day.

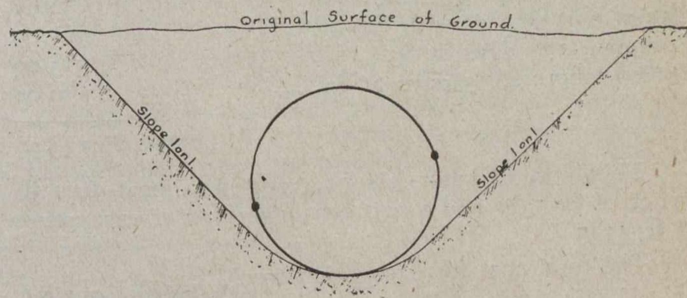
To determine the cost per cubic yard for excavating the trench by use of the trenching machine, a length of trench was taken extending from Sta. 969-52 to Sta. 1090-92, or a total of 12,140 ft. The machines were worked in this section three shifts per 24 hours for one month, from May 15th to June 16th, 1909. An accurate force account was kept by the department for this period.

*Paper read before the American Waterworks Convention, Richmond, Va., May 10th, 1917.

The total cost of excavating per cubic yard was subdivided under the following:—

(1) Rental of machines.
(2) Repairs and coal for machines.
(3) Labor force.

The total amount of excavation made by the two machines was approximately 400,000 cu. yds., or 200,000



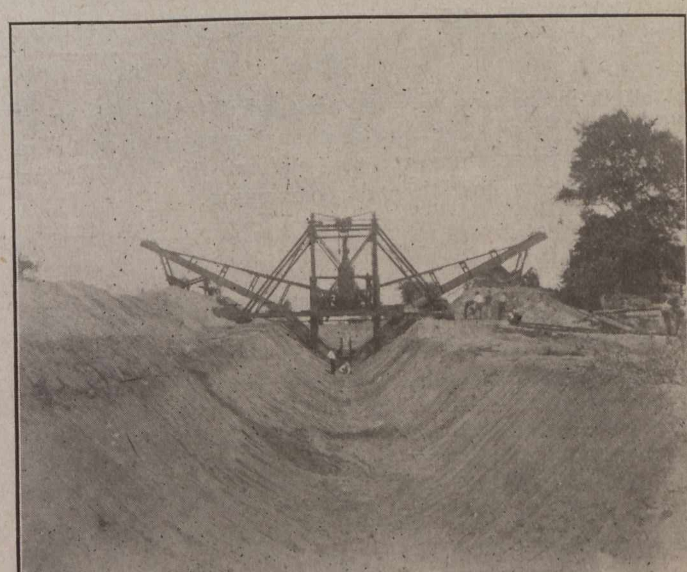
Typical Cross-section of Trench.

cu. yds. for each machine. The cost for rental per cubic yard would, therefore, be for

	Per cu. yd.
Machine No. 1—The first 100,000 cu. yds......	$.085
" " The second 100,000 cu. yds...	.055
Machine No 2—The first 100,000 cu. yds.	.093
" " The second 100,000 cu. yds...	.055

The average for both machines would be $0.072 per cubic yard.

The trenching machine excavated the trench with side slopes of 1 on 1 and the bottom of the trench rounded to conform with the curve of the pipe. The average depth of the trench for the 12,140 feet excavated was approximately 8.0 feet. This gave a total of 48,560 cubic yards, or 4 cubic yards per linear foot of trench. The repairs on the two machines for the first six months, including the cost of setting up, amounted to $6,000, and the cost of coal for the same period was $2,000. The



Austin Trenching Machine Excavating a 16-ft. Trench.

cost for repairs, coal, etc., for one month would be $1,334, or $0.0275 per cubic yard.

The force included:—

(a) The men who operated the machines.

(b) The gang laying and shifting the track and moving machines.

(c) The gang who trimmed the trench to grade after the machine had passed.

This force was as follows:—

General foreman, two months at $125	$ 250.00
Foreman, 143.5 days at $2.50	358.75
Laborers, 2,368 days at $1.40	3,315.20
Teams, 266 days at $5	1,330.00
Boys, 45 days at 75 cents	33.75
Engineman, 176 days at $4	704.00
Foreman, 171 days at $3	513.00
Skilled laborers, 15 days at $2	30.00
	$6,534.70

This cost of labor shows a cost per lineal foot of trench of $0.5382 and a cost per cubic yard of excavation of $0.1345.

The total cost for excavation would be:—

	Per cu. yd.
Rental of machine	$0.072
Repairs and coal for machine	0.0275
Labor	0.1345
	$0.2340

This cost per cubic yard is equivalent to $0.936 per lineal foot of trench.

The following summary of cost of laying the pipe will enable a comparison to be made between the excavation cost and that of other factors in the work:—

	Per lin. ft.
Clearing and grubbing	$ .037
Excavating	.928
Unloading and distributing	.1911
Laying	.2166
Digging bell holes	.084
Riveting	.345
Caulking	.288
Testing	.24
Backfilling	1.061
Cleaning up, etc.	.0993
	$3.49

It is interesting to note that on this job the backfilling cost 15 per cent. more than the excavation. The usual experience warrants an estimate to backfill at a materially lower cost than the excavation.

Mr. F. H. Whitton, general manager of the Steel Company of Canada and Mr. Wilbur Hutchison, of Winnipeg, have been appointed directors of the Sawyer-Massey Company.

The Imperial Munitions Board has authorized the Algoma Steel Corporation and the Dominion Steel Corporation to roll 50,000 tons of standard section rails for Canadian railroads that helped the Dominion government by allowing rails in service to be exported to the war zone. These roads were unable to secure new rails from United States mills. The Canadian rails will be distributed among the Canadian Pacific, the Intercolonial the Grand Trunk, and the Temiskaming and Northern Railroad Companies.

An increase of 1,000,000 acres to the irrigated area in California could be made by the end of next year, according to a statement recently made by Prof. Frank Adams, of the University of California, if all the irrigation companies of the state can show the same proportionate increase as that indicated by estimates for 1917 filed by 86 companies. Reports of these companies show that in 1917 the increase over 1916 will be from 300,000 to 350,000 acres. There are approximately 450 irrigation companies in the state.

CHEMISTRY IN CANADIAN WOODS.*

By Dr. John S. Bates,
Superintendent of Forest Products Laboratories.

THE destructive distillation of hardwoods is the only important distillation industry in Canada where wood is used as raw material. There are now eleven plants in Ontario and Quebce, and the industry is well organized. It is gratifying to note that manufacture is carried beyond the stage of the crude products, where so many of Canada's industrial activities cease, and that the specially refined and derived products are produced in Canada for local and export trade. In the limited list of chemicals which are regularly exported from Canada there are only three of much importance, namely, calcium carbide, acetate of lime and methyl alcohol, the last two of which are entirely produced by hardwood distillation. It is important to remember that practically all the wood alcohol and acetic acid, which are so essential to modern civilization, are produced by the destructive distillation of hardwood. The Canadian plants together consume over 500 cords of wood per day. Maple, beech and birch are the main species used, although oak, hickory and other hardwoods are suitable if they can be obtained. The primary distillation process is rather crude, the cordwood sticks being run into retorts on cars and the retorts being heated externally by fire which is controlled to some extent. The crude decomposition products which are driven off go through a series of refining operations for the separation and purification of the valuable products.

Hardwood charcoal is the other valuable product, and is mainly used as household fuel and for manufacture of charcoal iron. The wood gas is of rather low heating value and is burned under the retorts. The hardwood tar is also used as fuel at the plant in most cases as the constituents have not the inherent value of the more widely-known coal tar; however, the recovery of certain by-products has important possibilities. The various creosote oils which are obtained in the course of separating the wood alcohol and acetic acid from the tar are at present of minor value, but recent investigations by the Forest Products Laboratories of Canada indicate that they are suitable for the flotation of cobalt and other Canadian ores. So-called beechwood creosote is a standard article in the drug trade, and is made by chemical treatment of hardwood creosote oils.

