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The Canadian Engineer

WEEKLY

ESTABLISHED 1893.

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The Canadian Engineer

ESTABLISHED 1893.

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Index to Contents:

The Index to Editorial Articles is on page 96; index to Advertisements on page 126; the Buyers' Guide is on pages 152-6; the Catalogue Index on page 157

THE ANNUAL RAILWAY NUMBER.

The third issue in September of The Canadian Engineer has been the Annual Railway Issue. The current issue is larger and brighter, not only in presswork and editorial matter, but in the volume and character of the advertising pages. The demand for space in this issue, the increasing orders for additional copies, and the pleasure we have experienced in preparing the special number lead us to already plan larger and brighter ideas for the Annual Number of 1911.

The railroad transportation routes of Canada have not only been developed as avenues of commerce, but they have been the pioneers and missionaries in the agricultural and mining developments of our great areas. With the opening of the C.P.R., Canada was a narrow ribbon stretched across the North American continent close to the forty-ninth parallel. The Canadian Northern widened the band, and within the last two years the Grand Trunk Pacific has invaded the hinterland and rolled northward the frontier a few hundred miles more. The traveller, the trapper and the rancher are now lamenting the disappearance of the last of the wild lands.

This issue of the Railway Number presents concisely the history and the development of the Canadian railways; it outlines the financial obligations and compares Canadian transportation conditions with the conditions in other countries; it goes fully into the railway situation and indicates the necessities of the future. Modern rolling stock is described, and reference is made to the development of the past few years. The terminal facilities are referred to, and a lengthy article dealing with the electrification of steam roads will be found of unusual interest just now because of the attention which is being given to the electrification of yards and terminals and tunnels.

Outside of the editorial matter, which has been especially prepared for the reader of this number, we would call your attention to the large number of advertisements which have been especially prepared for those interested in railway work and allied interests. The large number of full-page advertisements which appear are an indication that the manufacturer is prepared to display the output of his factory. Whether an intending purchaser or not, you will find many suggestions in the advertising pages.

TRACKWORK.

People of to-day have taken so much to travel that many times a year the whole population trusts itself to the mercies of the railway train. For the travellers' safety good track is necessary, and trackmen must be, like soldiers, ever on the alert, watching for loose joints, sunken ties, washouts and obstructions. The trackman's tools are his arms, and, like the successful soldier, he must have the most modern and reliable equipment to meet present-day conditions.

The autumn months are the most important for trackwork, and a roadbed in good condition in the autumn will give splendid service throughout the winter and come through the spring thaws and freshets in fine shape.

The ditches and drains and watercourses must be opened and cleared of grass and weeds to allow of quick run-off of the fall rains. Switches and switch fixtures must be trued up and adjusted and frequently re-spiked to be in condition for the heavy traffic of the autumn and to go into the winter in good alignment and adjustment.

Through the summer months new ties have been laid, and, in some sections the renewal of rails has been an important feature of the season's work. Usually, the re-laying has meant the replacing of 30-foot rails by 33-foot rails, thus eliminating every tenth joint. Not only do the new rails make a saving in angle-bars, bolts and nut-locks, but they give a better roadway and a safer track. Some are advocating a 50-foot rail, it being claimed that the expansion will not be more than can be taken care of, and that when the rail manufacturers have altered their equipment to suit the new length, it will mean a better rail for the road, and likewise a less expensive one.

In the laying of new track, the proper expansion joint to leave has hitherto been too much a matter of chance. Since so many of our accidents have been caused by the spread rail, the allowance for proper expansion is important. The difficulty in leaving the right space between the rails has been to secure foremen with the right kind of judgment in the matter. In addition to being provided with thermometers, the foreman must recognize that while at times the thermometer may register a certain temperature in the shade, the rail exposed to the sun may show a much higher temperature. He must study the weather conditions and notice carefully the variations in the temperature throughout the day. But absolute exactness is impossible. Much will depend on the foremen's good judgment.

Good trackwork means a saving in maintenance and in re-laying stock, and contributes more than anything else to the comfort of the travelling public.

INTERURBAN RAILWAY SERVICE.

The interurban railway lines have become such an important link between the merchant and the country purchaser, between the city office man and his opportunity for country quiet and country freedom, that we are surprised more attention is not given to the pushing of interurban lines in all directions from centres of population to farming and gardening areas and rest resorts.

The recent strike on one of the large steam roads of Canada created a situation which presented favorable opportunities to the interurban road for developing freight traffic, and as a result we find one of our electric roads hauling freight fifty miles from lake to lake, transhipping it and delivering it at a railway division point at the same charges as the steam road ordinarily collected. Inland towns have delivered to them by standard gauge interurban roads such heavy freight as coal and lumber, and the merchant and the transportation man should not be slow to widen their trade horizon, but be alert enough to grasp the opportunities that interurban roads offer.

We hear a great deal to-day about the high cost of living, of the necessity for better markets. The interurban roads have one of the quickest and most satisfactory solutions. They bring districts twenty or thirty miles from the city within an hour of the city market. They make the market for quantities of perishable goods, which teaming over rough roads or delay in delivery make unsuitable for use. In this way they find a market for produce, and bring to the consumer, at a reasonable cost, his supplies. The frequency of interurban service makes it possible for the people of country districts to enjoy the entertainment provided where the population is denser, and they provide for the city dwellers quick and frequent service away from the dust and noise of city streets.

TRACK BALLAST.

In the past the question of the proper amount of ballast required on railroad work has been settled by the consideration of convenience and first cost. Theory has had but little to do with the proper design of railway tracks in connection with ballast.

The American Railway Engineering and Maintenance of Way Association have a special committee on ballasting, and one of the questions they are now considering is the proper thickness of ballast to ensure uniform distribution of loads on the roadbed. Two theories have been advanced as to the distribution of the load. One assumes the load to be distributed in pyramidial form, the sides of the pyramid forming an angle of sixty degrees to the base. Others hold that this distribution does not follow a straight line, but is along a curve. On either of these assumptions, if we consider the bearing of the load alone, it is a waste to add ballast beyond a certain depth when the spacing of the ties is decided upon. On the other hand, leaving out of consideration the rails, the unit load on the road can be reduced by increasing the thickness of the ballast under the ties and spacing the ties so that compression areas just touch and do not overlap.

In North America railroads have adopted the method of close tie-spacing, the minimum spacing being eliminated by the amount of room required for tamping. The introduction of a hundred-pound rail has led to the wider spacing because of the stiffer girder heavy rails furnish.

In connection with Canadian railroads it has been frequently remarked that the maintenance charges do not vary with the per train-mile, and that the per train-mile charges for maintenance vary somewhat with the character of the track and with the volume of traffic.

In consideration of this question of ballasting there are so many questions other than the bearing power that have to be considered that the question becomes complicated. Ballasting is frequently carried on as much for drainage as for the bedding of the ties, and the various materials, varying from fine sand to crushed stone, each have different bedding qualities.

Railway operation is becoming more a matter of plan and purpose than heretofore, and the increased attention which is being given to track work will develop more scientific methods of handling this problem.

CAR DETAILS.

When one travels in a modern Pullman coach or a first-class interurban trolley car, he cannot but admire the design and workmanship which provide safety and comfort to the traveller.

The travelling man is not concerned so much with the engine design—all he expects is to make schedule time, but he is deeply concerned in the dozen and one things with which he comes in contact in the coaches. The ventilators, the door-catch, the window fasteners, the grasp handles—these are things with which he has an intimate knowledge, and which are his immediate concern. Clothing torn on a projecting screw head, fingers pinched in an ill-designed door, windows that lift two inches and no more, irritate and annoy a traveller, and the master mechanic who can spend time enough to see that his men remove these causes of irritability or can design equipment which will eliminate these annoyances as much as possible is a valuable man to his company and a public benefactor.

EDITORIAL NOTES.

The collection of rolling stock at the Brussels Exhibition has been one of the most notable. All the larger manufacturing countries were not represented, but the great array of rolling stock indicated that the large makers were anxious that their product be known. Germany made a grand display in her own building. It is unfortunate that Great Britain and the United States did not see fit to take part in this display. They are two of the largest manufacturers of railway rolling stock.

* * * *

In our table of steam railways a clerical error occurs in connection with the Grand Trunk Pacific. The table makes it appear as if the present mileage of this road was fifteen miles. This should have read fifteen hundred miles.

COST OF OPERATING RAILWAYS.

The accompanying diagram should prove interesting to railway managers and employees. It should be of some help also to conscientious statesmen who are often asked to throw the harpoon into the railroad before the latest wound has healed. It will surprise some people to learn that, according to Government reports, 43.58 per cent. of the gross earnings of Canadian railways goes to labor direct, as compared with 41 per cent. paid on the same account by American roads. This is largely due to the climatic conditions and to the lower earning power of the Canadian railways.

Moreover, American roads, covering about the same territory as Canadian roads cover, operate through a settled country, serving 87,000,000 people, while Canadian roads have only 7,000,000 to serve.

In addition to the 43 per cent. of gross paid for labor, 75 per cent. of the money paid on account of fuel and oil, representing 9.7 per cent. of gross earnings, goes to the men who mine coal and boil oil. This brings the amount paid to labor directly and indirectly up to 52.65 per cent. of the earnings. The cost of upkeep, material, equipment and supplies eats up 8.82 per cent. of the gross earnings, 6.02 per cent. of which goes to the men who work with their heads and hands to produce these items and articles.

So we find that the railway pays out close to 60 per cent. of every dollar taken in for labor.

The fact that Canadian railways pay considerably more of each dollar on this account than is paid by their American competitors refutes the argument that American manufacturers come to Canada in order to secure cheaper labor.

Naturally our winters being longer and harder and our days shorter than the winters and days are farther south our railways get less out of the day's work.

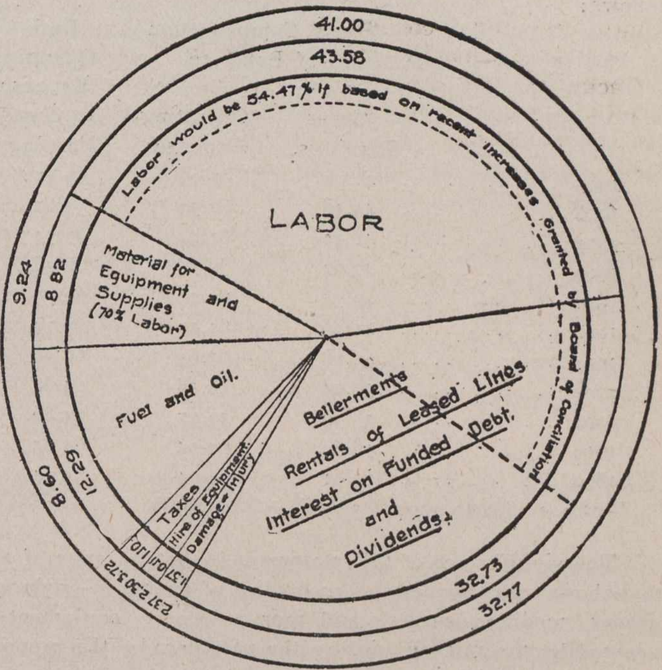


Diagram showing how the gross earnings of the Canadian Railways for year ending June 30th, 1909, were spent.

Comparative figures for United States Railways are shown in outer circle. Gross earnings $145,056,336.

Dotted line shows the extent to which the cost of labor would ultimately be increased, and its consequent effect on betterments and finances of the railways, if the increases allowed by the Board of Conciliation to trainmen are granted.

Another point against our railway is that nearly every American line running east and west passes through or near some vast coal field. Canadian roads have not only to haul their coal great distances, but in addition have to pay a heavy duty on every ton of coal they import, a serious handicap.

The tendency in Canada, as in the States for the past decade, has been raised taxes and at the same time reduce the earning power and increase the fixed charges. In the meantime during the past ten years the wages of railway employees in Canada have been increased by nearly 30 per cent.

So all things considered Canadian railways make a splendid showing from most any viewpoint, and they unquestionably have in many respects a harder row to hoe than have the American lines, with whom for transcontinental traffic they must compete.

Always when planning war on the railway the railway employee has to keep in mind the benefits accruing from pension or superannuation funds, the saving of years, which are lost to him if he severed his connections with the road. As the railways contribute largely to this fund, they very naturally insist upon an oversight of that department. In the case of a recent strike at Winnipeg one faithful old employee had but a year to serve before becoming eligible for benefits, but he was forced to walk out and lose a life pension.

An interesting table compiled by the Bureau of Railway Statistics gives the proportion of compensation of United States Railway employes to gross earnings and operating expenses and of operating ratio ten years, 1899 to 1909, as follows:

	Ratio Compensation of Labor to Gross Earnings.	Ratio Compensation of Labor to Operating Expenses.	Ratio of Operating Expenses to Gross Earnings.
1909	41.00%	62.06%	66.12%
1908	43.38	62.33	69.67
1907	41.42	61.41	67.53
1906	40.02	60.79	66.08
1905	40.34	60.40	66.78
1904	41.36	61.07	67.79
1903	40.78	61.65	66.16
1902	39.28	60.58	64.66
1901	38.39	59.27	64.86
1900	38.82	60.04	64.65
1899	39.81	61.04	65.24
Increase 1899 to 1909	3.00%	1.65%	1.35%

The significance of this statement is that, in spite of all the labor-saving devices and economies of operation—reduced grades, modified curves and more efficient equipment—adopted by the railways during the past decade, the proportionate cost of labor to earnings and to expenses has increased. The fact that it has been above 40 per cent. persistently since 1902 proves that labor continues to receive its full proportion of the receipts of American railways.

RAILWAY SIGNALING.

J. A. Whyte.

Railway block signaling systems are primarily devised to facilitate the operation of trains over conjested trackage, and to permit of higher speeds without sacrificing the factor of safety in travel. This short talk shall be more confined to that part of railway signaling which has more to do with the engineering practice, namely, fixed signals. By a fixed signal is meant a signal of fixed location to indicate conditions affecting the movement of a train.

Signaling systems could be divided into three general heads, namely, "Manual Block System," "Controlled Manual Block System," and "Automatic Block Signal System." The "block" in signaling practice refers to a stretch of track of a defined length into which trains are admitted by a fixed signal located at its entrance end. The "block signal" is a fixed signal located at the entrance end of a block section for the purpose of admitting trains to the section it governs.

"The Manual Block System" comprises a system of consecutive blocks or stations, the signals in which are moved by hand upon the information received by telegraph, telephone, or by other means of communication.

"The Controlled Manual Block System" comprises a system of consecutive blocks or stations, the signals in which are controlled by or through the agency of electricity, compressed air, fluids or gases, and so designed and constructed that the signals cannot be made to display a "clear" or "proceed" indication without the co-operation of the signal man at both ends of the block or station.