Wood waste of various kinds can be used in place of coal for the generation of producer gas, and this method of utilization is practised in Europe and to some extent in the United States. The increased efficiency of the producer and gas engine over the boiler and steam engine is a well-known advantage in the handling of fuels. In Canada wood waste occurs in such large quantities and is so easily used as fuel directly under steam boilers that there is not so much occasion for installing the more complicated large-scale gas producers. In line with the manufacture of producer gas it is important to mention the destructive distillation of wood waste modified to yield the maximum amount of wood gas. A number of centres in America are now using wood gas for heating and illuminating purposes and as motor fuel.

The steam and solvent process applies to resinous longleaf pine in the Southern States. The selected wood waste is hogged or chipped, steamed to drive off most

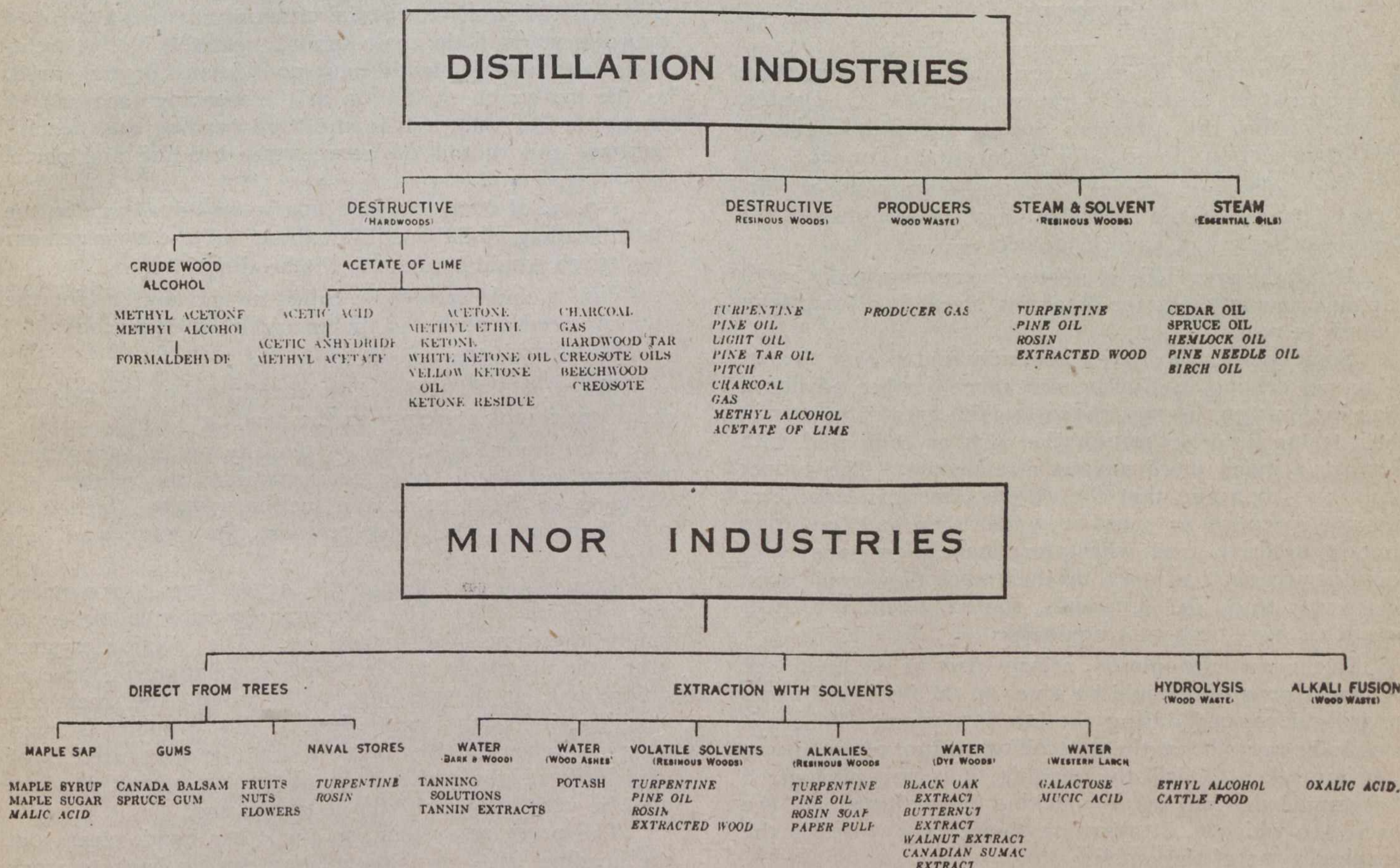
*Abstracted from paper before the Canadian Society of Civil Engineers.

of the turpentine and pine oil and then extracted with gasoline or other volatile solvent for the recovery of rosin. The extracted wood is used in the manufacture of composition flooring blocks, and is also suitable for manufacture of pulp. The resinous wood material in Canada is limited in quantity and not very high in quality, so that economic recovery of products is a more difficult problem.

There is a variety of other processes for recovering products from trees, only a few of which are of importance in Canada at present.

Of products which are taken directly from the living trees maple sap takes quite a large place. The maple sugar industry in Canada furnishes products worth over two million dollars per year, over half of which comes from the province of Quebec. Calcium bi-malate has been recovered from the "sugar sand" in boiling down the syrup, and is considered by the Macdonald College authorities to be superior to cream of tartar or other acid materials used in baking powder. Malic acid can also be produced from the malate of lime, and is a high-priced chemical. Canada balsam and spruce gum are well-known products which are obtained from balsam fir and spruce, respectively. Some of the fruits, nuts and flowers come from forest trees, although it is not intended to include the whole fruit industry, for example, under this head. The naval stores industry of the Southern States provides the bulk of the turpentine and rosin used throughout the world, and involves the "chipping" of long-leaf pine trees. Experiments are now being carried out on western yellow pine in British Columbia with some prospect of commercial success.

Solvents are used in various ways to extract valuable products from certain kinds of wood material. In Canada hemlock bark is used directly in the tanneries and at one plant in New Brunswick for the manufacture of concentrated tannin extract. Oak bark and chestnut wood are of minor importance owing to the limited range of these species in the southern sections of Canada. The recovery of potash from wood ashes was at one time the main source of potash in Canada, but for many years the cheap potash salts from Germany have overshadowed all other sources. Since the outbreak of war there has been some revival of potash recovery in Canada owing to the great advance in prices. Hardwood ashes are the richer for treating, but in any case wood ashes should reach the land as fertilizer. The extraction of resinous woods with volatile solvents and the separation of the turpentine and pine oil from the rosin by distillation is not a promising industry for Canada on account of the limited supply of sufficiently resinous woods as already explained. This also holds true of extraction with weak alkali solutions whereby turpentine and pine oil are distilled with the steam, the rosin recovered from the solution in the form of soap by "salting out" with more alkali and the extracted wood cooked with the strengthened alkali to produce paper pulp. Dye woods are of but little importance in Canada. The extract of black oil is used partly as a tanning material and partly as a dye, while walnut and butternut extracts give a brown coloring material and the flowers of sumac a red dye, which is at least used locally throughout the country. The laboratory of the United States Forest Service has made an interesting discovery that western larch contains from 6 to 8 per cent. of water-soluble material, which is mainly galactose sugar. Various products, including table syrup, ethy alcohol and muric acid, which may be used as a constituent of baking powder can be manufactured therefrom. It may



In the above Diagram the Trees named show the Ramifications of Manufacturing in the Chemical Branches of the Wood Industries.

be that a small industry can be established in Western Canada.

By heating a softwood sawdust at moderately high temperatures with a strong solution of caustic soda or caustic potash a large proportion of the wood is converted into sodium oxalate. The valuable product, oxalic acid, can be recovered by precipitation of the extract with lime and treatment of the calcium oxalate with sulphuric acid. One plant has been established in the United States, but it is doubtful if the industry will assume large proportions on account of cheap production of oxalic acid by other chemical methods, especially in Europe.

CONSTRUCTION METHODS FOR ROGERS PASS TUNNEL.

IN *The Canadian Engineer* for March 1st, 1917, there appeared an abstract of the paper by A. C. Dennis, read before the American Society of Civil Engineers on "Construction Methods for Rogers Pass Tunnel."