"The Automatic Block Signal System" comprises a series of consecutive blocks, the signals in which are controlled and operated automatically through the means of electrical track circuits by the presence of a train into, through, and out of the block section to which the signals are connected, and worked by the agency of electricity or pneumatic power.

It is considered impractical to predict with certainty the ultimate traffic conditions of a particular stretch of track and the signaling system to be adopted must be designed to take care of all traffic demands expected to arise within a reasonable period of years, also to have sufficient flexibility to permit of convenient additions to meet the increased traffic which may develop.

After deciding the system best suited to meet the requirements the tracks are laid out into blocks to secure the greatest number of train movements at determined speeds consistent with economical operation and safety. The length of the blocks are determined by the traffic conditions at determined speeds, governed by the minimum braking distances on varying grades at determined speeds consistent with economical train operation. The proper spacing of signals and the headway thus arrived at gives the capacity and earning power of the particular trackage signaled, and the comparative ratio between the unit cost per block-mile and the earning capacity per train block-mile-year determines the commercial value of the block system adopted. Block signaling might be safely termed "Railway Traffic Assurance," and the cost of the maintenance and up-keep of the block system called the "Premiums."

The question might be asked: Do the railways receive a fair return in payment of the "Traffic Insurance Premiums?"

In England the steam roads have comparatively short mileage and obviously very heavy traffic. As the traffic increased they found themselves face to face with serious problems. They increased their trackage until some other economical means for facilitating train operation had to be devised as their right of way unfortunately had bounds. It was thus found compulsory to devise means whereby they could increase their train movements on the same trackage without lowering the factor of safety in travel. The English roads have consequently been the pioneers in the use of block signaling systems.

The Controlled Manual Block System without the use of track circuits are now very extensively used in England and by it enormous train movements under terrific speeds are permitted with almost perfect safety in travel.

According to the British Board of Trade report on railway accidents in Great Britain during the fiscal year 1909, only one passenger was killed in a train accident, and in fact excepting this accident which happened on July 2nd, 1909, none were killed in this way in twenty months. The number of train accidents total twenty-one. The number of employees killed total eighty-two, and the passengers injured three hundred and ninety. This is a remarkable and most creditable report when fully considering the density of traffic, number of passengers carried and the English fogs, and speaks well for the English discipline of the railway employee and the efficiency of the block signaling system. Do the English roads receive a fair return for the payment of the traffic insurance premiums?

It is known that during the developments of the New York Subway Rapid Transit Service, the successful and efficient operation of this undertaking very largely depended upon the adoption of a proper system of block signaling.

In fact the selection of the system of block signaling was rivalled in importance only by that of the provision of the proper motive power. The traffic anticipated was unparalleled in history and the new problems thus confronted were many and difficult. Plans were devised to permit of a one-minute headway on express tracks and three-minute headway on the local tracks. After most careful consideration the Automatic Block Signal System was selected with all the switches both for the main line movements and yards to be operated by electro-pneumatic power from central points through interlocking towers. The cost of this complete system was at that time believed to be the largest single order ever given to a signal manufacturing company, and involved an expenditure for the complete system approximately one million, eight hundred thousand dollars. That this system permits of reasonable speeds and facilitates train movements over a most restricted trackage at absolute safety is beyond question.

The fact that a very large number of steam and electric roads throughout the world are adopting very extensively the use of modern block signal systems bears evidence of its value, not only to relieve the congestion but also to permit of a greater number of train movements over the same trackage without lessening the factor of safety in travel

In United States (in round figures) over 40,000 miles of line are worked by the Manual Block Signal regulated by the telegraph; 3,300 miles by telephone and 850 miles by electric bells. The Control Manual Signals without the use of track circuits are in use on 3,000 miles, and 750 miles using track circuits at stations; 250 miles by controlled manual apparatus with continuous track circuits throughout the block section. 250 miles of railway is operated by electric train staff system and approximately 15,000 miles of road is operated by the automatic block system. Many roads have installed block signals to its passenger tracks only, while others have installations on both passenger and freight tracks. In view of the permissive feature of automatic block signaling some have considered it not good practice to signal single track roads, however, there is installed over 6,000 miles of single track automatic block signal in the United States operating to complete satisfaction.

Although block signaling is a comparative new art, the developments have been most rapid and remarkable. It is quite obvious that a new art develops new conditions both in requirements of operation and specifications of manufacture. It was found that the specifications in the manufacture of apparatus used for the telegraph, telephone, light and power, and kindred lines of electrical devices would not do for certain devices used in railway block signaling.

In the former arts the attendant is usually close at hand to take immediate care of the apparatus and plant under his control in cases of trouble. For example, should, during a storm, a wire break or become crossed with other lines (probably wires of the block signal system), the attendant immediately cuts out certain apparatus or shuts down the entire plant as the nature and seriousness of the case warrants and the trouble is repaired immediately or at least is investigated immediately. In railway signaling the conditions are dissimilar, usually the apparatus is isolated and many miles from the nearest attendant. A train involving an expenditure of one hundred thousand dollars and carrying several hundred passengers is speeding at seventy miles an hour. The lives of these passengers must not be permitted to hang in the balance by the mere breaking or crossing of wires, and the signal governing the movement of the train must assume the danger or stop position. This signaling apparatus has no human hand to care for it in such circumstances, but, however, must be designed and constructed and practically taught to take care not only of itself but to have a care for the hundreds of lives over which it is held as guardian during travel over the tracks it controls. This piece of mechanism is taught that it is better to stop a train when not necessary than not to stop a train when it is necessary. The first lesson it receives is obedience, and second punctuality and regularity. Its entire makeup is watched with care, and its behavior is always at stake. It is quite to be expected that when so much depends upon the faultless operation of this piece of mechanism, that the utmost care must be given in its manufacture.

In Canada we have stretches of track which warrant block signaling, and while no signaling has been done to speak of, it is considered that the Canadian railway management shall not lag behind their world-wide reputation as progressive and enterprising railroad builders when the merits of modern railway signaling are put before them. Should it be shown that the cost of the upkeep and maintenance of a complete installation of block signaling is less than the cost of the accidents, loss to rolling stock, betterments, payments in injury and death claims while the trackage is under low unit-earning capacity, is the factor of the materially increased unit-earning capacity on the same trackage, permitting of higher speeds and tonnage, comfort and safety in travel, a fair return for the payment of traffic insurance premiums.

GRADING WORK ON THE C. N. O. RAILWAY, TORONTO-OTTAWA LINE.

The Canadian Northern Ontario Railway has completed in the Province of Ontario a line from Toronto to beyond Sudbury, a line from Ottawa to Hawkesbury, which crossing the Ottawa River connects with Montreal and Quebec; and in the spring of 1910 they commenced their Toronto-Ottawa line. This last leaves the Toronto-Sudbury line about a mile north of Rosedale Station, working eastward to the north of East Toronto, and then down to Port Hope on Lake Ontario, following the shore line until Belleville is reached, it then strikes in a north-easterly direction to Ottawa.

Fig. 1.
Wheel Scrapers.

As far as the line is now constructed, the grading has been common excavation, and because of the nearness of the line to the lake front the rivers and streams have been crossed at their largest points, necessitating some very large fills and bridges. For most of the grading, slusher scrapers were used, and, for the larger fills, or where the haul was long, wheelers, as shown in Fig 1.

Where the cut was very large and the haul long, steam shovels were put in, and the accompanying illustration shows a Marion Shovel, Model No. 30, at work in a said cut. This is a 25-ton shovel with a ¾-yard dipper, working in conjunction with 1½-yard Koppell steel hopper cars. These cars are being operated on 20-pound steel, and the average output per 10-hour day is 30 to 35 trains of ten cars each, the maximum haul being 2,500 feet. These cars dump easily, clean well, and with good usage continue long in service; but when damaged are not so easily repaired in the construction camp as wooden ones. The fill (60,000 cubic yards) on which they are working, is being built up in lifts of ten feet.

Fig. 2.
Steam Shovel in Cut.

The force engaged on this work is: On the shovel—engineer, fireman, two laborers, man and horse spotting, and man and team drawing water; on the dump—foreman, man and team, four men levelling or when lifting track, seven.

The Marion "Improved Model 'A'" shown in this illustration has a 1¾-yard dipper, and loads from 100 to 125 three-yard cars per day, the material being sand and gravel. The maximum haul is 1,400 feet and the cars, which are of the side-dump wooden variety are spotted at the shovel with a team, which hauls them to the mouth of the cut, where they are attached to a steel cable, operated from a stationary hoist, shewn in photo No. 4.

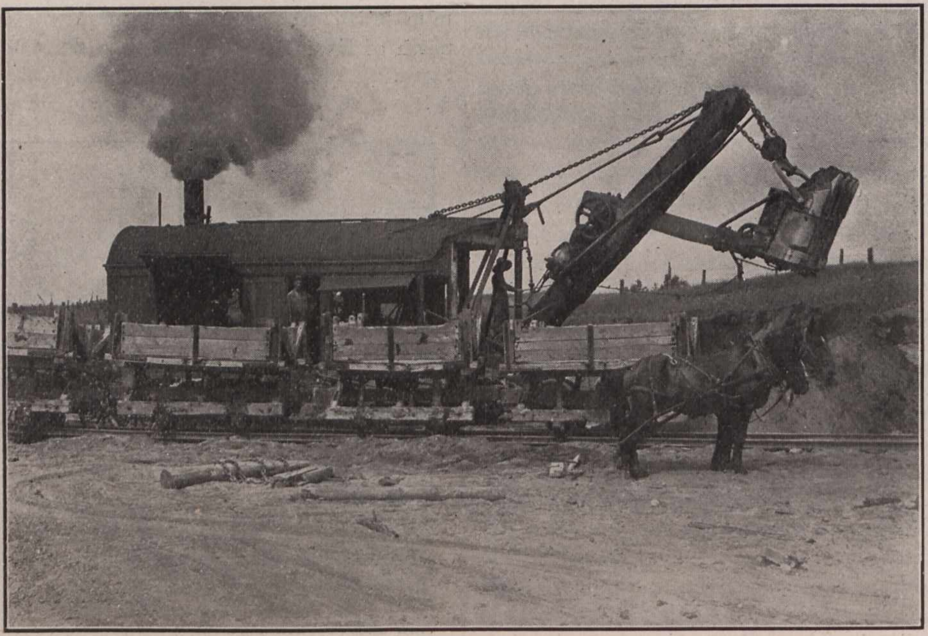


Fig. 3.
Marion Steam Shovel Filling Cars.

These cars run on 60-pound track, 36-in. gauge, and the force consists of engineer, cranesman, fireman, two laborers, together with two teams and teamsters. One engineer handles the stationary engine, one brakesman the cable, and the dump requires five men and a foreman.

For the first time in railroad construction corrugated metal pipe (shewn in photo 1) was put in for the smaller culverts, while concrete arches or flat tops were used in the

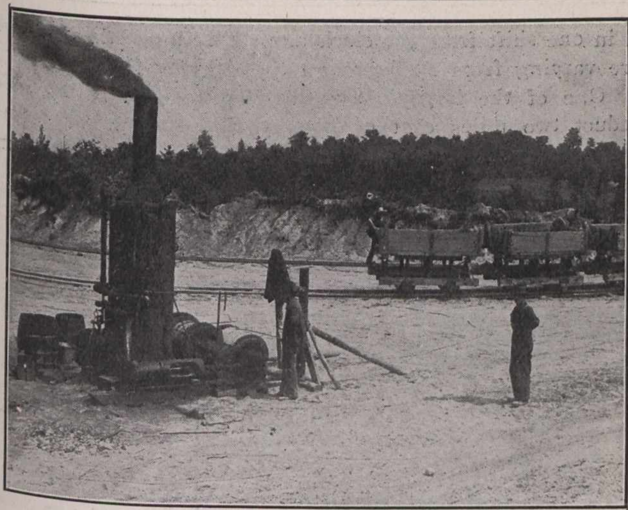


Fig. 4.
Stationary Engine Hauling Cars.

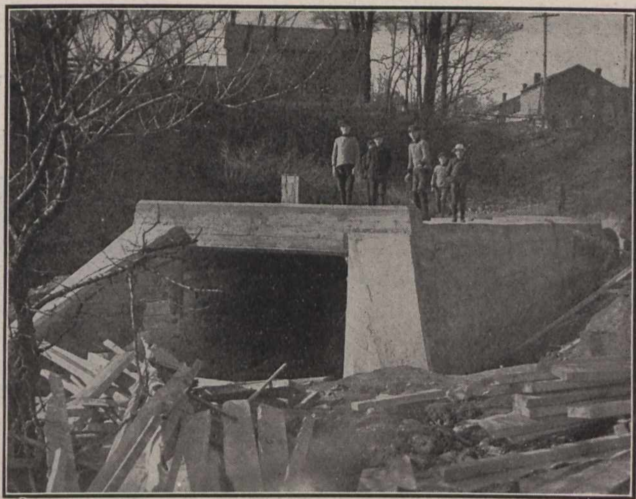


Fig. 5.