The following abstract of the discussion of Mr. Dennis' paper is taken from the March Proceedings of the American Society of Civil Engineers:—

R. H. Keays: This is a very interesting paper, as it explains new methods for obtaining speed in driving long tunnels in rock.

Some years ago it was generally stated that the art of tunnel driving in Europe was much further advanced than in America, as was shown by the great progress in the various tunnels through the Alps as compared with America's much more modest attainments. The proper reply was to argue that the reason American engineers did not specialize in speed was that they had no long tunnels to drive, and when, for financial reasons, they found it necessary to speed up their work they would soon find a way to do so. Certainly, some of their records of late years have been very creditable.

In the writer's opinion, a large part of the credit for the great progress should be given to the improved types of drills developed during the last few years. Where it used to be agreed that the controlling feature of speed was the time taken to drill the heading, it is now considered that tunnel driving is a mucking proposition, and the feature to which most attention should be devoted is the cleaning away of the muck.

In explaining why the pioneer tunnel method was used for the Rogers Pass Tunnel, the author states that the usual "top heading and bench" method was considered too slow and the "bottom heading" method too expensive.

As to the "top heading and bench" method, the writer is of the impression that it has not yet shown its capabilities as to speed, no tunnel driving with modern drills having as yet been attempted where speed was the primary object and where the conditions were so nearly ideal for fast work as in the Rogers Pass Tunnel. The writer has never used the bottom heading method, but has always heard it recommended for its economy. Substantiating this claim, the writer knows of several tunnels where it was used, but they were of such short length that speed was of minor importance.

From a careful reading of the paper, the writer is of the opinion that the author has not demonstrated that the pioneer heading has enough advantages to justify its use as a standard method.

The author gives a list of reasons for using the pioneer heading, showing various advantages which no doubt would expedite work in the main tunnel; but, in the writer's opinion, it would be very little. The paragraphs explaining the location of the portals of the pioneer headings, however, would indicate that, on account of avoiding a lot of soft ground work, the pioneer heading could be driven far in advance of the main heading, but as no heading was driven in the main tunnel, using the pioneer heading to work from, the writer does not understand how greater speed was made in the main tunnel on this account. It merely cheapened the cost of driving the pioneer heading and provided better dumping ground.

The writer assumes that the main heading was being excavated at one face only at any one time, and also that enlargement operations were being carried on at one place only.

Of the reasons given by the author for adopting the pioneer heading, No. 2 is the only one that could tend to expedite work in the main tunnel. Reason No. 1, treating of ventilation, should have no influence on the speed, as the matter of ventilation at the working face can be taken care of very well in the "top heading and bench" method, and ventilation between the heading and portal is not important.

No. 3, of course, would not be an advantage in the "top heading and bench" method, for the enlargement operations would be close to the heading.

No. 4 could hardly be called an advantage, for the rate of speed depends on the enlargement operations.

No. 5 is rather unimportant.

No. 6 would also be of no advantage, as the enlargement operations are close to the heading.

Ventilating systems, as usually put in, are disappointing. There is no agreement as to the relative advantages of the pressure and suction systems, the size of pipe to be used, the pressures, or the quantity of air necessary.

It may be said that much larger pipes are required with suction than with pressure systems in order to handle the same quantity of air. The suction system keeps the air of the whole tunnel in relatively good condition, but, at the heading itself, where the men are working, it has the least effect. This trouble is augmented, generally, by the fact that the pipe used is of very light weight and is leaky at the joints, so that there may be very little air taken in at the end.

The pressure system, on the other hand, clears out the heading first, so that the men can go back to work immediately, and ventilation between the working face and the portal is not important.

The pressures generated at the fan are usually so low that a very large pipe is needed in order to get the volume. For economical reasons, a large pipe is always made of light material, which is not satisfactory.

The writer, therefore, on account of the foregoing considerations, believes that a medium pressure system, using a relatively small, screw-joint, standard steel pipe for delivering air to the heading, is the best.

On a recent job he used a Connersville blower, good for a pressure of 10 lbs., delivering 750 ft. of air per min. to a heading somewhat more than a mile distant. The pipe was of steel, 6 ins. in diameter, and the maximum pressure was about 7 lbs. The condition of the air at the heading was always good. The heading and bench were always shot at the same time, every 8 hours, and the blower was usually run for about 2 hours each time.

F. Lavis: This account of the most successful tunnelling operation in North America—and this is said with, it is believed, due appreciation of all the work of this kind which has been done in recent years—is a tribute to the advent of the engineer as a director of a type of construction which requires the planning and organizing ability of which usually only the trained engineer is capable.

Confronted with the problems of organization required for the successful economical completion of the long Alpine tunnels, Europeans long ago realized that these were problems for the engineer, and were not of the kind which could be put through solely by "pick, shovel, and pluck," or mere driving power, unaided by a trained mind to plan and execute.

The writer fully recognizes the value of the qualities of the contractor, especially those of the railway contractor, which are very necessary, and which engineers seldom possess. The need of planning, of co-ordinating the work of the organization with the plans, the successful modification of the plans to fit both the conditions and the organization as they develop, are, however, essentially qualifications which the properly trained engineer alone possesses.

Though this is not the first tunnel driven in North America which has demonstrated the ability of the engineer as an organizer along lines which require this necessary co-ordination of planning with execution, it is the latest and most successful, and the writer believes that the realization of this phase, of the conduct of the operations which have resulted so successfully, is of quite as great importance as the recognition of the successful application and improvement in the "pioneer heading" method, important as this latter is as a demonstration of efficiency.

The paper is filled with instances which show the careful, continuous study of conditions and improvements in details as the work progressed. Many of these latter are not altogether new; some of them have been advocated by the writer and others; but as their general application to tunnelling is by no means common, even yet, it seems permissible, even at the risk of repetition, to refer briefly to some of them:

Ventilation is a *sine qua non.*

Bonus system used.

Hammer drills used entirely, columns carefully set with relation to line and grade, holes pointed by clinometer.

Three helpers were used for each two drills.

Fuse was used instead of batteries for blasting.

Water was used to wet down the muck pile and wash the dirt from the sides, roof, and face.

Muckers have brief rest between each carload.

Mucking sheets were used.

There is also one statement full of significance to those who have had much tunnel experience, namely, that "the plant was properly put in and properly looked after, and caused practically no delay." This epitomizes the attitude of those responsible for the conduct of the work, and indicates one of the most important reasons for the success attained.

Lazarus White: The pioneer tunnel was of quite a small bore, and, as Mr. Dennis has stated, it served primarily for ventilation, because through it any quantity of air was sent around the heading, and blew out the smoke. The tunnel was both the driest and the best ventilated of any the speaker has visited. On account of the extensive blasting that was done, it must be realized that the ventilation had to be well nigh perfect, because from fifteen to twenty rounds were set off in succession in order to break up the rock ahead of the steam shovel.

In any ordinary method of tunnel ventilation, this would have made the work difficult, if not impracticable, but, with this pioneer tunnel, the air was sent around and blown through the main tunnel. There was an immense fan in the pioneer heading through which there was always a strong wind blowing.

Another feature, not brought out very strongly in the paper, which contributed very largely to the success of this tunnel, was the drills used. The speaker believes they were little water-fed drills. With these it was possible to maintain the high rate of progress in the heading, and they contributed very largely to the success of the work.

The wooden water pipe, used for ventilation, served its purpose well, and was much superior to the ordinary iron pipe. It was well laid, and the joints were so tight that the exhaust could be conducted through it.

T. Kennard Thomson: The speaker understands that the report of the late Virgil G. Bogue, M.Am.Soc.C.E., is a masterpiece of one of the foremost of old-time railroad engineers, and it would seem that its publication in full, in connection with this paper, would be of great value to other engineers and students. For that reason it is hoped that the author will prevail on the Canadian Pacific Railway Company to allow its publication in full.

One reason for haste in those days was to get some return on the money as soon as possible, and an even more important reason was the fear that, if the road was not quickly completed, a turn of the political wheel might prevent it from being finished for many years.