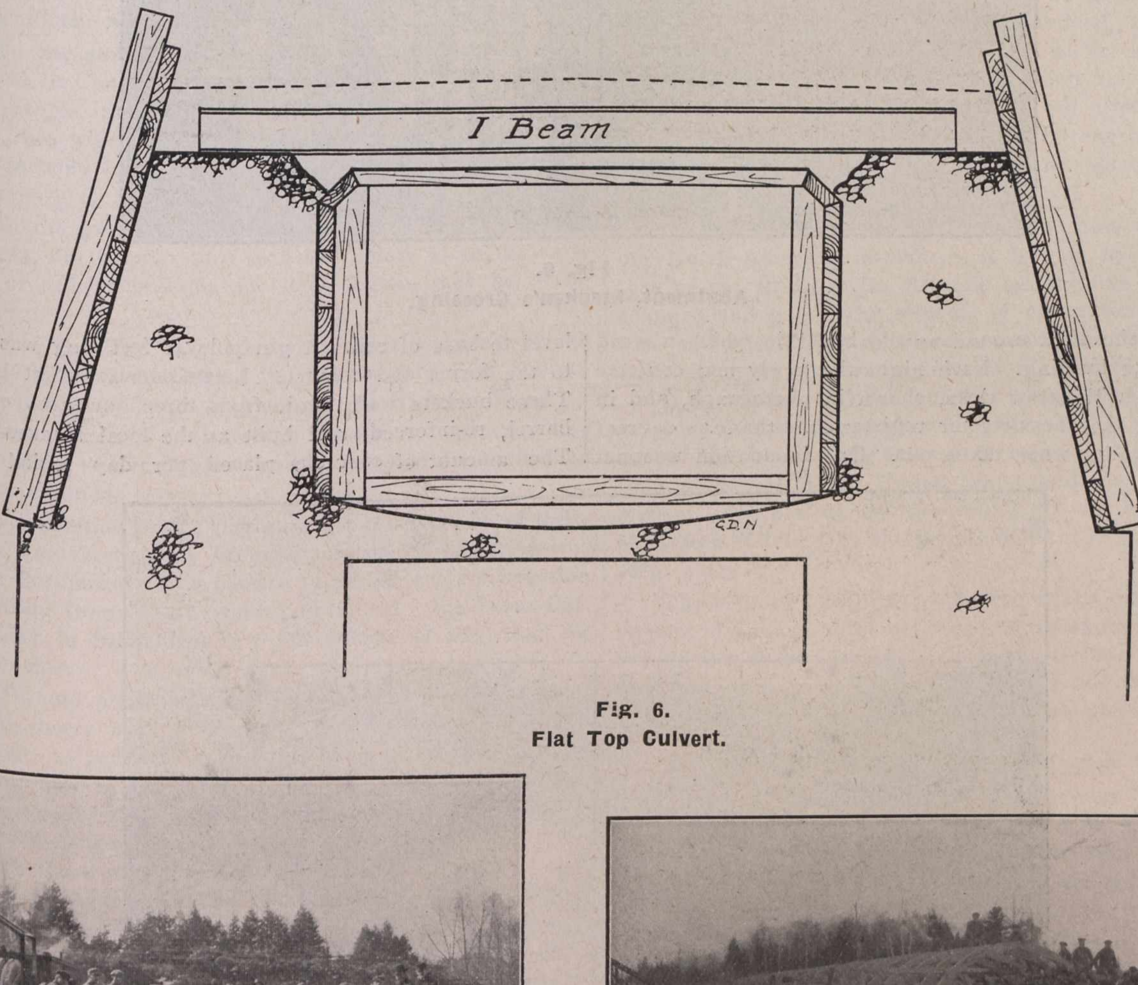


Fig. 6.
Flat Top Culvert.

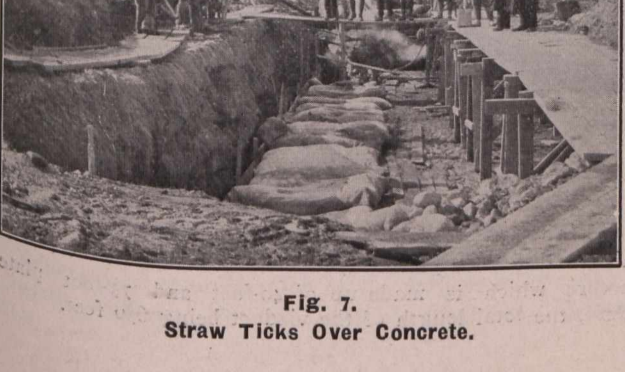


Fig. 7.
Straw Ticks Over Concrete.

Fig. 8.
Concrete Arch.

larger openings. Photo No. 5 shows a 6 x 8 flat top culvert 75 feet long, located in Orono.

During last January and February a 20-foot concrete arch culvert was built about one mile west of Orono, in a 34-foot fill. The water was heated with steam, and the gravel was shovelled around an old boiler in which a wood fire was kept burning. Each night the newly laid concrete was covered with straw ticks, shown in photograph, and in no case did the thermometer register less than 40 degrees F. next morning when taken out. One foundation was put in at a time, and when ready for the arch forms, the first was carefully thawed out with steam and hot water, the two walls were then built together until the arch ring was reached. The ends of the culvert were boarded up, a stove placed inside, and the whole of the arch ring of 110 yards was put on in one shift from 7 o'clock a.m. to 11 p.m., the temperature varying from 25 degrees to 40 degrees F.

One of the largest structures on the line is the steel viaduct two miles east of Bowmanville station. The east abutment seen in the foreground is 38 feet high from ground level to base of rail. A gin pole 40 feet long was fastened to the forms and concrete hoisted in a bucket by team. These buckets were made from three quarters of an oil barrel, re-inforced, and built at the local blacksmith shop. The amount of concrete placed per day varied from 50 yards in the foundation to 10 yards at the top, a ¾-yard Coring Batch mixer, motor driven, being used. In the background is the west abutment, height 20 feet with parallel retaining walls. Ten pairs of pedestals will support the superstructure which is made up of 40-foot and 75-foot plate girders, the total length of the viaduct being 650 feet.

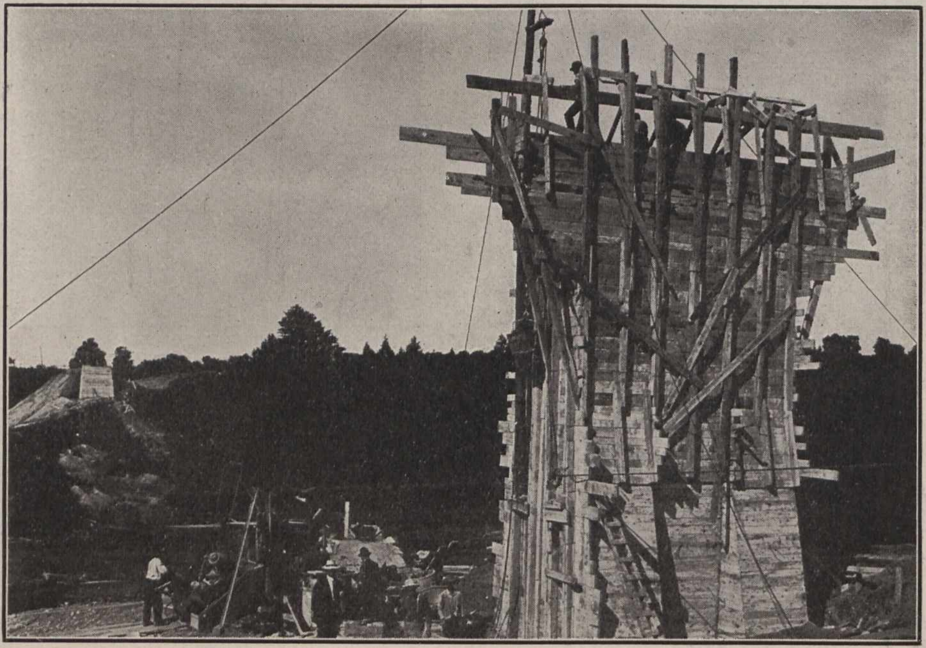
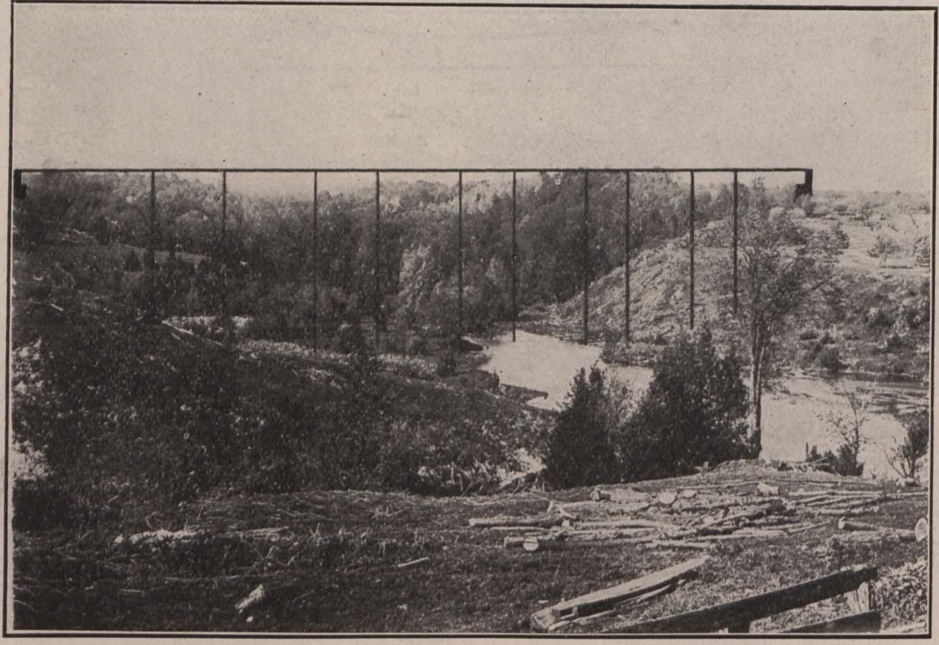


Fig. 9.
Abutment, Stephen's Crossing.



Sketch of girders at Stephen's Crossings.

RAILWAY DEVELOPMENT IN CANADA.

R. A. Baldwin.

Railways form a tremendous factor in the commercial importance and development of any country and especially is this true in regard to Canada.

The railway has been the potent factor in enabling the Western farmers of the United States and Canada to prosper and multiply by supplying their productions to the more populous countries of Europe. It has compelled the British farmer largely to discontinue the growing of cereals and has brought the agricultural interests of Great Britain to the verge of bankruptcy. Here, in Canada, it has conducted population along lines other than the original rivers, streams and lakes and has widened beyond all calculation the area of productive labor.

The least expanse of this country has been brought all the year round under grip by means of railways which have supplemented the exceptional facilities Canada possesses in her magnificent waterways.

When one stops to consider that there are 24,104 miles of railway in Canada at the present time, that they employ 125,000 people, and that their aggregate earnings for the year of 1909 were over $145,000,000, one has some idea of their immensity and importance.

The purpose of this paper is to trace briefly the beginning and the growth of this wonderful system of railways in Canada, but before doing so a few points as to the early history of railway building in Great Britain may be of interest.

In 1814 the first locomotive that propelled itself by adhesion of its wheels on round top rails was tried at Killingworth Colliery by George Stephenson and Nicholas Wood.

In the autumn of 1825 George Stephenson opened a line from Stockton to Darlington, and a speed of five miles an hour was attained.

The opposition by the public to the construction of these railways was very plainly brought out when application was made to Parliament for a charter to permit the construction of a railway from Manchester to Liverpool. Sir Isaac Caffins' speech in Parliament is a fair sample of the attack of the opponents.

He "would not consent to see widows' premises and their strawberry beds invaded. Railway trains would take many hours to perform the journey between Manchester and Liverpool, and in the event of the success of the scheme what, he would like to ask, was to be done for all those who had advanced money in making and repairing turnpikes? What with those who might still wish to travel in their own or hired carriages after the fashion of their forefathers? What was to become of coachmakers, harnessmakers, coachmasters and coachmen, underkeepers, horse breeders and horse dealers? Was the House aware of the smoke and noise, the hiss and the whirl, which locomotive engines passing at the rate of ten or twelve miles an hour would occasion? Not even the cattle ploughing in the fields or grazing in the meadows could behold them without dismay. Iron would be raised in price 100 per cent. or more; probably be exhausted altogether. It would be the greatest mischief, the most complete disturber of quiet and comfort in all parts of the kingdom that the ingenuity of man could invent."

The agitation for railways in British North America began almost as soon as the success of George Stephenson's railway was assured. One of the earliest efforts was made in St. Andrews, N.B., in 1827. In 1828 John Wilson convened a public meeting in St. Andrews to discuss the question of a railway to Quebec.

In 1832 Mr. Henry Fairbairn, writing in the United Service Journal, turned the attention of the British public to the necessity of a railway system for British North America. He proposed first to form a railway from Quebec to the Harbor of St. Andrews upon the Bay of Fundy. He pointed out the advantages of a railway which would convey the trade of the St. Lawrence to the Atlantic, with more speed, regularity and security than by the St. Lawrence River.

He supported his plan by an argument from the Imperial standpoint. He said: "Indeed, if the difficulties and expense of constructing these works in our North American colonies were tenfold greater an imperative necessity would exist for their adoption, if it is desired by the Government of this country (Great Britain) to maintain an equality of commercial advantages with the neighboring United States, for the splendid advantages of the railway system are well understood in that country, where great navigable rivers are about to be superseded by railways of great magnitude, reaching over hundreds of miles. Indeed, in no country will the results of the railway system be so extensive as in the United States, for it will neutralize their only disadvantage, inland distance from the sea, and it will effect the work of centuries to connect, consolidate and strengthen that giant territory lying beneath all climes and spreading over a quarter of the globe.

"If, then, we would contend with these advantages in our North American provinces, it is only by similar works that we can bring to the Atlantic agricultural exports of the colonies and secure the streams of emigration which otherwise with the facility of inland transportation will be rapidly diverted to the western regions of the United States."

It is needless to point out that a man who, seventy-eight years ago, could foreshadow the advantages and the necessity of the tremendous amount of railway building that has been going on in the United States and Canada up to the present time, had no ordinary mind. It was his ideas which have been followed by the people of Canada with the results seen to-day.

Three years later—1835—the Imperial Government made a grant of £10,000 to be expended in the exploration and survey of the proposed line of railway from Quebec to St. Andrews. The survey was placed under the control of Capt. Yule, an officer in the Royal Engineers, and the work was begun on the 24th of July, 1836.

In another direction the suggestion of Mr. Fairbairn bore immediate fruit. A company known as The Company of the Proprietors of the Champlain and St. Lawrence Railroads obtained a charter for the construction of a railroad from Laprairie on the St. Lawrence River to St. John's on the Richelieu. This road was first opened in July, 1836, and has the distinction of being the first passenger railway in Canada. The first train consisted of four passenger coaches drawn by horses, locomotive power being adopted in the following year.

The length of the line was 16 miles and the gauge 5 feet 6 inches.

The object was to connect the waters of the St. Lawrence with those of Lake Champlain by taking the base line of an isoceles triangle instead of the two water sides up to that time used thus securing speedy communication between Montreal and New York by a mixed water and soil route.

In the year 1844 this railway carried 27,118 passengers, 12,639 tons of freight, and its gross receipts were £15,234.

The expenditure was 77.8 per cent. of the total receipts in 1844. In 1909 the expenditure of all railways in Canada was 71.7 per cent., notwithstanding the fact that a great portion of the mileage had not in 1909 attained its normal earning power. Thus the proportion of receipts needed to meet working and other expenses has been considerably reduced in the intervening years.

In 1850 there were in what is now the Dominion of Canada, 66 miles of railway, the result of fifteen years' efforts; the chief dependence for Imperial communication was upon the river system aided by the few and shallow canals then in operation.

In 1851, an Act was passed by the Canadian Legislature, making provision for the construction of a main trunk line through the two Canadas.

In the same session the question of the gauges was taken up by the Canadian Railway Committee, when the question of the gauges of steam railway was decided upon. Numerous engineers and railway experts were examined, and the diversities of opinion were very numerous. In the United States the railways had gauges from 4 feet 8½ inches to 6 feet. Finally after a long investigation the gauge of 5 feet 6 inches was adopted as one of the best adapted for the promotion of Canadian interests.