In addition to the commercial reasons for haste in constructing the Rogers Pass Tunnel, the fear of snow slides may have been another incentive—the author has stated that the snowfall there is from 30 to 50 ft. a year. The speaker assisted in the design of the first snowsheds on this road. These were to be constructed in cuts on the hillsides in such a way that the snow slides or avalanches would never strike directly on the roof of the shed, but merely shoot or slide over it. Some of these designs were modified by others, so that the roofs projected up too far, with disastrous results in every case. Trees adjacent to a snow slide would often be cut off as if by a knife about 20 ft. above the ground, or at the surface of the standing snow, by the force of the wind generated by the falling avalanche. Nothing can be built to stop those giant snow slides after they have fallen from 3,000 to 5,000 ft. The snow and ice piled up in winter many feet, and even after the intense heat of August a depth of some 30 ft. or more would be left.

STEWART COMPANY SUES SUB-CONTRACTOR.

Action to recover $169,619.73 in connection with the Toronto Harbor sub-contract has been entered at Osgoode Hall by the Canadian Stewart Co. against I. A. Hodge, of Syracuse, N.Y. In February, 1914, the Canadian Stewart Company, who are the main contractors on the harbor work, let a sub-contract to Mr. Hodge for part of the ship channel, and the Stewart Company allege that the work was so negligently done that the greater portion of it was rejected by the Minister of Public Works and the material supplied for the work by the Stewart Company was lost. It is further alleged that Mr. Hodge refused to remedy the conditions complained of.

R. S. Lea, consulting engineer, of Montreal, is suing the city of Medicine Hat for commission as consulting engineer on the installation of the city's waterworks, the cost of which was between six and seven thousand dollars. The commission, which was at the rate of 5 per cent. on the cost of installation, has been paid by the city, except a balance of about $6,000, and it is for this amount that the plaintiff has entered suit.

The Engineer's Library

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer, 62 Church Street, Toronto.

CONTENTS.

BOOK REVIEWS.

The Design of Railway Location. By Clement C. Williams, Professor of Railway Engineering, University of Kansas. Published by John Wiley & Sons, Inc., New York; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1917. 517 pages, 106 figures, 62 tables, 6x9 ins., cloth. Price, $3.50 net. (Reviewed by Wm. C. Willard, plant engineer, Kilbourne & Jacobs Mfg. Co., Columbus, Ohio, formerly assistant professor of railway engineering, McGill University.)

"The Design of Railway Location," by Clement C. Williams, consists of an introductory chapter and four major parts.

Chapter 1, the introduction, devotes 22 pages to a description of early railroads, their types of track and locomotives, operating conditions, and growth of railway systems. Though interesting to read, this chapter could be condensed to one-third the space without in any way reducing its value. For instance, neither the student nor the practical railroad man is materially benefited by a description of how Horatio Allen—"the first man who took hold of a lever to run a locomotive in America"—settled in his own mind whether to take his first trestle at high speed or low speed. In describing the untimely end of the locomotive, the "Best Friend" of Charleston, the author might have completed the story by tracing back "safety first" to the "barrier car"—a car loaded with bales of cotton and placed immediately back of the locomotive—used by the South Carolina Railroad after the explosion of the "Best Friend," and widely advertised as being a great protection to the passengers when the boiler exploded.

Part A takes up the subject of railway economics and legislation. Chapters 2 and 3 discuss capitalization, incorporation, systems of organization, and legal control of railways. Though the divisional and departmental systems of organization are described, no mention is made of the fact that the organization of most American railways are neither clearly divisional nor clearly departmental.

The vast and complex subject of valuation is covered by Chapter 4 in 18 pages.

The approximate methods of estimating the volume of traffic which a new road may expect to receive are thoroughly covered in Chapter 5. This should be supplemented by a statement that the only reliable method of getting a final estimate of the probable volume of traffic is for a traffic expert to make a "house-to-house" field survey of the tributary area.

In Chapter 6 is given a complete list of the 1914 classification of operating expenses as adopted by the Interstate Commerce Commission. Tables are included which give the percentages of the various items of the classification in effect prior to July 1, 1914, for the fiscal year 1914. These would be of greater value if they covered a more extended period. Taxes are briefly referred to in this chapter.

Rates, freight classifications, switching charges, demurrage, c.l. and l.c.l. rates are taken up in Chapter 7, but no mention is made of how little effect the work of the designer of railway location has upon railway rates.

Part B is a discussion of the operating conditions affecting location. It constitutes 179 of the 504 pages and is the most important part of the book. Chapter 8 is a general explanation of locomotive performance. Under "fuel" some mention should be made of pulverized fuel.

Electric traction is discussed in Chapter 9. Because of the growing importance of steam-road electrification no modern book on railway location would be complete without referring to its possibilities.

In Chapter 10 are given weights and dimensions of cars and locomotives, the economy of large cars and locomotives is emphasized, and draft gear and the air brake are described.

Chapters 11 and 12 contain a comprehensive discussion of train resistance, locomotive rating, economic speed of trains, and the location of terminals and sidings.

In Chapters 13, 14 and 15 are discussed grade resistance, ruling grades, value of grade reduction, momentum and minor grades, the velocity or virtual profile, velocity-distance and velocity-time curves, rise-and-fall and its effect upon operating expenses, and pusher grades.

Chapter 16 is a discussion of the effect of distance upon operating expenses. Chapter 17 deals with curvature, its limiting effect upon tonnage and speed, its effect upon operating expenses, and its compensation. Twenty-one pages are devoted to curvature while but 12 pages are allowed for distance.

Part C, consisting of 73 pages, deals with special problems in railway location. Line changes and grade reduction are taken up in Chapter 18; the elimination of grade crossings is discussed in Chapter 19, and the maximum capacity of single track and the necessity for additional tracks are covered in a satisfactory manner in Chapter 20. These three chapters cover matters not heretofore included in books of this nature and are a valuable addition.

Chapter 21 discusses briefly the location of electric interurban railways. The problems arising in the location of electric railways are quite different from those of steam-railway location, and might well be left for a book dealing entirely with electric railways.

The heading of Part D is "Practical Location Surveys." It consists of 105 pages. Chapters 22 to 26 inclusive discuss in order, reconnaissance, the preliminary survey, the location survey, construction surveys, and railroad construction estimates. All of these subjects are covered in a much more thorough manner in books previously published.

Appendix A is a reproduction of the specifications for the formation of the roadway, from the Manual of the American Railway Engineering Association.

In general, the book attempts to cover too broad a field. The topic headings are not numbered and cross-referencing is made cumbersome. The table of contents gives an outline of the data included in each chapter in the place of a complete list of the topic headings.

The Theory and Practice of Working Plans (Forest Organization). By A. B. Recknagel, A.B., M.F., Professor of Forestry, Cornell University. Published by John Wiley & Sons, New York; Canadian selling agents, Renouf Publishing Co., Montreal. Second edition, 1917. 265 pages, 6 plates, 5¾ x 9 ins., cloth. Price, $2.00 net. (Reviewed by B. E. Fernow, University of Toronto, Toronto.)

The subject matter of this volume can have only a limited interest to the general engineer, except as it is useful to study and understand the organization of any business—in this case the business of furnishing the engineer systematically and continually with one of the important materials of construction—a business which as yet is undeveloped in Canada and hardly on the continent, the business of forestry. It comprises the mathematical side of forest organization.

This organization is based on the realization that the forest crop requires many years, 75 to 100 and more, to mature, that the annual growth cannot be directly utilized, and hence needs special arrangements to permit an annual harvest of appropriate amount, based upon the annual increment—to secure what is technically called the "sustained yield." The problem is to change a naturally intermittent business into an annual one.

The forester is fortunate in having formulated an ideal forest, which would fulfil the requirement of the sustained yield, *i.e.*, the yield which will eventually allow an annual or periodic harvest of the increment. This ideal, the so-called "normal forest," is composed of as many stands differing in age as there are years in the rotation—normal age classes—which represent the normal stock on which the normal increment accumulates, and permits an annual cut of mature timber representing the annual forest increment on the whole property.

The art of the organizer and the object of the working plan is to gradually bring the usually abnormal forest into approximately normal conditions in such a manner that the future is provided for without too much sacrifice of present interests.

This is done largely by determining a proper felling budget during the time of the change to normal conditions, and it may take 100 and more years before the object is attained.