The gauges of the Grand Trunk, the Toronto and Guelph, and the Toronto and Goderich railways were fixed at 5 feet 6 inches.

Gradually, however, commercial considerations were urged in favor of the 4 feet 8½ inch gauge, and it has been generally adopted by nearly all the railways in Canada, there being but two passenger railways in the older provinces, the Prince Edward Island, 210 miles long, with a gauge of 3 feet 6 inches, and another, the Carillion and Grenville Railway, 13 miles long, with a gauge of 5 feet 6 inches.

In the same year as the question of the gauges was considered (1851) delegates from the British North American provinces went to England to arrange for the construction of the Intercolonial Railway.

Grand Trunk Railway.

The original bill of incorporation of the Grand Trunk Railway proposed only a railway from Toronto to Montreal, 333 miles, but there were at the time charters providing for railways from Montreal to the boundary line towards Portland, 130 miles of which, about one-third, was constructed from Quebec to Richmond, 96 miles to join this and from Toronto to Sarnia on the western frontier of Upper Canada. In 1852, what was known as the Amalgamation Act was passed for the Grand Trunk Railway, enabling all these to unite in one general scheme. The total length of the first prospectus was 1,119 miles and the estimated cost £9,500,000. The sections were opened as follows: From Portland to Montreal in 1852, from Richmond to Quebec with a branch to Three Rivers in 1864, from Montreal to Toronto in 1856, from Toronto to Sarnia in 1858.

Great financial difficulties were encountered during the construction of these roads, and the Government was appealed to for additional assistance and subsequently the company borrowed from the Government, including the amounts agreed upon at the time of incorporation, $15,142,633.

The Grand Trunk Railway has since that time added greatly to the mileage and has now, besides its lines in Canada, important lines in States of Michigan, Illinois and Wisconsin.

The Canadian Pacific Railway.

The Canadian Pacific Railway Bill was brought before the Dominion Legislature in 1851 and was reported on adversely after a long and interesting discussion in the course of which Allan McDonnell, of Toronto, read a very able paper in favor of the scheme which was to connect the western shores of Lake Superior with the Pacific Ocean. The idea of a transcontinental route even at that date had been for some time before the public mind.

In 1871 the Government appointed Mr. Sandford Fleming, engineer in chief, with instructions to make preliminary surveys for this route, and he submitted his preliminary report in 1872.

The position at that date may be summed up in a few sentences.

But little was known of the great extent of country which now constitutes the Dominion when British Columbia became part of Canada. Between the settlements on the waters of the St. Lawrence River and the Pacific Coast there extended vast trackless regions with a winter climate of much severity. Between the Ottawa River and the prairie region it was rocky and wooded. Between the prairie and the Pacific Ocean it was designated a "sea of mountains." Both these regions were forbidding. The prairie region was better known; it had been examined about ten years earlier by a scientific expedition (sent out by the Imperial Government), the members of which declared the utter impossibility of establishing a Canadian Pacific Railway. The officer (Capt. Palliser) in command of the expedition, after four years' exploration, aided by assistants of great ability and energy, thus summed up the result:

"The knowledge of the country, on the whole, would never lead me to advocate a line of communication from Canada across the continent to the Pacific exclusively through British territory. The time has now forever gone by for effecting such an object, and the unfortunate choice of an astronomical boundary line has completely isolated the Central American possessions of Great Britain from Canada on the east, and also debarred them from any eligible access from the Pacific Coast on the west."

But the work of construction commenced in 1874. The first practical step in establishing the Pacific Railway was the purchase of 50,000 tons of steel rails. In the same year contracts were entered into for clearing the forest land along the projected line of railway and erecting a telegraph line from Lake Superior 1,200 miles westward.

In 1874 the Pembina branch was begun and the line east of Lake Nipissing was subsidized.

When the Mackenzie Government went out of power in October, 1878, the Macdonald administration continued the construction as a public work.

It was some years before the route through the mountain region was definitely established. Meanwhile, construction proceeded wherever possible under the circumstances which obtained, and by the year 1880 had entered into 67 contracts with various persons for supplying additional steel rails, rolling stock, grading and bridging. On these services $9,486,565 had been expended on December 31st, 1879, on 710 miles in various stages of advancement.

In 1880, reverting to their original policy of construction by a private company, the Macdonald Government entered into a contract with the Canadian Pacific Railway Syndicate. That contract provided on the part of the Government (1) for a cash subsidy of $5,000,000 and a land grant of 25,000,000 acres; (2) for the admission free of duty of all steel rails, fish-plates and other fastenings, spikes, bolts and nuts, wire, timber and all material for bridges to be used in the original construction of the railway and of a telegraph line, and all telegraphic apparatus for the first equipment of the telegraph line; (3) that for 20 years from the date of the contract no line of railway should be authorized by the Dominion Parliament to be constructed south of the Canadian Pacific line except such line as might run south-west or to the westward of south-west, nor to within 15 miles of latitude 49; (4) for freedom from taxation forever so far as the company's railway property was concerned, and for 20 years for such portion of the land grant as should not be sold or occupied; (5) that the several sections of the railway already constructed by the Government or under contract should, when completed by the Government, become the property of the company, and (6) that the Government should grant the requisite lands for right of way, stations and other purposes specified in the contract.

On the part of the company the contract provided (1) that it should complete the railway according to a fixed standard; (2) that the railway should be completed, equipped and in running order not later than 1st May, 1891, and (3) that the company should thereafter and forever efficiently maintain and run the railway.

When the company started it had to build about 2,000 miles of railway. By the close of the year, 163 miles had been constructed by the company west of Winnipeg. In 1882 a further distance of 423 miles had been laid with rails. In December, 1883, Laggan, near the summit of the Rocky Mountains and 956 miles from Winnipeg, was reached by the railway.

The Government prosecuted work on the line eastward from Winnipeg and Port Arthur, 430 miles from that city, was connected with it in May, 1883.

During 1884 the company attacked and mastered the difficult section north of Lake Superior, employing an army of 10,000 to 12,000 navvies and 1,500 to 2,000 teams of horses. Twelve steamers were employed to bring supplies for the men and teams engaged. This section was completed early in 1885 and opened for traffic in the autumn.

Simultaneously with the operations north of Lake Superior work was energetically prosecuted in the mountains of British Columbia, and in less than a year the enormous difficulties of the Kicking Horse Pass were overcome.

Near the close of 1884 the Government had completed the line from Burrard Inlet to Savona's Ferry (210 miles), and the company were thus able to attack the west end of their section.

On the 7th November, 1885, the last spike was driven by Sir Donald Smith. The railway was completed, fifty-four months having been taken in doing the work, instead of the 120 months allowed under the contract of 1881.

The difficulties of construction were very great. More than 300 miles of the railway track had to be cut through solid rock. Numerous tunnels pierced the mountains. Rivers and streams by the hundred were crossed by bridges, some of which are over a thousand feet in length. Fourteen streams were diverted from their course by means of tunnels.

The main line of the Canadian Pacific Railway from Montreal to Vancouver is 2,905 miles in length. Under arrangement with the Quebec and the Dominion Governments, the North Shore Railway, connecting Montreal and Quebec, was acquired by the company in 1882.

The branch line from Sudbury to Sault Ste. Marie was opened in conjunction with the St. Paul & Minneapolis Railway and the first freight train passed over it on the 9th January, 1888.

The Dominion Government aided the enterprise, as already mentioned, including a grant of $25,000,000 and 25,000,000 acres of land. The construction of the portions of the line by the Government cost $30,818,414.

Notwithstanding these aids, the financial undertaking was enormous. Indeed it may be said that the financial difficulties encountered were no less formidable than the physical obstructions.

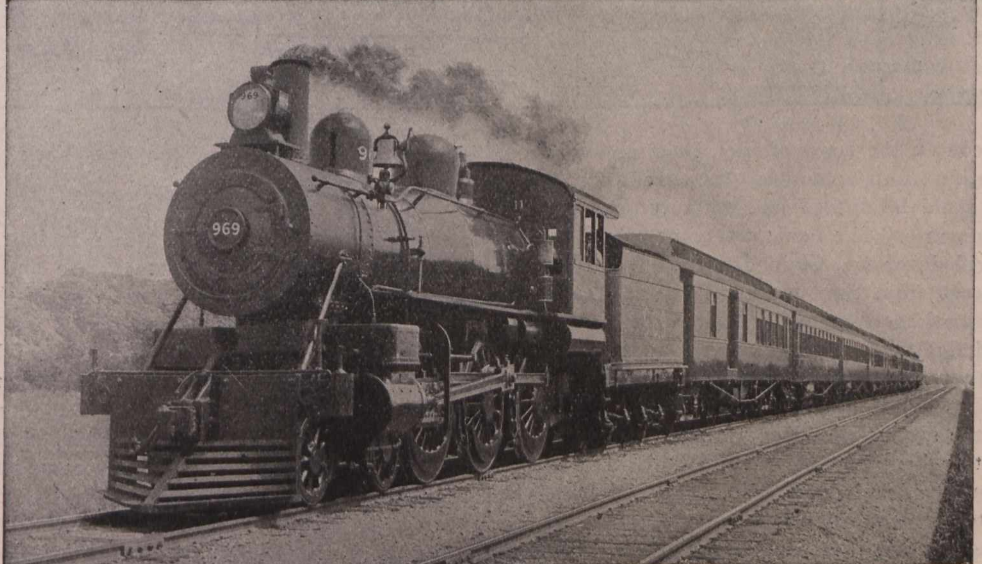
The total cost of the 3,243 miles given in the Railway Returns as forming the Canadian Pacific proper is stated in the same returns at $150,101,923. The total amount contributed to the enterprise by the Government of Canada is given in the Public Accounts at $62,604,535.

The Canadian Pacific Railway has kept on building and leasing new lines until to-day it is the largest railway system in the world, and besides, has magnificent steamship service on the Atlantic and Pacific Oceans and the Great Lakes. (Continued on page 122.)

THE GRAND TRUNK SYSTEM.

By Edward Angus.

Most of the great railway systems of America have been created by the merging of a number of lines. This is especially true of the Hill system and the Harriman lines. It is in no sense true of the great and growing Grand Trunk System. It has always been the Grand Trunk, reaching out, to be sure, building and buying, but building about the parent road.

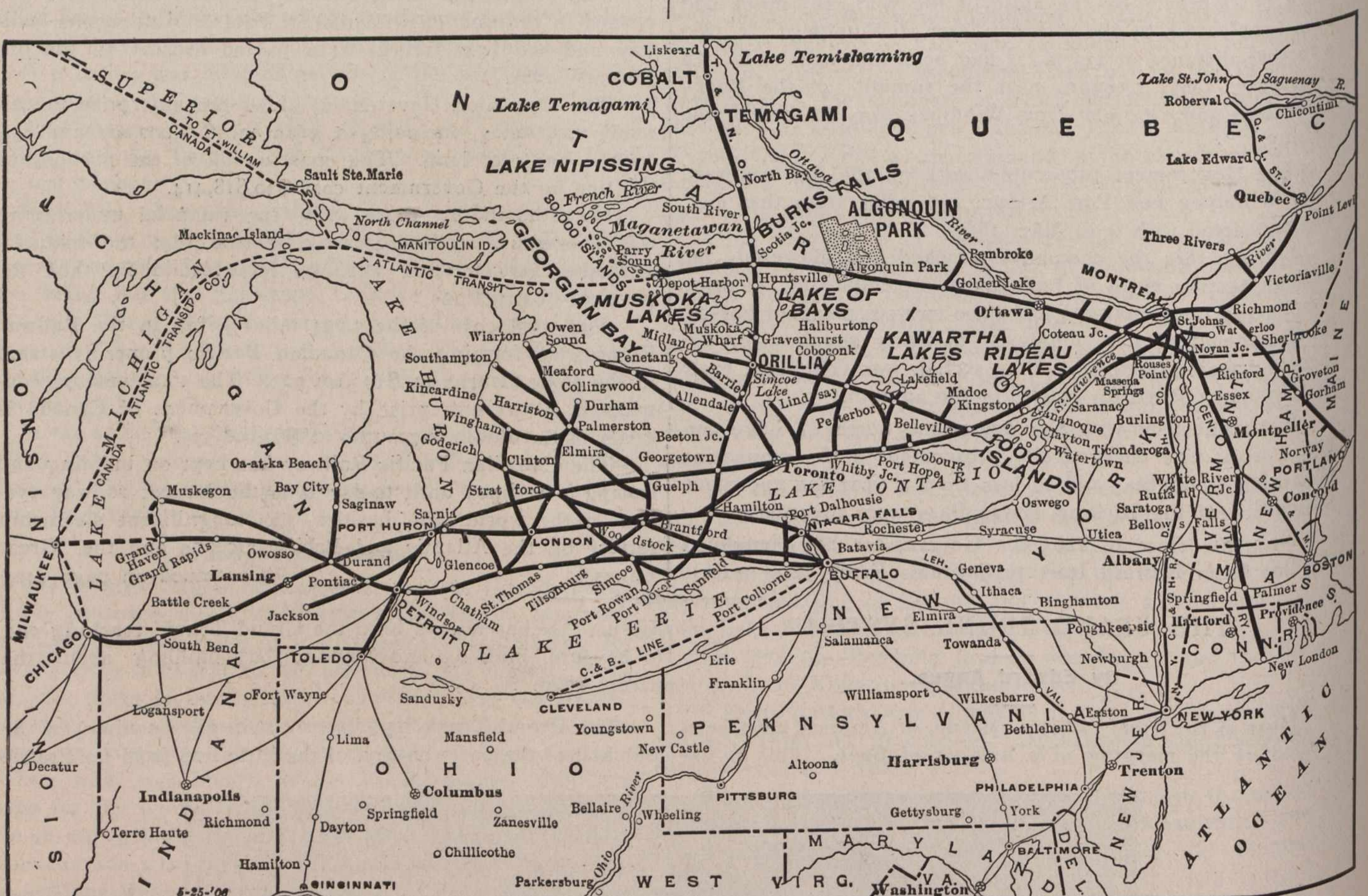


The Grand Trunk had its origin in the opening, in the first half of the past century, of the little line from La Prairie to St. John's, Quebec. This was the first steam railway Canada and the second on the American continent.

For something like fifty years the Grand Trunk was a training school for young men who later went to the "States" to fill positions of importance and responsibility on American roads. Serving a county known chiefly for its high-grade exports of bright, competent and energetic young men, it paid beggar's wages, and could ill afford that, —hence the exodus.