There are eighteen different methods described for approaching this problem, mostly developed in Germany, for regulating the cut and securing systematic procedure.

The first chapter is concerned with the method of securing the basis or data for this regulating, which consist of a forest survey, including ascertainment of forest conditions, stock on hand, increment, actual and normal, yield tables, subdivision of the property, the determination of the rotation, *i.e.*, the felling age or desirable age of harvest, the desirable silvicultural methods, etc.

Some 80 pages are devoted to description of the practices in regard to working plans in Germany and France, Austria, and in America. While in the European countries working plans are really followed, in America, *i.e.*, the United States, the making of working plans is still largely academic discussion. In Canada there is as yet nothing but exploitation of the natural forest without reference to the future and the normal forest; the organization of a continuous business of forest cropping is still only a wish, with little show of realization.

Railway Estimates, Design, Quantities and Costs. By F. Lavis, M.Can.Soc.C.E. Published by the McGraw-Hill Book Co., Inc., New York. First edition, 1917. 608 pages, 99 illustrations, 6 x 9 ins., cloth. Price, $5. (Reviewed by G. J. L. Boyd, Creosoted Block Paving Co., C.P.R. Building, Toronto.)

The author has in this book made available in convenient and concise form a vast store of practical information and cost data for engineers called upon to report on the value of, or estimate the probable cost of proposed railways, either before or after surveys have been made,—to estimate the value of existing lines,—to design the general features of a proposed railway or modify the design of an existing line,—to determine the value or utility of such feature of the general design of railways as affect their cost or value as transportation machines.

The work has been prepared by an engineer from his own experience in actual work as well as having had access to the records of many railroads, thus giving an added value to the data.

Under appropriate headings are first given general data, such as preliminary estimates previous to survey, and estimates based on surveys; general costs of complete railroads, etc.; then follows construction methods and costs, including clearing and grubbing, earth and rock excavation, tunnels, masonry, bridges (railway and highway), track and track work, fencing, crossings, section houses, telegraph, signals, shop and yard buildings, stations, etc. Chapter 11 devotes 72 pages to rolling stock, in all its phases, followed by Appendix "A" "General Specifications and Forms of Contract"; Appendix "B," "Appraisal of the Lehigh Valley Railroad"; Appendix "C," "Processes of Timber Preservation"; Appendix "C," "Processes of Timber Preservation"; Appendix "D," "General Railway Statistics," with 31 pages of tables complete an excellent and practical work which should have a place in every consulting and practising engineer's library.

Examples in Battery Engineering. By Prof. F. E. Austin. Published by the author, 1917. 90 pages, 39 illustrations, 4¾ x 7¾ ins., cloth. Price, $1.25. (Reviewed by E. G. Ernest, general manager, Canadian National Carbon Co., Limited, Toronto.)

This book appears to be concise, accurate and to the point, and covers in a comprehensive way the fundamental principles involved in battery engineering. It should be valuable to engineering students and others who use batteries and to those who sell batteries, in order that they may have the knowledge necessary to give the best possible service.

PUBLICATIONS RECEIVED.

Ontario Bureau of Mines.—Twenty-fifth (1916) annual report.

Provincial Board of Health of Ontario.—Thirty-fourth annual report for the year 1915.

Canadian Society of Civil Engineers.—Transactions of the society from January to June, 1916.

The Kingshighway.—A report by the City Plan Commission, St. Louis, Mo., January 23, 1917.

Annual Report of The J. G. White Companies, general offices, 43 Exchange Place, New York City.

Manitoba Public Utilities Commission.—Fifth annual report for the year ended November 30th, 1916.

Sun Oils, Vol. VI., Filling and Shipping.—Published by the Sun Co., 1428 South Penn Square, Philadelphia, Pa.

Mineral Production of Canada.—Annual report for the calendar year 1915. Issued by the Department of Mines, Ottawa.

Sewage Disposal.—Twelfth and thirteenth semi-annual reports, 1916, of the Sewage Disposal Commission of the city of Fitchburg, Mass.

Wheaton District, Southern Yukon.—By D. D. Cairnes. Supplement to Memoir 31, Geological Survey, Department of Mines, Canada.

The Southern Plains of Alberta.—By D. B. Dowling. Memoir 93, No. 78 Geological Series, Geological Survey, Department of Mines, Canada.

Association of Dominion Land Surveyors.—Report of the tenth annual meeting held at Ottawa on January 31st and February 1st and 2nd, 1917.

Tennis Every Day on Concrete Courts.—Illustrated pamphlet, published by the Portland Cement Association, 111 West Washington Street, Chicago, Ill.

The Remodelling of an Old Graving Dock at Southampton.—By R. N. Sinclair, M.C.I. Paper read before the Concrete Institute on February 22nd, 1917.

Asphyxiation from Blast-Furnace Gas. — Technical Paper 106, Bureau of Mines, Department of the Interior, Washington, D.C. By Frederick H. Willcox.

The Coal-Fields and Coal Industry of Eastern Canada. A general survey and description by Francis W. Gray. Bulletin No. 14 published by the Dept. of Mines, Canada.

California Railroad Commission.—Bulletin of the progress of the California Railroad Commission's investigation of railroad grade crossings in the State, April, 1917.

Forest Branch.—Report of the Forest Branch, Department of Lands, British Columbia, for the year ending December 31st, 1916. M. A. Grainger, chief forester.

Scroggie, Barker, Thistle and Kirkman Creeks, Yukon Territory.—By D. D. Cairnes. Memoir 97, Geological Series No. 79. Issued by the Dept. of Mines, Ottawa.

Recent and Fossil Ripple-Mark.—By E. M. Kindle. Canada Geological Survey Museum Bulletin No. 25, Geological Series No. 34. Issued by the Department of Mines, Ottawa.

Canadian Society of Civil Engineers.—Report of proceedings of the thirty-first annual meeting held at the society's house, 176 Mansfield Street, Montreal, January 23rd and 24th, 1917.

Chemical and Biological Survey of the Waters of Illinois.—Report for year ending December 31st, 1915, Water Survey Series No. 13. Published by the University of Illinois, Urbana, Ill.

How to Build Up Furnace Efficiency.—A handbook of fuel economy. By Jos. W. Hays, Rogers Park, Chicago, Ill. Tenth edition, 1916. 154 pages, 5 x 7¼ ins., paper cover, illustrated. Price, $1.00.

Oxygen Mine Rescue Apparatus and Physiological Effects on Users.—By Yandell Henderson and James W. Paul. Technical Paper 82, Bureau of Mines, Department of the Interior, Washington, D.C.

Building and Ornamental Stones of Canada.—Report covering the provinces of Manitoba, Saskatchewan and Alberta, by Wm. A. Parkes, B.A., Ph.D. Published by the Department of Mines, Ottawa.

The International Nickel Company.—Fifteenth annual report of the International Nickel Co., 43 Exchange Place, New York City, for the fiscal year ended March 31st, 1917. President, Ambrose Monell.

The Alloys of Chromium, Copper and Nickel.—A preliminary study by D. F. McFarland and Oscar E. Harder. Bulletin No. 93, Engineering Experiment Station, University of Illinois, Urbana, Ill. Price 30 cents.

Report on Enlargement of the Montreal Aqueduct.—By H. E. Vautelet, Arthur St. Laurent and J. B. McRae, consulting engineers. Reprinted from *The Canadian Engineer*, issues of May 31st and June 7th, 1917.

Bulletin of the Imperial Institute.—A quarterly record of progress in tropical industries, etc., of the natural resources of the colonies and India. Published by John Murray, Albemarle Street, London, W., England.

Magnetic and Other Properties of Iron-Aluminum Alloys Melted in Vacuo.—By Trygve D. Yensen and Walter A. Gatward. Bulletin No. 95, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Public Road Mileage and Revenues.—Bulletin No. 389 of the United States Department of Agriculture, Washington, D.C., dealing with public road mileage and revenues in the Central, Mountain and Pacific States, 1914.

Combustion in the Fuel Bed of Hand-Fired Furnaces.—By Henry Kreisinger, F. K. Ovitz and C. E. Augustine. Technical paper No. 137. Issued by the Bureau of Mines, Department of the Interior, Washington, D.C.