After years of struggle it reached the sea at Portland and extended to Chicago, but it was by no means a first-class line. And then again it suffered by having the Atlantic Ocean between it and the men who presided over its destinies.

In 1896 Mr. Charles M. Hays took charge as general manager. Mr. Hays had learned his trade from the ground-up, and he knew what the road wanted. It had become a sort of Railway-Aged People's Home. The new management superannuated the aged and infirm, set young men to work and put new life into the old machine.



It cut the weeds on the right of way, built new bridges, doubled the main line and separated the grade crossings whenever money could be spared and wherever the municipalities would co-operate. The new management bought new rolling and electrified the St. Clair Tunnel. It raised the pay of its employees from time to time, created a plan of apprenticeship, organized night schools, and gave as prizes scholarships at McGill. It changed a second rate single-tracked railway to a first-class double-tracked line. In a single decade it trebled its carrying capacity, doubled its dividends and at the same time spent millions for permanent improvements. It took up the old sixty-pound rail and put down eighty pound. which is now being replaced with one hundred pound steel.

The present total mileage of the Grand Trunk, including its subsidiary lines, is 5,400 miles, with a double track mileage of 1,035, which makes it not only the longest double track railway in Canada, but one of the longest continuous double track railways under one management in the world.

During the year 1909, on the entire Grand Trunk System, the number of tons of freight handled amounted to 19,233,485 tons, while the number of passengers handled was 13,916,147. According to the official reports for 1909, the Grand Trunk takes rank among the ten largest systems on the North American continent, based on the business handled (freight, tonnage and passengers), while on its lines in Canada only, it handled 1,431,754 tons of freight and 1,167,000 passengers more than the railway ranking next as a common carrier; also, according to the Government reports, it handled 25 per cent. of the total freight hauled, and 33 per cent. of all the passengers carried by all the railways in Canada.

The Grand Trunk Pacific.

The pathfinder, the locating engineer, "The man with one leg over a fence listening for a dog," is, according to Jeanette Gilder, editor of the New York Critic, "the hero of the Anglo Saxon race."

When the Grand Trunk Pacific is completed and trains are travelling from Ocean to Ocean in four days, as they will be able to do with the greatest ease and safety, then will every man who had even a little part in the location of that line have reason to feel proud of his work. The result of their labors and the final location was, I have no doubt, as great a surprise to themselves as it was to President Hays and the members of the Government without whose co-operation the work would have been impossible. It is not at all likely that any of the promoters of this great undertaking ever hoped to cross the continent on a four-tenths grade, a feat made possible by the fact that the Rocky Mountain range breaks up in the Peace River county, enabling the engineers to thread their way through the broken hills. Of course, a line so nearly level costs money. Even in the Prairie section there was mountain work. Many of the rivers cut deep into the surface of the earth out in the Prairie Provinces. Even in the forests of New Ontario and in Northern Quebec there are many deep rivers to bridge. By way of compensation they found in this same forest wide reaches of almost level land; one tangent south of Hudson Bay being over sixty miles long. In the western part of this timbered section, however, north-west of Lake Superior, they found a rough and rugged country. Here the work is heavy, so, in order to keep to the ruling grade, they had to drive the line through hog-backs of solid rock, sometimes tunneling the ridges that resemble the surface of a troubled sea that had been suddenly chilled and turned to stone.

Fortunately for the builders of this new national highway the country has given them one continuous series of surprises.

The section east of Quebec, we may say, was pretty well known. West of Quebec, for fifty or sixty miles, the line serves a splendid farming district. Beyond this, it enters one of the greatest pulp-wood forests standing anywhere. While still in the Province of Quebec the line enters the great northern clay belt; a vast stretch of timbered clay land, 150 miles wide and 300 miles long. Some two thousand homesteaders have already settled in this new district. The Ontario Government has established an experimental farm, and the results of their experiments are among the surprises of this much maligned land.

Meanwhile the prairies have more than made good. The new sections in Saskatchewan and Alberta along the line have proven exceedingly attractive to homeseekers and are rapidly filling up with the richest and most intelligent class of new-comers that ever settled a new country in the history of the world, coming largely from Eastern Canada and from the middle western States. West of Edmonton the engineer spent three years searching every pass between the wheat fields and the Pacific before they finally settled on the Yellowhead as the best path for the "Iron Horse."

This entire territory was almost unexplored when the locating engineers headed west from Edmonton. The stories of the hardships of some of the early exploring parties. if it could be dragged out of them, would make Peary's alleged pilgrimage to the Pole look like a pleasure trip to the Montreal Ice Palace. In years to come, when these forests and streams, these crags and canons, limpid lakes and glittering glaciers brush by your window at the rate of a mile a minute, you will wonder where the hardship came in, but you, gentle reader, will never know, for your going will be swift and easy.

For the last 200 miles you will look out on the fertile valley of the Bulkley, and, later, nearer the sea, you will wend your way along the scenic shores of the Skeena, below your window the wide river and high above you the towering ranges, white-capped by the eternal snows.

Finally, where the Skeena tells her troubles to the sea, the wide harbor of Prince Rupert will flash into view—the wonderful land-locked harbor, a mile wide and fourteen miles long.

Here endeth the trail.

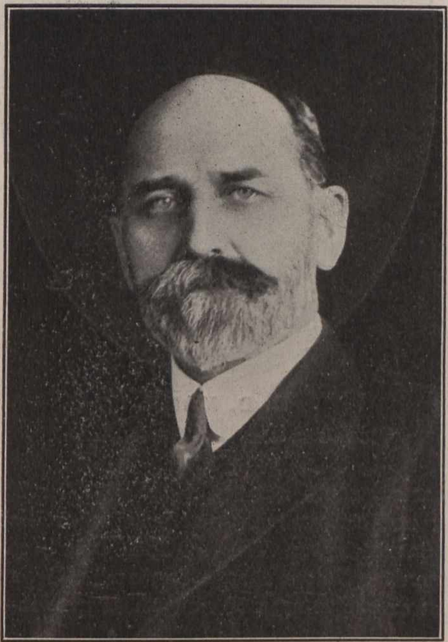
THE MACKENZIE-MANN SYSTEM.

In this country, man cannot live by bread alone. He must have railways; for transportation is to commerce what bread is to a hungry man. We cannot have too many railways although some may be in wrong places. The way to avoid building railways in the wrong place, is to have a long-sighted plan of development from the beginning. That is distinctively the case with the Canadian Northern. Though it was conceived in obscurity, it was born with its eyes wide open.

Mr. D. B. Hanna, the third Vice-President, who is sometimes mistakenly called the General Manager of the Canadian Northern Railways, because he knows the details of their conduct as well as he knows the names of his own children, reminded me the other day, that the Canadian Northern earns as much in a week as it did in the whole of the year 1897.

That is true in a double sense; for in 1897 the Canadian Northern had not been so baptized. It was a little jerkwater road running north-west from Gladstone, a village 83 miles from Winnipeg, and it belonged to the Lake Manitoba Railway and Canal Company, of which Mr. Hanna was the first General Superintendent—a sort of mother and father, schoolmaster and friend, rolled into one.

He made both ends meet on a gross income of $60,000 the first year, because he knew how to give a pioneer service to a pioneer country. Earnings have multiplied and surpluses have been available for the physical improvement of the road, because there has been the same kind of adaptation of methods to the ends sought to be obtained. If you want to know how to cut your coat according to your cloth, you can generally best get it done with the help of some Scotsman who has sharpened his native wit by experience in Eastern as well as Western Canada, with a few New York episodes thrown in.



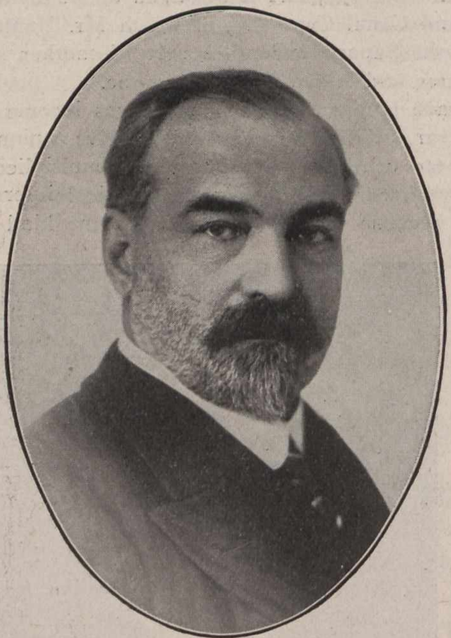
WM. MACKENZIE,
President C. N. R. System.

When Mr. D. B. Hanna began operating the Lake Manitoba Railway & Canal Company, Mr. Mackenzie and Mr. Mann were acquiring the controlling interests represented by other charters, which, like that of the Lake Manitoba Railway & Canal Company, brought to their proprietors only the vexation of persistent inability to finance them.

The people who knew everything about the West, including those who manufactured agricultural implements, had made up their minds that the first transcontinental line was being built on the very limit of the wheat-growing area, and that to risk money on the possibilities of profitable farming in the centre of Manitoba, was to court very severe dispensations of Providence. But Mr. Mackenzie and Mr. Mann had faith as well as works among their assets.

Last spring, when the "Royal Edward," the first of the great liners of the Canadian Northern Atlantic Fleet, and being brought from Glasgow to Bristol, to inaugurate the service between Bristol and Montreal, Mr. Mackenzie told his guests, representing no insignificant proportion of the wealth and intellect of the British nation, that though it may be true that but for his partner and himself there would be fewer miles of railway in Canada, anybody with as much faith as they had in the country could have achieved equal results—a delightful example of Mr. Mackenzie's modesty when he talks about himself.

But faith in the country had failed to make a competitive Canadian railway in the West. The people who owned



D. D. MANN.
Vice-President C. N. R. System.

various charters could not make progress, probably because they could not conceive a great scheme of development to cover the Saskatchewan Valley, which had been proclaimed by such men as United States Consul Taylor, of Winnipeg, as the most extensive area of rich wheat growing land in the world.

Mr. Mackenzie and Mr. Mann started their immense scheme in shreds and patches. The year after they built from Gladstone to Dauphin, they started to construct out of Winnipeg the Manitoba and South Eastern Railway, which was to carry wheat to Lake Superior. Four hundred miles east of Winnipeg there was in existence a piece of track running from Port Arthur towards Duluth that belonged to the Port Arthur, Duluth and Western Railway Company, the tribulations of which were reflected in the name by which the people of the north shore of Lake Superior sympathetically referred to it—the Poverty, Agony, Distress and Wretchedness line.

The Port Arthur, Duluth and Western was bought, and a beginning made to connect it with the Manitoba and South Eastern, which was coming from Winnipeg to the Lake of the Woods. The linking-up had to be undertaken in pursuance of the charter of the Ontario and Rainy River Railway Company, which, to all appearances, was own brother to the organization whose line stuck in the wilderness.

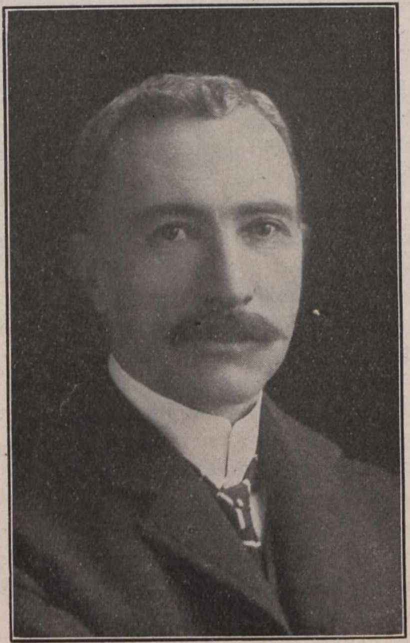
While these beginnings were being made in apparently haphazard fashion, property for terminals was secured in Winnipeg, and plans prepared for an advance through the Saskatchewan Valley to Edmonton.

Obviously the Lake Manitoba Railway and Canal charter was for a limited undertaking. Another charter, that of the Winnipeg Great Northern Railway, which contemplated a line to Hudson Bay, and which had a fluctuating history, was brought into the Mackenzie-Mann fold, and, during 1899, in conformity with it, the original line was carried 195 miles beyond Gladstone. In the same year, the Manitoba and South Eastern had reached Rainy River, and from Dauphin westerly the first 25 miles had been built in the direction of the open Valley of Saskatchewan.

About this time it was decided to give the lines that would presently be connected the name of the Canadian Northern. How, where, and by whom this decision was reached is a matter of Canadian railway history, which will only be fully chronicled when the appropriate time arrives.

Soon after it had been decided to call the new piece of railway the Canadian Northern, and before announcement of the change had been made, the Northern Pacific, which had 351 miles of track in Manitoba, determined to abandon the field, for it was becoming dangerous to allow the farmers of Minnesota and Dakota to see that the Canadian customers of the Northern Pacific were shipping their wheat at much lower rates than were charged in the States. The decision eventuated in the acquisition of the Northern Pacific lines in Manitoba by the Government, and the leasing of them to the Canadian Northern for 999 years, with the option to purchase at any time.

The arrangement secured to the Canadian Northern extensive terminals at Winnipeg in addition to the lands already purchased, and furnished a line within 18 miles of Gladstone.



M. H. McLEOD.
General Manager C. N. R. Western Lines.

In the first year of this century, then the Canadian Northern Railway made its bow to the Dominion with 1,200 miles of line, and its credit firmly established in London. In that year, also, Winnipeg was joined to Port Arthur, but the whole of the line was not taken over by the operating department until early in 1902.

The crop of 1902 was the first which the Canadian Northern Railway carried to the head of navigation without the assistance of other railways, and it delivered over twelve million bushels of grain to the elevators at Port Arthur.

The first annual report of the Canadian Northern Railway Company, dated Toronto, September, 1903, showed gross earnings of $2,449,579; operating expenses, $1,589,293, and, after paying fixed charges, a surplus of $222,921. The operated mileage of 1,276 was made up of 353.7 in Ontario, 856.8 in Manitoba, 22.2 in the North-West Territories, and 43.7 in the State of Minnesota, by the fact that the Lake of the Woods is not all in Canadian territory.

The report for the fiscal year ending June the 30th, 1910, is not yet completed. That for the year ending June 30th, 1909, shows gross earnings of $10,581,767; expenses, $7,015,405; net earnings, $3,566,362, and fixed charges, $2,919,617, leaving a surplus of $646,745.

The mileage summary was as follows:—

Ontario	353.7
Manitoba	1,521.1
Saskatchewan	1,006.4
Alberta	214.2
Minnesota	43.7
	3,140.1

In 1909, therefore, the fixed charges had grown to be half a million dollars more than the gross earnings were six years previously. The latest approximate figures available show that for the year just ended, the net earnings were over $600,000 in excess of those of the previous year.

The expansion of the Canadian Northern has been distinguished by three main movements. It began as the opener-up of new territory, and it has continued pre-eminently in the same course. It was the first to give real competition to the existing railway, which was thought at one time to have the whole West thoroughly cinched, and has continued its course of giving economical service to the farmer; for, where it cost twenty-four cents to carry a bushel of grain to Fort William, the job is now done for half the price, and when the Canadian Northern became competitive for passenger traffic, the mileage rate for human travellers all through the prairie country also declined.

The Canadian Northern, early in its career, tapped the forest areas which fringe the plains, and it is carrying ever increasing quantities of lumber and coal to the farmers, and has in hand great extensions in Alberta and British Columbia that will enlarge the most important channels of business which must accompany the growth of agriculture.

When the Dominion Government projected a railway across the plains, it sent its explorers to find out the best sections of country through which a road destined to flourish might pass. The first location was through the Saskatchewan Valley, to Yellowhead Pass and to Burrard Inlet. The finest land was found in the Saskatchewan Valley, through which the road was surveyed, and for 600 miles beyond the Red River the stations were named, and over a part of the distance the telegraph was constructed. But, finally, the location was changed because it was thought best not to leave the southern half of the country defenceless before American corporations.

From Port Arthur, the Canadian Northern follows broadly the canoe route from Lake Superior to the Lake of the Woods, by which Verendrye and the French pioneers reached the Saskatchewan country in the first half of the 18th century, and which later bore the great brigades of canoes which brought the furred wealth of the North-West Company from mountain and plain, even unto Montreal.

The Canadian Northern traversing the western hinterland of Lakes Manitoba and Winnipegosis passed Lake Dauphin and called its first terminus by that name which perpetuates the courage and loyalty of the French who first occupied Canada.

If you look at the map, you will see that the Canadian Northern is advancing across the Province of Saskatchewan in five chief lines. As a wheat-producing territory, with a crop last year of 92,000,000 bushels, Saskatchewan has exceeded all other states and provinces in North America, except Minnesota.

This is due, of course, to railway expansion, of which the Goose Lake line, running south-west from Saskatoon to Calgary, is an excellent example. From 76 miles of track through to a district where, until the fall of 1908, there was not a single steel rail, the season of 1909 furnished two million bushels of grain for export.

Last year the Canadian Northern began a campaign of expansion in Alberta which must have a great effect upon the development of that province. I cannot do better than quote from the "Edmonton Journal's" account of President Mackenzie's visit to that city during June:

"The programme of the company in Alberta this year includes the completion of the Athabasca Landing line, north of Edmonton, the completion of the Vegreville-Calgary line, the completion of grading on the Strathcona-Camrose cut-off, the completion of the Goose Lake extension to meet the Vegreville line, the commencement of the extension west of Edmonton to the Yellowhead, the commencement of their guaranteed line towards the Grand Prairie country, and the commencement of a line running from Stettler west to the Brazeau coal fields to connect with the main line near the mountains west of Edmonton."

The Canadian Northern has begun construction in British Columbia. Premier McBride went to the country in November, 1909, on a policy of guaranteeing the bonds of the Canadian Northern for 500 miles from the Yellowhead Pass to Vancouver and New Westminster, and for 100 miles from Victoria to Barkley Sound on Vancouver Island. Only four opponents of the Government returned from the polls. The first session of the new Legislature passed an Act implementing the preliminary agreement which had been entered into, in connection with which Canadian Northern surveyors had been at work ever since the early summer of 1909. In accordance with the Act, construction from new Westminster north-west has already been commenced. The Canadian Northern is under contract to complete its lines to the Pacific coast in four years.

All this expansion in the western provinces is having its corollary in the growth of railways under Canadian Northern control in Eastern Canada, at present being operated separately. The chief of these is the Canadian Northern Ontario Railway. This line, which is to connect the manufacturing centres of Ontario and Montreal with the West has a completed mileage of 385 miles, of which 327 miles are in operation from Toronto to Sudbury, the Moose Mountain Iron Mines at Sellwood, and Gowganda Junction.

The Canadian Northern Ontario traverses the delightful Muskoka Lakes region, and has built a branch to and docks at Key Harbor on the Georgian Bay, for the shipment of Moose Mountain iron ore, for which there is a growing demand in the United States. It also taps the Sudbury nickel district, and at Gowganda Junction it is nearer the Gowganda silver district than any other railway.

As part of a new linking of Toronto with Hamilton and Buffalo on the west, and Ottawa, Montreal and Quebec on the east, construction on the first hundred miles between Toronto and Ottawa was begun in the autumn of 1909, and will be completed within the year.

During 1909 Ottawa was connected with Montreal and Quebec by a section of the Canadian Northern Ontario Railway, extending from that city to Hawkesbury on the Quebec side of the Ottawa River, which was already the Western terminus of the Canadian Northern Quebec Railway.

The Canadian Northern Quebec has 333 miles, and gives to Quebec its shortest route to Ottawa, and a competitive line between Quebec and Montreal north of the St. Lawrence.

The Canadian Northern also controls two railways in the Province of Nova Scotia; the Halifax and South Western, which skirts the Atlantic shore from Halifax to Yarmouth, and crosses the centre of the peninsula. This railway has branches into the agricultural and lumbering districts around Lake Rossignol, and reaches Port Wade on the Bay of Fundy by the western side of the Annapolis Valley.

On Cape Breton Island is the Inverness Railway, from Port Hawkesbury to Inverness. The product of the Inverness coal mine is taken to Port Hastings, an ice-free port in the Straits of Canso. The mine, as well as the railway, is a Mackenzie and Mann enterprise, and supports a town of over 2,500 inhabitants.

For eight months in the year, the freight business between east and west mainly goes by the Great Lakes. By its control of a fleet of lake steamships, the Canadian Northern is, therefore, able to handle freight from tidewater to Edmonton for about eight months in the year. It is necessary to supplement this by an all-rail route, for which purpose the gap between Gowganda Junction and Port Arthur—roughly 450 miles—must be filled, and eventually a short line to obviate the necessity of hauling freight from Montreal to the West by way of Toronto. This will be accomplished by connecting Ottawa with the Toronto-Sudbury line at or near Key Junction, so as to give rapid connection with Key Harbor. For the Gowganda-Port Arthur gap, the Ontario Government has proffered a land grant of 4,000 acres per mile, and it is anticipated that the completion of this line will synchronize with the completion of the line through British Columbia, which is guaranteed for 1914.

This year is notable not only for the advent of the Canadian Northern at the Pacific Coast, but for its appearance among Atlantic passenger fleets. In May, the Royal Line of the Canadian Northern Railway system began a fortnightly service between Bristol and Montreal, with the "Royal Edward" and "Royal George," the two fastest, as well as the most splendidly equipped, steamers in the Canadian trade, and which give Bristol its first up-to-date passenger service to Canada.

The inauguration of ocean steamship service means, of course, that the Canadian Northern Railway will become a more prominent factor in emigration work from the British Isles, and will the more readily receive in Great Britain the recognition which it has long deserved, as one of the prime factors in the development of the resources of Canada.

SIR THOMAS SHAUGHNESSY.

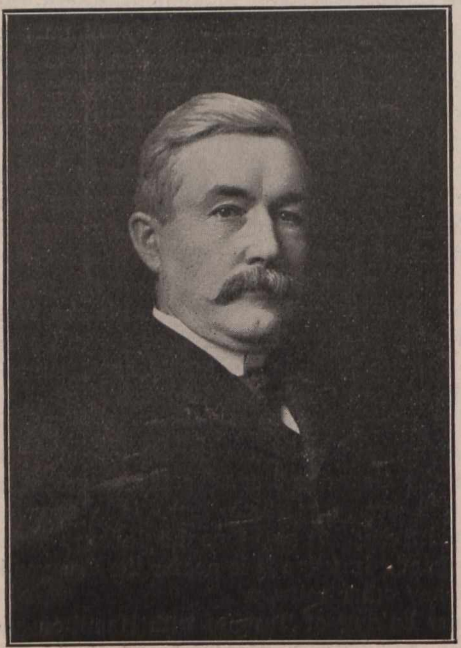
Thomas George Shaughnessy, Knight Bachelor, came to Canada in 1882, and under Sir William Van Horne gave his skill to the work of building up the strongest Canadian railway corporation.

At that time Mr. Shaughnessy was in the full flush of youthful vigor, keen and alert and anxious to make a reputation for himself in his adopted country.

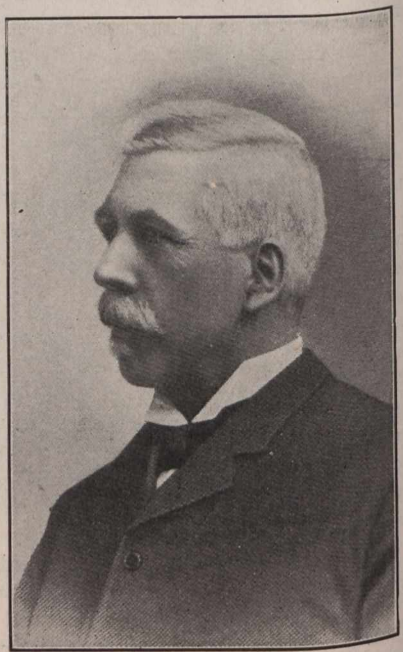
Mr. Shaughnessy was one of the younger men who was not dismayed by the press-created criticism, but working earnestly for the Canadian Pacific Railway and incidentally for the development of Canada. He was in 1901 created a Knight Bachelor, a deserving honor for one who had reached so important a position in Canadian railway and transportation circles.

Sir Thomas was born in Milwaukee, Wis., in 1853, and at the age of sixteen joined the staff of the Chicago, Milwaukee & St. Paul Railway. In 1882 he joined Sir William Van Horne on the C. P. R., and when Sir William resigned the presidency, although ready to become the chairman of the Executive Committee, Sir Thomas succeeded him as president.

In 1907 he was created a Knight Commander of the Victorian Order.


J. W. LEONARD
General Manager C. P. R. Eastern Lines.


SIR THOMAS SHAUGHNESSY
President C. P. R. System.


WM. WHYTE
2nd Vice-President C. P. R. System

Until the entry in the Canadian railway field of Sir William Van Horne, railroad men were of the English school, trained in the art of railway organization and management of Great Britain. Sir William, himself an American, brought with him a number of American railway men and his introduction of American methods on Canadian roads was at that time the subject of unfavorable comment by the Canadian press.

CANADIAN RAILROAD STATISTICS.

How They Compare with Those of Other Countries—Canada To-day Has More Than Twenty-four Thousand Miles of Roads, and Forty Years Ago Less than Three Thousand.

By FRED W. FIELD,
Editor Monetary Times of Canada.

Only 7 per cent. of Canadian railroads are owned by the Government.

Canada's railroads are the lowest capitalized in the world, $55,638 per mile.

Canada has the largest railway mileage in the world in proportion to its population.

Canada's railroad mileage has increased in forty years from 2,524 to 24,104 miles or 854 per cent.

Compared with European countries, Canada is third in the list, in the matter of railroad mileage increase during the past 50 years, with a percentage gain of 1,132.

Statistics are not necessarily dull. The railroad statistics of Canada, when analysed, reveal a wonderful story of development. The Dominion has grown on its lines on communication. In 1836, we had sixteen miles of railroad in operation. To-day we have more than twenty-four thousand miles. This increase in seventy-four years of 156,000 per cent. is not only evidence of expansion in railroad mileage, but also of general development. It is interesting to learn what this young country has accomplished in the matter of transportation compared with the progress of other countries. By taking a wide range the comparison will prove attractive. The United States apparently enjoys supremacy in the matter of railroad mileage. The collection of statistics from the countries of the world is a laborious task, and the latest published figures are a record to the end of 1908. From these it is seen that there were then 72,000 more miles of railway in North America than in Europe. If allowance be made for the railway mileage in Canada, Mexico and Central America, the United States had considerable more railway mileage than the whole of Europe and about one-third of the world's total mileage.

Of the World's Railways

The grand total for the world is 611,478 miles, which is an increase of 61,505 miles, or 11.2 per cent., since 1904, and of 16,445 miles (2.8 per cent.) over 1907. This is fully up to the progress of recent years, the mileage opened in the world in each of the last five years having been:

1904.	1905.	1906.	1907.	1908.
16,508	13,039	17,394	14,627	16,445

The distribution of railways at the end of 1908 was as follows:

	Miles.
Europe	202,109
Asia	58,813
Africa	19,211
Old World	280,133
North America	274,372
South America	39,013
Australasia	17,960
New World	331,345

America Led in Increase.

Of the increase of 61,505 miles since 1904 considerably more than half was in America, (33,690 miles), and of this 27,115 miles was in North America, against 12,265 miles in Europe, 10,830 in Asia, 3,574 in Africa, and 1,147 in Australia, with which the 89 miles on the Hawaiian Islands are counted. Of all the new countries of the world Australia is most backward in railway construction.

In Asia and Africa, the mileage in each has increased nearly 23 per cent. within four years—proportionately faster than in any other quarter of the globe. In Africa the lines are chiefly built for the traffic of mines, etc., developed by Europeans, not at all for the natives. At the end of 1908 China had very nearly as much railway mileage as Japan, (4,998 miles against 5,035). Its mileage has increased as follows for the four years ended with 1908:

1904.	1905.	1906.	1907.	1908.
1,228	2,247	3,700	4,163	4,998

More than half of the Asiatic mileage is still in India, where additions are made on a moderate scale, but without interruption.

Railway Development in Europe.

M. Thery, a French writer, has just published some striking statistics dealing with railway development in Europe during the past fifty years. His figures alone are interesting, and more so when we compare them to development in our own country. The total railway equipment of all European countries is calculated by M. Thery as having been for 1858, 51,483 kilometers; for 1883, 185,442 kilometers, and for 1908, 318,312 kilometers. Put into English miles in round figures, these amounts represent for 1858, 32,000 miles; for 1883, 115,000 miles, and for 1908, 198,000 miles.

The country first in the matter of actual trackage increase is Russia. In ratio of mileage, either to population or to area, Russia is surpassed by Germany, France, Austria-Hungary, England, and many of the smaller countries. The following table shows the increase in trackage, in English miles, for each of the last two quarter centuries for the leading countries. I have taken M. Thery's statistics, figured them into English miles and added the Canadian statistics:

Country	1858.	1883.	1908.	Percentage increase 1858 to 1908.
Russia	988	15,342	36,257	+3,559
Germany	7,280	22,864	36,042	+ 396
France	5,444	18,452	30,029	+ 451
Austria-Hungary	2,811	12,737	25,836	+ 819
Great Britain	10,430	18,656	23,089	+ 121
Italy	1,117	5,516	10,306	+ 822
Spain	1,190	6,092	9,221	+ 674
Sweden	329	3,974	8,316	+2,427
Canada	1,863	9,577	22,966	+1,132

Canada Comes Third

Russia shows the greatest percentage increase in the fifty years' period, Sweden coming second and Canada third. The figures show that in Europe Germany has increased her equipment within the last twenty-five years more than any other country except Russia, but that she has been closely followed by Austria-Hungary. If England and France make a less favorable showing between 1883 and 1908, it is because they had made more rapid progress during the previous quarter century and stood in 1883 far in advance of their European rivals.