The Rational Design of Reinforced Concrete Wharves and Jetties, with particular reference to those for wet docks that have a permanent water level. Paper read before the Concrete Institute by W. Cleaver, M.Inst.C.E., on March 22nd, 1917.

The Results of Physical Tests of Road-building Rock in 1916, Including all Compression Tests.—By Prévost Hubbard, chemical engineer, and Frank H. Jackson, Jr., assistant testing engineer. Bulletin No. 537 issued by the United States Dept. of Agriculture, Washington, D.C.

Water Hammer Problems Solved by the Use of Alignment Charts.—Water hammer phenomena reviewed with charts for graphical solution of Joukovsky's and Allievi's formulæ. By R. L. Hearn, B.A.Sc., hydraulic department, Hydro-Electric Power Commission of Ontario. Reprinted from *The Canadian Engineer*, December 7th, 1916.

The Philadelphia Plan for Unified Federal Regulation of Railroads.—Presented by the Philadelphia Bourse and a program of basic regulatory legislation presented by the Philadelphia Joint Committee on the Reasonable Regulation of Railroads. Secretary, Emil P. Albrecht, 58 The Bourse, Philadelphia, Pa.

Engineering.—A brief prepared for the Governor and the General Assembly of the State of Illinois concerning the work of the College of Engineering and the Engineering Experiment Station of the University of Illinois, Urbana, Ill., and a statement of their needs for the two years beginning July 1, 1917. Compiled by the Dean and heads of departments.

International Joint Commission.—Hearings of the International Joint Commission in re remedies for the Pollution of boundary waters between the United States and Canada, being public hearings held at Buffalo, N.Y., and Detroit, Mich., June 21-27, 1916, and Ogdensburg, N.Y., August 25, 1916. Published by the United States Government, Washington, D.C.

Design of Outlet Sewers and Sewer Outlets.—Report submitted to the Board of Estimate and Apportionment, City of New York, by the chief engineer of the board on behalf of the consulting engineers, recommending the adoption of certain general rules governing the design of outlet sewers and sewer outlets, which report was approved and which rules were adopted by the Board of Estimate and Apportionment at a meeting held on February 23, 1917.

United States Government Specification for Portland Cement.—Circular No. 33 of the Bureau of Standards, Department of Commerce, Washington, D.C. S. W. Stratton, director. This specification is the result of several years' work of a joint conference, representing the United States Government, the American Society of Civil Engineers, and the American Society for Testing Materials. It was adopted by the United States Government and by the American Society for Testing Materials, to become effective January 1st, 1917.

The Activated Sludge Process of Sewage Treatment.—By J. Edward Porter, chemical engineer, General Filtration Co., Inc., Rochester, N.Y. A bibliography of the subject arranged in chronological order. It includes, in addition, the nomenclature concerning the activated sludge process as suggested by Messrs. Dallyn, Hammond and Hatton, a committee appointed for that purpose by the American Society of Civil Engineers, notes on patents, etc. This publication will undoubtedly be found very useful and informative to all who are interested in sewage disposal and should find a place in the library of all civil engineers. Contains forty-two pages, 6 x 9 ins.

CATALOGUES RECEIVED.

The Whalen Form.—A 24-page illustrated booklet issued by E. J. Whalen, Syracuse, N.Y.

Excelsior Airometer.—A 15-page illustrated leaflet issued by The Denver Hydro Co., Denver, Colorado.

How a Tarvia Macadam Roadway is Constructed.—A 36-page illustrated booklet published by The Barrett Co., New York.

Portable Rock-drilling Outfits.—Catalogue No. 15, illustrated, issued by Chris D. Schramm & Son, Philadelphia, Pa.

Birch Pump Valves.—Illustrated folder issued by the Birch-Hintz Manufacturing Co., Chicago, giving descriptions of installations of their pump valves.

Thermodynamic Analysis of duty test of the De Laval steam turbine-driven centrifugal pump at Montreal.—Thirty-one page illustrated booklet issued by the De Laval Steam Turbine Co., Trenton, N.J.

Modern Methods of Brick Pavement Construction for roads and streets built with wire cut-lug brick. A 27-page illustrated booklet, published by The Dunn Wire-Cut Lug Brick Co., Conneaut, Ohio.

Storage Buildings.—Booklet issued by Lockwood, Greene & Co., engineers, 60 Federal Street, Boston, illustrating and describing a number of storage and warehouse buildings recently designed by them.

Tarvia, Tarvia-X and Tarvia-B.—Three booklets issued by The Barrett Co., New York, describing the use of Tarvia, and giving illustrations of roads in different parts of the United States on which it has been used.

Wood Tanks and Vats.—Folder issued by the Goold, Shapley & Muir Co., Limited, Brantford, Ont., describing with illustrations wood tanks and vats for all purposes, and towers and tanks for sprinkler, water supply systems, etc.

Standard Cast-iron Extension Shut-off Boxes for water and gas service pipes and street mains.—Illustrated booklet published by Bingham & Taylor, Buffalo, N.Y. Contains 28 pages and describes their different types of boxes, etc., together with price lists.

Mineral Rubber Pipe Coating.—Illustrated, 23-page booklet issued by the Standard Asphalt & Rubber Co., 208 South La Salle Street, Chicago, Ill., describing Sarco mineral rubber pipe coating for protecting steel, cast or wrought iron pipe against corrosion, tuberculation, electrolysis, earth's salts, or other damaging influences.

Chanelath Hand Book.—Sixty-four pages and cover, 6″ x 9″, coated paper, well illustrated. Containing information descriptive of Chanelath, and data on its erection, design, specifications, etc. Illustrates use for floors, ceilings, partitions, curtain walls, etc. Distributed by the Burns Cement-Gun Construction Co., Toronto, agents for the Northwestern Expanded Metal Co., Chicago.

Steel Storage Tanks and Plate Metal Work.—A 24-page and cover booklet issued by the Canadian Chicago Bridge & Iron Co., Limited, of Bridgeburg, Ont. Contains a score of illustrations of Canadian work carried out by this company, including overhead tanks for the city of Toronto filtration plant; for all of the Canadian railroads; for Canada Car Co., Proctor & Gamble, City Dairy Co. and many other industrial concerns; and for municipal waterworks at Stratford, Cartierville and a dozen other Canadian municipalities.

Progress in Waterworks Pumps.—A 48-page booklet published by the De Laval Steam Turbine Co., Trenton, N.J., discussing the general economic and engineering conditions affecting the design and installation of steam turbine-driven centrifugal pumps for city water supply. Installations in fifteen of the principal cities of the United States and Canada are described, including 34 units aggregating 999,000,000 gallons per day capacity. The publication should be of value to anyone interested in the handling of water in large quantities.

Air Compressors.—Bulletin K-302, 16 pages, 6 x 9 ins., illustrating a line of steam-driven, straight-line, single-stage air compressors manufactured by the Canadian Ingersoll-Rand Co., Limited, of Montreal. The type of machine described is designed to cover the field of those requiring compact, self-contained units of small and medium size for service in shop, foundry, mill or electrical plant, etc. Automatic splash lubrication, dust-proof construction, "Circo" silent leaf valves and quick convertibility to belt-drive are among the leading features of the design dwelt upon in this publication.

THE WILEY BULLETIN.

An innovation that will be welcomed by all technical men is "The Wiley Bulletin," the first number of which has appeared under date of May, 1917. This bulletin is a booklet devoted to the publications of John Wiley & Sons, Inc., of New York, and is being distributed in Canada by their agents, the Renouf Publishing Co. of Montreal.

It is divided into thirteen departments: namely, civil engineering; mechanical engineering; electrical engineering; mathematics; chemistry; medicine and sanitation; mining, metallurgy and geology; agricultural engineering; agriculture and horticulture; forestry; drafting and design; valuation and management; and military.

Under each heading is given a list of the latest, recent and forthcoming books. Photographs and biographies of some of the authors are published, together with a brief review of each book and its table of contents. The bulletin will be most useful to engineers in enabling them to keep up-to-date in their technical reading and in deciding what books to buy.

Among the forthcoming books which are indexed in the bulletin are the following:—

Rural Highway Engineering, by Geo. R. Chatburn, C.E., Prof. of Applied Mechanics, University of Nebraska.