Examining the railroad development in Europe for the quarter century, Russia increased its mileage in that period by 136 per cent., Germany by 57 per cent. Canada stands in front of all European countries with an increase of 139 per cent. The following table shows the railway mileage of Canada compared with that of the other countries cited by the French statistician:

Country	Inhabitants per mile of line.
Russia	2,941
Germany	1,587
France	1,333
Austria-Hungary	1,854
Great Britain	1,912
Italy	3,119
Spain	1,960
Sweden	621
Canada	300

Another Canadian Record

Canada, therefore, has the largest railway mileage in proportion to population, while in relation to area it has the smallest. This record not only applies when compared with the mileage of the above countries, but still holds good compared with that of any country in the world.

The history of the construction and operation of the European lines shows a steady tendency, outside of Great Britain, towards government ownership. Bismarck took energetic steps to unify the German lines through a central administration, and had the best of them purchased by the different German States. Almost all the lines of Austria-Hungary belong to the State, and in Italy, after the large purchases of private lines about 1905, 7,910 miles belonged to the State in 1908 out of a total trackage of 10,306 miles.

Of the lines owned by the six leading States the aggregate at the beginning of 1908 was 161,561 miles, or 82 per cent. of the entire trackage of Europe. Only 7 per cent. of the Canadian railroads are government-owned.

Capital Per Mile.

The cost of construction of all European lines up to 1902 was estimated by M. Neymarck at 102,817,000,000 francs ($20,000,000,000), or an average per kilometer of 366,173 francs ($72,000). According to a later calculation for the close of 1907, the outlay had risen to about 134,000,000,000 francs ($26,000,000,000). The capital obligation per mile of Canadian roads is $55,638.

Turning to the subject of capitalization the statistics of capital show that 176,905 miles of railway in Europe are represented by $21,459,270,000, which is very nearly as much as the capital of 335,286 miles in other countries, making approximate averages of $121,303 per mile in Europe and $65,100 for the rest of the world. This applied to mileage whose capital is not reported would make the total capital invested in railways in the world $51,184,000,000, not including street and electric lines and the like.

Canada's Roads are the Lowest Capitalized

A statement was recently made by the Bureau of Railway News and Statistics in the United States that the railways of that country are the lowest capitalized in the world. This is apparently incorrect. The outstanding capitalization is given at $57,201, and the following comparison is made with other countries:

Country	Capitalization per mile.
Great Britain	$275,040
Belgium	169,806
France	139,390
Italy	124,730
Austria	112,879
Germany	109,788
United States	57,201

In analysing the statistics respecting Canadian railroads, we find that the capitalization is $55,638 per mile, which thus gives Canada the credit of possessing the lowest capitalized railroads in the world.

Of the Capital Obligations

The capital obligation arising out of Canadian railroad stock and bond issues, totalling last year $1,308,481,416, amounts to $54,285 per mile of line. But that result is somewhat misleading, since, before such a calculation can properly be made, certain facts have to be taken into account. For example, the above total of $1,308,481,416 includes the stock and bond liability of the Grand Trunk Pacific, while the mileage of that line is not embraced in the total of 24,104 miles forming the divisor. On the other hand, the mileage of government-owned lines in Canada forms a part of the 24,104, against which there is not any issue of either stock or bonds. Therefore, in dealing primarily with corporation railways the capital liabilities of the Grand Trunk Pacific must be eliminated, along with the mileage of government-owned lines. This process reduces the money side of the equation to $1,222,089,976 and the mileage to 21,965. On this basis the result is $55,638, which correctly represents the stock and bond liability of Canadian corporate railways per mile. The capital obligation may be set down as follows: Stocks, $28,345 per mile; bonds, $27,293 per mile. This is a creditable record.

RAILWAY SITUATION IN CANADA.

J. L. Payne,
Comptroller of Railway Statistics.

With 24,104 miles of railway in operation on 30th June, 1909, Canada may be said to have demonstrated her capacity to meet the transportation needs of her rapidly swelling commerce. This position was reached by steady advancement in the work of construction. Between 1880 and 1890 the addition to mileage was 5,820, 4,506 miles were built between 1890 and 1900, and 6,447 miles during the last decade. At the present time over 5,000 miles of railway are under actual construction, including the transcontinental line of the Grand Trunk Pacific, of which upwards of 1,000 miles are in operation, although officially regarded as incomplete.

"Under Construction" is an exceedingly comprehensive term. It covers the work of building all the way between the preliminary survey and the driving of the last spike. For this reason, it is always difficult to answer the question most frequently asked of the department with which my work is identified: "How many miles of railway are under construction in Canada?" Popularly, construction is regarded as grading, track laying, bridge building and so on, and it is with such a definition in mind that I have alluded to the work now in progress upon more than 5,000 miles of line. It is not practicable to be more definite.

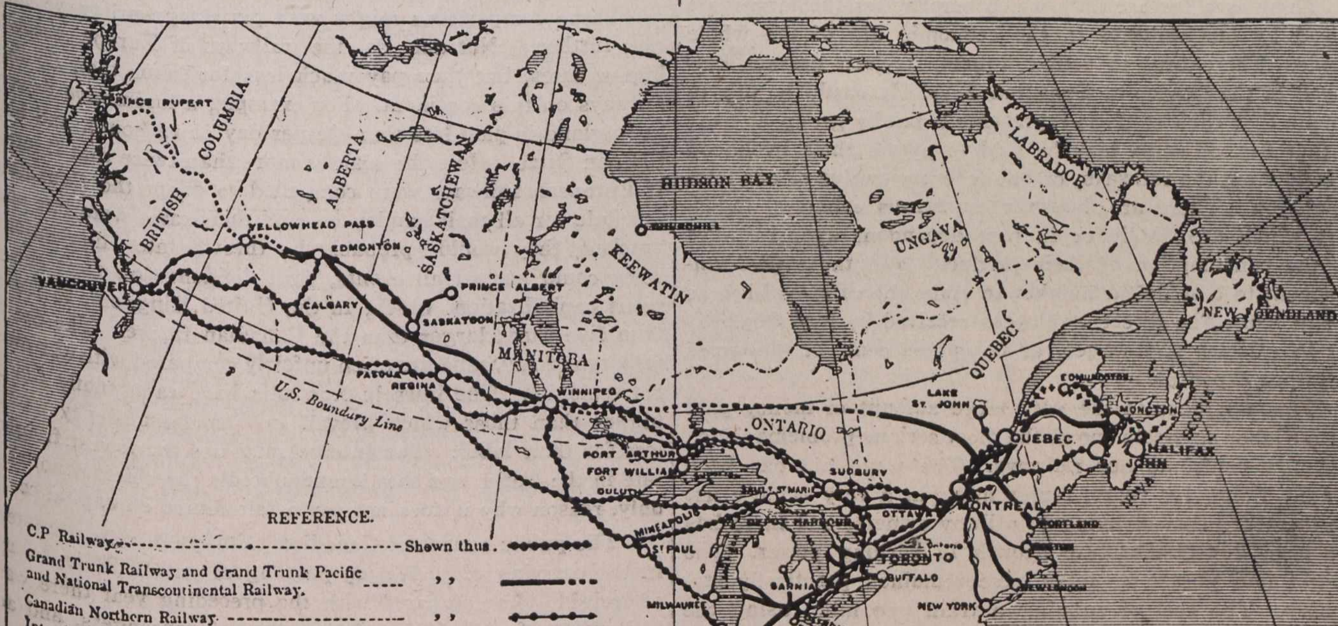
Although no other country has shown a more robust spirit of enterprise in this regard, nor has any other nation made such large sacrifices to provide adequate transportation facilities, it is true that Canada has the lowest railway mileage per 100 square miles of territory of any civilized land under the sun. On the other hand, she has the highest railway mileage in proportion to population. To be exact, she has six-tenths of a mile of line for every 100 square miles of her area, and one mile for every 300 of her inhabitants. New Zealand comes nearest to Canada by the population test, with one mile of line to every 330 inhabitants, while New South Wales approaches closest by the territorial test, with 1.1 miles of line per 100 square miles. Just to show the relative meaning of these figures, it may be said that Great Britain has 19 miles of railway per 100 square miles of area, and 1,912 inhabitants per mile of railway, while the United States has 6.4 miles of line per 100 square miles of territory, and 365 inhabitants per mile of railway.

It may be interesting to observe that the 24,104 miles of railway in Canada are divided among the various provinces as follows:—

Ontario	8,229.11
Quebec	3,662.94
Manitoba	3,205.30
Saskatchewan	2,631.34
Alberta	1,321.52
British Columbia	1,795.94
New Brunswick	1,547.25
Nova Scotia	1,350.53
Prince Edward Island	269.33
Yukon	90.91

ments. The average cost per mile of Canadian railways, as measured by stock and bond issues, has been $55,638. This is slightly below the figure revealed by United States statistics, and very much lower than the cost in European countries.

It has just been said that no other nation under the sun has made such large sacrifices to secure transportation facilities as has Canada. That is absolutely true. Of course, Australia and New Zealand built, own and operate all their railways; but they receive back a fair rate of interest on the total outlay. The 30,000 miles of line in India were constructed by the State, yet there also by a plan of leasing and out of earnings the burden of cost is met. Belgium, France, Germany and other countries in Europe have invested colossal sums in the State ownership of railways; but the people have not been directly taxed therefor. Up to 30th June last there had been paid out of the Dominion Treasury, $135,549,987 in cash aid to railways, to which the various provinces added $35,588,526 and the municipalities, $17,824,823. Not one farthing of return has been received upon this expenditure, nor ever will be. It was a gift. To these cash subventions have been added 55,116,017 acres of land, from the sale of which many millions have already been received by the grantees and the prospective value of which no one can



The Principal Railways of Canada.

It will be seen that 9,045 miles of line, or nearly 38 per cent. of the total, lie west of the Great Lakes. That is a development of less than thirty years; but to anyone cognizant of the trend of population and enterprise, it is obvious that before 1915 the eastern provinces will have the lesser mileage. It is in the West that construction is proceeding with marvellous rapidity, and yet falls short of the demand. To maintain the present ratio of one mile to every 300 inhabitants, the provinces beyond the lakes will require more than two miles of railway to be built and equipped each day. Just what that means in capital, material and labor is really very large.

With the exception of agriculture, the money invested in railways in Canada is larger than in any other industry. The capital liability amounted on 30th June last to $1,308,481,416, exclusive of $111,545,903 expended on Government-owned lines, and is growing at the rate of $75,000,000 a year without taking into account the outlay on such associated enterprises as car foundries, steel rail mills and bridge building establish-

compute. This statement of paternalism takes no account whatever of the cost to Government of the eastern division of the Grand Trunk Pacific, now under construction, and which may be put down at not less than $115,000,000, nor of the outstanding guarantees. These latter do not fall below $200,000,000 at the present time. If cash subsidies, land grants, guarantees and cost of construction by Government were combined, the aggregate might fairly be put down at more than $600,000,000, or something like $75 for every man, woman and child in the Dominion.

All this has been done cheerfully by a people conscious of their needs and convinced of the soundness of their method. It may be that the time is approaching when State aid will wholly cease; but it would not seem to be imminent. Canada is essentially a pastoral country, and geographical conditions call for lines of transportation which cannot be made immediately profitable to their owners. Production in any form, be it of potatoes or machinery, is dependent upon a market, and railways supply the link between farm and factory on one hand and the consumer on the other. This is, of course, obvious; but in these days, when corporate rights are being viewed by many in a spirit of hostility, it might at least suggest an attitude of compromise if the relationship between all industrial life and the railways were fully realized. In other words, to what extent would every soul in the land suffer if to-morrow the railways should cease to operate?

One could practically count on the fingers of his two hands the railways in Canada which yield a reasonable return to their owners. It is not worth while to pause here and discuss the causes which have operated to bring about this condition. The fact only is of immediate concern. There were last year, 87 reporting lines in the Dominion, representing 161 different railway organizations, and of these 30 were operated at a loss as between income and outgo. There were net earnings of $40,456,251 on a total business of $145,056,336; but 95 per cent. of that profit was divided among eight companies. The remaining five per cent. went to roads which merely made one hand wash the other, or had a relatively small balance on the credit side. Such a situation should not be lost sight of in the consideration of railway interests by the onlooking, and not always accurately informed, public.

There is a further fact, which emphasizes the large part played by our railways in the economic life of the whole people. There are, in round figures, 125,000 persons employed in the service of Canadian lines. It would be fair to assume that each of these represents a family group of five; so that 625,000 souls may be said to obtain their livelihood directly from the railways, or one in every twelve of our total population. There are, however, numerous collateral industries which are wholly or in part dependent upon railways for the consumption of their products, and these give employment to a sufficient number to make the ratio as high as one in ten. The direct employees received in 1909 $63,216,662 in salaries and wages, or 60.43 per cent. of the gross operating expenses.

This reference to the very large amount of money paid out for labor suggests one of the most serious problems which just now confronts our railways. The wage bill has been steadily rising for years, representing in a very acute sense the increased cost of living to railway owners, and there has not been a commensurate growth in earning power. The freight and passenger rates have remained practically stationary. The cost of running a train one mile, using the total train mileage and gross operating expenses as the factors, has increased from 86 cents to $1.30 since 1900. This advance of 51.5 per cent. has been almost wholly due to the higher cost of labor. The tendency is still upward. During the current year the wage bill of American railroads has been swollen by more than $100,000,000, and a proportionate increase has occurred in Canada. This larger outgo has been met in part by economies of one sort and another; but the time must be near when higher freight rates will be unavoidable.

There have been several spasmodic efforts in Canada to create an agitation in favor of a two-cent passenger rate. In the face of a persistent growth in general operating cost such a reduction could not be fairly asked; but, apart from that aspect, it would seem that even the present three-cent rate does not yield a profit. I take the responsibility of saying that few railways make ends meet in connection with their passenger service. It it were not for indirect gain, the receipts from ticket sales would not meet the cost of running passenger trains on more than ten railways in America. Our railways provide an excellent service; yet last year, while the train mileage actually increased, fewer passengers rode on the trains and the receipts from tickets fell off. Under such conditions it would appear to be untimely, to say the least, to demand that the railways should forfeit one-third of their income from ticket sales. They would be seriously crippled if this were done.