Water Supply Engineering, by A. Prescott Folwell, author of "Municipal Engineering Practice" and "Sewerage." This is the third edition of this book, revised and enlarged.

Steam Charts, by F. O. Ellenwood, Prof. of Heating and Power Engineering at Cornell University. This special edition has been published in compliance with the suggestion of engineers engaged in steam turbine design. New tables have been added.

Hydro Electric Stations, by David B. Rushmore and Eric A. Lof. This book will cover both the hydraulic and electrical equipment, but with emphasis on the latter, it being intended primarily for electrical engineers.

Atmospheric Circulation and Radiation, by Frank H. Bigelow, Prof. of Meteorology in the Argentine Meteorological office.

Bio-Chemical Catalysers, by Dr. Jean Effront, Director of the Institute of Fermentations of Brussels. (English translation by Prof. Samuel C. Prescott, Massachusetts Institute of Technology). A companion volume to the authors' "Enzymes and Their Applications."

Quantitative Analysis, by Prof. Henry Fay, of the Massachusetts Institute of Technology.

The Chemistry of Colloids, by Richard Zsigmondy. (Authorized translation by Prof. E. B. Spear, Massachusetts Institute of Technology). This includes a description on industrial colloidal chemistry and on clays and colloids in sanitation.

Biochemical Catalysts in Life and in Industry, by Dr. Jean Effront. (Translation by Prof. Samuel C. Prescott, Massachusetts Institute of Technology).

Testing for the Flotation Process, by A. W. Fahrenwald, Prof. of Mining and Metallurgical Engineering, New Mexico State School of Mines.

Technical Analysis of Brass, by Wm. B. Price, Chief Chemist, Scoville Mfg. Co., Waterbury, Conn. Second edition, thoroughly revised.

Electric Furnaces in the Iron and Steel Industry, by W. Rodenhauser and I. Schoenawa. Second English editon, by C. H. Vom Baur. Revised to bring the book abreast of modern practice.

Ordnance and Gunnery, by Lt.-Col. Wm. H. Tshappat, Prof. of Ordnance and Gunnery at the N.S. Military Academy. This book will be used at West Point as a textbook, replacing Lissak's Ordnance and Gunnery.

A company, registered in New Zealand, with a capital of £180,000 in £1 shares, £80,000 of which is required almost immediately, has undertaken a very important and interesting mining proposition at Yetholme, near Bathurst, in New South Wales. There is there a huge field of low-grade molybdenum ore, and the company has acquired three properties carrying this ore, which have been amalgamated in one under the name of the Mammoth Molybdenite Mines. They comprise an area of 327 acres. A start will be made with a ball mill, treating 40 tons of ore per day. Later, it is intended to treat 1,000 tons per day, yielding £42,000 per week, and employing a large number of men. Even at that rate, the mine is estimated to have forty years of life.

A GOOD ROADS COMPETITION.

"The province of Saskatchewan seems a pretty remote place to many people in the United States," says a recent bulletin of the American Highway Association, "and there is a general feeling that it is decidedly 'new,' and not quite ready to take on all the obligations regarding public works which are assumed in sections settled for a longer period. Yet there are many parts of the United States where the improvement of the roads receives much less intelligent attention than is paid to it in this Canadian province. Perhaps one reason for the good results attained there has been the readiness of the authorities to profit by experience elsewhere. The amount of money they have had to spend on roads has been small. The Good Roads Year Book gives last year's expenditure as only $450,000, although this is unusually low on account of war conditions. But this money is made to yield the maximum return by intelligent outlay. Over 2,300 miles of road are now being kept in good condition by dragging them by the methods developed by the United States Office of Public Roads. After a country road has been graded and drained, dragging is the best method of keeping it in condition in most cases, and so the Provincial Highway Commission gives numerous prizes every year for the best-dragged roads in each section of the province and a grand prize for the best results of dragging on any road anywhere under its jurisdiction. As a result of this stimulating influence, and the wide distribution of the report giving the results of this annual competition for distinction in public efficiency, the earth roads of Saskatchewan are kept in a condition which would startle the local road authorities in many of the older-settled sections of the United States, could they see them. Moreover, these results are attained at an average annual expense of about $15 to $18 per mile, a sum considerably less than is wasted annually on thousands of miles of earth roads in the original thirteen States without yielding any visible improvement."

DOMINION STEEL CORPORATION.

"We are booked up in steel products to the end of the calendar year," President Workman told the shareholders of Dominion Steel Corporation at the annual meeting held at Montreal last week, "and in addition to that our shell steel output for the first six months of 1918 has been disposed of."

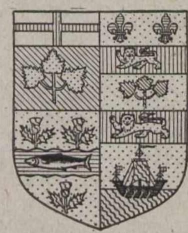
In a general review of the present position and the after-the-war outlook, Mr. Workman had this to say:—

"While the statements now before you indicate a greatly improved condition as compared with the previous history of the corporation, it must not be forgotten that lean years have been the rule rather than the exception, and it must, therefore, be my policy to exercise conservatism in all our undertakings. I feel particularly committed to this course, having in view the keen competition that will undoubtedly arise after the war.

"Many corporations engaged in the steel industry across the border have been able, partly through exemption until a comparatively recent date from taxation, and partly by reason of other advantages resulting from the attitude of neutrality long maintained by their government, to accumulate large surpluses, and to practically amortize their plants. We, in Canada, have borne responsibilities of this nature for a much greater period, and it must not be lost sight of that this condition demands careful study and the exercise of rigid economy, in order that we may not be placed in a position of disadvantage as regards our competitors."

The exports of railway material from England for the first three months of the present year were as follows, the corresponding figures for 1916 being added in brackets: Locomotives, £406,203 (£330,487); steel rails, £195,239 (£98,519); carriages, £66,494 (£124,320); wagons, £130,119 (£138,135); wheels and axles, £35,231 (£52,857); tires and axles, £51,242 (£83,348); chairs and metal sleepers, £23,733 (£27,322); miscellaneous permanent way, £117,804 (£105,730); permanent way of every description, £338,580 (£245,488). The tonnage of rails was 12,870 (10,422), and of chairs and sleepers 1,684 (2,666).

Editorial



1867 1917

The Jubilee of Confederation

NEXT Sunday, July 1st, Canada will celebrate the Jubilee of Confederation—the completion of the first half century of the Dominion's life. "The date," says the parliamentary committee appointed to report upon arrangements for the anniversary, "finds Canada with a record of achievements and resources such as few young countries possess, and it finds her also throwing herself into the world's struggle for liberty in a way that sets the final seal of nationhood upon her brow."

While not essentially an engineering topic, it is only fitting that all Canadian papers should make special reference to this notable date, and at this time pass in brief review some of the more remarkable of the country's achievements and resources.

In 1867 Canada comprised four provinces, embracing a narrow strip along the lower lakes and the St. Lawrence, with a limited frontage on the Atlantic. In 1917 there are nine provinces (besides a large unorganized territory) embracing half a continent, stretching from the Pacific to the Atlantic and from the United States to the North Pole.

From an area of 540,000 square miles and a population of 3,600,000, Canada has grown to 3,729,665 square miles and about 7,600,000 population.

In 1867 immigration was small and sporadic. In 1913 it reached 402,000 and in 1914, 385,000. Canada, since 1900, has taken the place of the United States as the chief magnet for old-world immigration.

The total value of Canadian field crops in fifteen years rose from $195,000,000 (in 1901) to $841,000,000 (in 1915). The value of live stock has increased three-fold in the past fifteen years, reaching $800,000,000 in 1916.

The exportable surplus of Canadian agricultural products in 1868-70 was only $13,000,000; in 1916-17 it was $480,000,000.

The total value of the fisheries catch in 1970 was $6,577,391; in 1915, $31,264,631.

The value of the annual product of the mines has grown from $10,000,000 to $137,000,000 within forty years.

The value of log products in 1871 was $34,156,483; at present it is about $175,000,000.

There were but few factories in Canada at the time of Confederation; to-day the annual value of manufactures is estimated to be over $1,300,000,000. Such products as wood pulp, automobiles, electrical apparatus, etc., which were unknown in 1867, now run into many millions of value annually.

In 1871 the manufactures of iron and steel were considerably less than $3,000,000, while in 1915 they reached $50,000,000 and this figure has been greatly increased by the war. Foundry products, which valued a little more than $7,000,000 in 1871, were worth approximately $37,000,000 in 1915. The manufacture of railway and other cars in 1871 amounted to half a million dollars; in 1915 this item had increased to $25,000,000. Just about $1,000,000 worth of paper was manufactured in 1871, and in 1915 thirty times as much was made.

At the time of Confederation about $20,000,000 had been expended on the improvement of the waterways of Canada; to date the expenditures on canals alone exceeds $106,000,000.

There were no roads or streets of permanent construction in Canada at the time of Confederation, while now every province in Canada has a good roads organization and every city has spent thousands—and some of them millions—upon street improvement. Quebec and Ontario have spent many millions of dollars upon road work, yet the good roads movement in Canada is still in its infancy and hundreds of miles of urban streets are still unpaved.

The science of building construction has probably advanced as far during the past half century as has any branch of engineering. The modern steel skyscraper, so familiar a sight in all large Canadian cities to-day, is a far cry from Toronto's famous first "Iron Block," with its cast iron columns and wrought iron floor beams. Thirty-five Canadian cities issued building permits totalling $38,783,994 in 1916, and $32,285,721 in 1915. Fifty-two Canadian cities issued building permits totalling $166,114,508 in 1913, and $94,807,577 in 1914. Compared with these figures, of course, the annual value of buildings erected about the time of Confederation was insignificant. Steel, cement, asbestos and many other modern materials were practically unknown then. Nearly all construction was of wood, brick or stone; mostly wood.

Bridge building, too, has developed rapidly. The wooden bridges of 1867 have largely been replaced by iron, steel or concrete structures. Nowhere in the world have difficult problems of design and construction of bridges been more successfully solved than in Canada. The Quebec Bridge, the Lethbridge Viaduct, the Victoria Bridge, the C.P.R. St. Lawrence River Bridge, the Outlook Bridge, the bridges at Niagara Falls and those in the Rockies may be mentioned among many Canadian structures known throughout the engineering world.

At Confederation there were 2,278 miles of railway in Canada, with an investment of $257,000,000. To-day there are 35,582 miles, involving a capital of $1,876,000,000. The freight handled in 1867 amounted to

5,670,000 tons; in 1915, there were carried 101,394,000 tons. Slightly over 5,000,000 passengers rode on Canadian railways in the year of Confederation, while for 1915 this figure exceeded 46,000,000.

The above figures do not include electric railways, of which, of course, there were none fifty years ago. In 1915 the mileage of electric railways in Canada was 1,590, and the passengers carried in 1914 numbered 615,000,000.

In 1867 there were just seven waterworks plants in Canada; in 1915 there were 528 such enterprises, including 72 filtration plants, and involving an expenditure of $123,725,633 and annual maintenance charges of $4,-558,539, exclusive of interest on the capital charges.

At Confederation there were comparatively very few sewers in Canada. In 1915 there were 279 sewerage systems in the country, costing $77,723,353, including 75 sewage treatment plants.

There were 13,057 post offices in Canada last year as compared with 3,638 in 1868, and the respective revenues of the post office department for those years were $808,000 and $13,046,000.

Canadian telegraph companies now handle 12,000,000 messages annually, compared with an absolutely insignificant business in 1867. Over fifty wireless stations have been built, and there are half a million telephones in use in Canada. The telephone, of course, was wholly unknown fifty years ago. The wire mileage of the telephone companies is approximately 1,500,000.

Imports in 1868 amounted to $68,500,000; in 1917, $845,300,000. Exports in 1868 were $45,500,000 as compared with $1,151,300,000 for 1917. Customs duties amounting to $8,800,000 were collected in 1868, compared with $147,600,000 for the fiscal year ending in 1917. Among the exports for 1917 were $85,600,000 worth of mine products compared with $1,276,000 for this item in 1868. Aluminum exports now amount to over $3,500,000 annually, and paper exports to more than $20,000,000.

The total assets of the Dominion Government at the time of Confederation were $17,000,000; to-day they are about $322,000,000. The total Dominion revenue on consolidated fund, which was $13,600,000 in 1868, was $172,100,000 in 1916.

The total on deposit in chartered banks grew from $33,000,000 in 1868 to $1,418,000,000 in 1916, while the post office savings bank deposits grew from $212,000 to more than $10,000,000. The amount to-day on deposit in all government savings institutions is over $54,000,000.

The only business paper in Canada in 1867 was The Monetary Times, of Toronto, and three other commercial papers which were absorbed by The Monetary Times. To-day there are 147 trade or class journals, representing every line of industry.

There are 26,000 schools in Canada, compared with 10,000 at the time of Confederation. The expenditure on education amounts to about $56,000,000, compared with $2,500,000 in 1867.

Canada has recruited 411,000 soldiers, and has sent 311,000 overseas. She has manufactured and shipped over $525,000,000 worth of munitions to date.

The necessity for restoring the devastation caused by the war must throw unlooked-for opportunities upon the newer countries of the world and especially upon Canada. Only a little more than one-ninth of the soil available for agriculture has been improved to date. There are possibly 390,000,000 acres of agricultural soil still available, of which probably 100,000,000 acres could be immediately improved. There are 500,000,000 to 600,000,000 acres under forest in Canada, half of which area carries timber of merchantable size. The mineral potentialities of the country are enormous, as are also the water power resources. In Canada to-day about 1,850,000 e.h.p. are hydraulically developed, and there are available falls totaling over 15,000,000 horse-power still undeveloped, probably not more than one-third of which are so far distant from settlement as to be impossible of development under present conditions.

With natural resources such as these to draw upon, we may, at this fiftieth anniversary of our nation's birth, look to the future with just confidence.

PERSONALS.

A. W. McVITTIE, of Victoria, B.C., has been gazetted a member of the Corporation of British Columbia Land Surveyors.

W. G. MURRIN, formerly general superintendent of the British Columbia Electric Railway Co., has been appointed assistant general manager.

R. H. PARKS has been appointed operating manager of the Canadian Car and Foundry Company, and W. S. ATWOOD has been appointed assistant to W. W. Butler, vice-president and managing director.

E. COTTON, a land surveyor of Victoria, B.C., has joined the Sixth Field Company, Canadian Engineers, at North Vancouver for overseas service. Mr. Cotton is a native of New Westminster and has had eleven years' experience in survey work.

N. A. MARSH, of the John verMehr Engineering Company's engineering staff, Toronto, has left for an extended trip to Brazil, South America, to supervise the erection of the verMehr water filtration plant which is being constructed at Pernambuco.

FRANK H. CROCKARD, formerly vice-president of the Tennessee Coal, Iron & Railroad Co., a subsidiary of the United States Steel Co., in active charge of construction and operation, with headquarters at Birmingham, Ala., has been elected president and general manager of the Nova Scotia Steel and Coal Company, to succeed Col. THOMAS CANTLEY, who has been elected chairman of the Board of Directors. Col. Cantley has been connected with the company for more than 30 years, having been general manager for 16 years, and president for the last two years.

Lieut.-Col. J. S. DENNIS, president of the Canadian Society of Civil Engineers and assistant to the president of the Canadian Pacific Railway Co., has been loaned to Gen. White, commander of the British-Canadian Recruiting Mission in the United States, to assist in obtaining British and Canadian recruits for the army. Col. Dennis will command the western states, with headquarters at Chicago. He expects to be in Montreal about every ten days, however, and will keep in touch with C.P.R. work and with the affairs of the Canadian Society.

T. E. RYDER, former manager of the St. John Branch of the Canadian Fairbanks-Morse Co., Limited, has just been promoted from the grade of lieutenant to that of captain. Capt. Ryder has also been awarded the Military Cross and has been mentioned in despatches upon more than one occasion. Previous to the war he was an officer in the St. John Battery. When war broke out he immediately enlisted for active service and was attached to the Ammunition Column, Heavy Battery. He still retains the title of manager of the St. John Branch of the Fairbanks-Morse Company, with leave of absence for war duties.

E B.