It is always dangerous to draw sweeping conclusions after a merely superficial view of the conditions governing any industry. The conduct of a large railway brings into play factors and conditions so numerous and complex that the layman should hesitate at all times before expressing a judgment on any matter of policy in relation thereto. He cannot very well see below the surface. It has already been pointed out that Canada has but 300 inhabitants for each mile of railway, and this suggests the important bearing which density of traffic has on railway operations. The Dominion had last year, a passenger density of 84,342, represented by the number of passengers carried one mile per mile of line. In the United States the passenger density was 126,176. Similarly, the difference in freight density in Canada and the United States was as between 545,991 and 947,450. In Great Britain and the more populous countries of Europe the available traffic per mile of line is even much greater than in the United States.

These comparisons might with perfect propriety be carried further. Not only do the railways of Europe receive higher rates, but they pay much less for labor than do the railways on this continent. For example, a locomotive driver in England is paid less than $2 per day of 12 hours, and his fireman $1.20. Here the scale is more than twice that figure. If European railways were compelled to adopt the Canadian schedule for all their employees, and their rates were left untouched, they would probably be thrown into liquidation. They could not, at all events, earn dividends on their enormous capitalization, which, in the United Kingdom, is more than five times larger than the Canadian figure. The State railways of Australia are often unfairly compared with our own Intercolonial. The lines in Australia have rates many times higher than those which prevail in Canada, and pay much less for their labor. The Intercolonial has the lowest freight rate in the world, and that is undoubtedly the chief, if not the only, reason why it does not pay a fair return on capital cost.

The public service of Canadian railways in 1909 consisted in the carrying of 32,683,309 passengers and 66,842,258 tons of freight. As compared with the preceding year there was a decrease of 1,361,683 in the number of passengers, and an increase of 3,771,091 in the tonnage of freight. Twenty years ago the number of passengers was 12,821,262 and the freight tonnage 20,787,469; so that traffic has increased rather more rapidly than construction. That is only proper. The railways would be in a poor way if the result had been otherwise. Nearly all the double tracking in the Dominion has been done within that period, the tractive power of locomotives has been increased, heavier rails have been laid down, and in many respects the traffic capacity of our lines has been bettered. There are now 1,464 miles of second track in the Dominion, of which 253 were constructed in 1909.

The average passenger journey last year was 62 miles, and the average number of passengers per train 51. The average receipts per passenger were $1.195, while the earnings for each passenger train mile were $1.15. The average haul of freight was 197 miles, and the average train load was 278 tons. Each loaded car carried an average of 16.98 tons, and the average number of loaded cars per train was 16.37. The average passenger journey and the average haul of freight are larger in Canada than in any other country, but the average load per train is heavier in the United

States by 110 tons. Our railways are steadily gaining in the weight of freight trains, and compare favorably with lines in those sections of the United States where the conditions are similar to those on this side of the boundary. It is the heavy coal and iron traffic in the Eastern States which fattens the American average.

The railways of Canada earned $145,056,336 in 1909, and paid out $104,600,084 in operating expenses. The ratio of the latter to the former was 72.1 per cent. Ten years ago the aggregate receipts were $70,740,270, and in that year the percentage of operating expenses was 67.4. In this significant fact is reflected the increasing cost of labor. The gross earnings in 1909 came from the following sources:

		Per cent.
Passenger service	$45,282,326	31.21
Freight service	96,685,076	66.65
Station and train privileges ...	493,895	.35
Telegraphs, rents, etc.	2,595,039	1.79

In the United States the percentage from freight is 70.44 and in Great Britain 50.35. In Germany the relative proportions correspond closely with those in Canada. The average receipts per ton of freight was $1.432, and the average receipts per ton per mile .727 cent. This latter rate, which is accepted as a standard of measurement the world over, was lower than the United States figure by .028, which would clearly indicate that our railways are not, on their whole business, imposing comparatively excessive freight charges.

The distribution of operating expenses in 1909, amounting to $104,600,084, was as follows:

		Per cent.
Way and structures..	$21,153,274	20.22
Equipment	21,510,304	20.56
Traffic expenses	3,798,825	3.63
Transportation	54,284,587	51.89
General expenses..	3,853,094	3.70

The largest single item in operating expenses is coal, which last year represented 16.77 per cent. Repairs, which appear under several heads, would probably exceed the cost of fuel if combined. Back of all, however, as has been pointed out, is labor, which eats up 60.43 of the aggregate income. It is a part of nearly every item in the analysis of operating expenses.

The train mileage of 1909 was 79,662,216, divided as follows: Passenger trains 32,295,730, freight trains 40,304,906, and mixed trains 7,061,580. In this service were employed 3,969 locomotives, 117,779 freight cars, and 4,192 passenger cars. Some notion of the relationship of car supply to available traffic may be had when it is pointed out that the freight cars on Canadian lines last year had a total carrying capacity of 3,385,313 tons. Of course, it is a purely fanciful thing to say that the 66,842,258 tons of freight hauled in 1909 could have been handled by loading each car twenty times, but the calculation is at least illuminating. Without going into that matter, it may be said that our Canadian railways have made a brave effort to meet the demands upon them by shippers for cars. The difficulty arises only at particular seasons. Then complaints are heard. The other side of the story is found in the fact that for considerable periods each year the sidings and yards are congested with idle cars. For example, on 17th February, 1909, there were 19,740 surplus freight cars on five of the chief railways. This situation continued in greater or less degree until October, and it represented what are really normal conditions at that season, taking one year with another.

The prevailing activity in railway construction is the natural accompaniment of our development as a progressive and busy nation. Not only will it continue, but it will inevitably extend and widen. As a people we are on the threshold of marvellous growth. The rising tide of immigration means more producers and more consumers. Commerce will keep pace, and with that advance must go on expanding railway mileage. The world seems to have awakened to an appreciation of our heritage, and we ourselves have learned to build by a new and larger gauge. By every test Canada is to-day going ahead faster than any other country, and it may be safely assumed that every step toward the realization of our full strength and capacity will in some degree be identified with enlarged railway interests. Commercial growth and railway growth not only go together, but they are so coordinated as to practically make one impossible without the other.

PROGRESS OF LOCOMOTIVE CONSTRUCTION IN CANADA.

Lacey R. Johnson.

Although it has been said, that of all the prime movers the locomotive in itself since its introduction has shown the least progress, one has only to call to mind the engines which hauled our passenger and freight trains thirty years ago, with their boilers well down between the driving wheels, with a view to keeping the centre of gravity as low as possible, with cylinders 15 inches, 16 inches, or at most 17 inches in diameter, and steam pressure not exceeding 140 lbs. per square inch, tenders carrying 2,000 to 2,500 gallons of water and six tons of coal, and then compare them with the ponderous machines in service to-day, and we are bound to admit that in the design, construction and performance of the modern locomotive, great results have been accomplished.

Thirty years ago, what was known as the "American Standard Engine," two pairs of driving wheels coupled together with a four-wheeled rigid centre truck in front (Fig. 1), was the almost universal type of locomotive used in Canada, the size or diameter of the driving wheels varying according to the service intended for—with a very few of the Mogul type, three pairs of drivers coupled with a two-wheeled flexible or radial truck in front, (Fig. 2), for heavy freight service. The total average gross weight of an engine and tender in working order with water and coal would be 30 to 40 tons, giving a tractive power of about 10,000 lbs., and capable of hauling 750 gross tons behind the tender on a practically level track, with a consumption of 100 lbs. of coal per mile. In those days the idea of designing special classes of locomotives for shunting and construction service was not thought of; a road engine run down and ready for the repair shop was considered the correct thing for yard shunting, and those engines which the operating department considered as out of date for regular traffic service were generally fixed up and turned over to the construction department.

To-day, conditions have changed,—the enormous increase in the volume of traffic, both passenger and freight, to be carried in most cases over a single line of rails, and the ever-increasing demands for more frequent and rapid service, have kept the locomotive designer busy meeting these demands by constructing machines which will do the work efficiently and also economically. With a country like Canada, stretching 4,000 miles from the Atlantic to the Pacific, every natural difficulty known to engineers in formation of country, and in climate, have to be encountered and met, and locomotives have to be designed to do their work under every conceivable difficulty. The gauge of the track, being fixed and unalterable, as also the width and height of tunnels and bridges, limits the designer in some of the most important dimensions, and in order to gain the additional size and weight for the required tractive power, the centre of gravity has had to be raised, and the whole engine lengthened out, and more wheels used for both driving and carrying, in order to avoid overloading the different axles, and also to distribute the weight over a greater surface of rail and road-bed, and particularly of bridges and viaducts. Operating officers who 30 years ago were satisfied with trains of 25 to 30 cars of 20 tons' capacity, to-day are clamoring for 90 to 100 cars of 30 tons' capacity, consequently the locomotive must not only be much more powerful, but must be equipped with automatic power brakes in order that the immense rolling mass may be brought to a stand-still quickly and surely, without putting an undue strain on the car couplings throughout the tremendous length of train, and also for retarding the speed of the train on down grade.

On our Trunk lines to-day in passenger service there are comparatively very few of the Standard 4.4.0 type of engine used; they have been replaced with what are known as ten wheelers, 4.6.0 type, Fig. 5, or Pacific 4.6.2, Fig. 6, and for lighter fast service the Atlantic 4.4.2. type, Fig. 7. The ten wheeler is a good all-round general service engine, which can be utilized for either passenger or freight service, as the tractive power gained by the three pairs of coupled drivers is high compared with the four coupled drivers of the Standard engine, and the Pacific type is really a development or enlargement of the ten wheeler, with the addition of another pair of carrying or idler wheels to carry the extra length and weight. It is really an inspiration to-day to stand on the platform of any of our railway stations and watch the noble specimens of the designer's art, as they glide along the steel roadway seemingly without any fuss or effort, hauling behind them the long train of massive and luxurious palace cars, many of which individually weigh (65 tons), considerably more than the locomotive of 30 years ago. The Atlantic type is suitable for lighter trains where high speed is the prin-

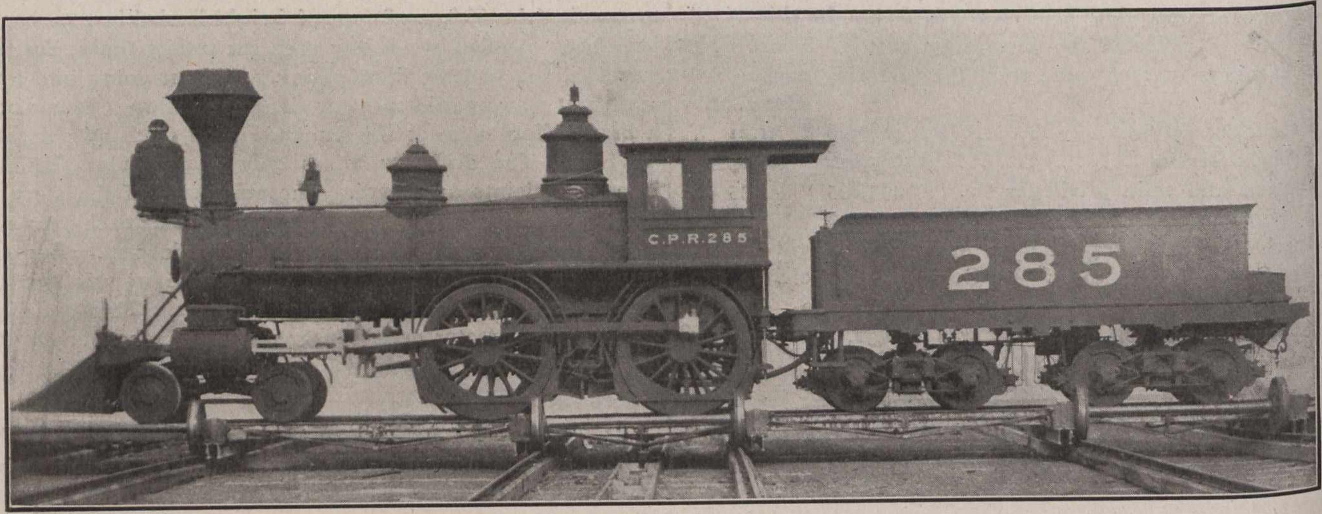
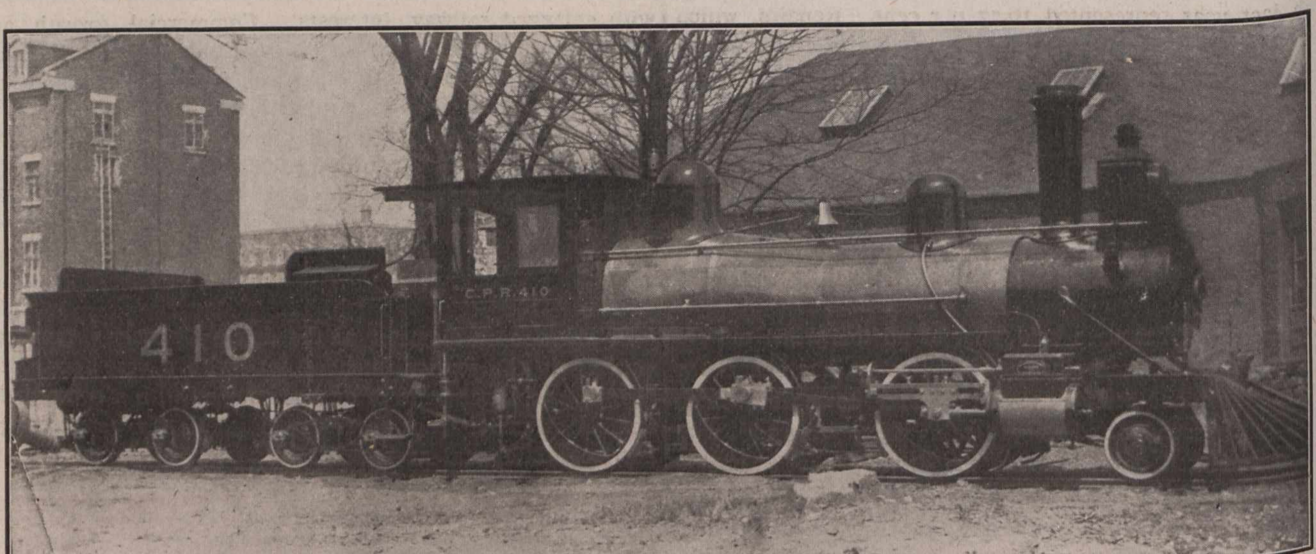


Fig. 1.

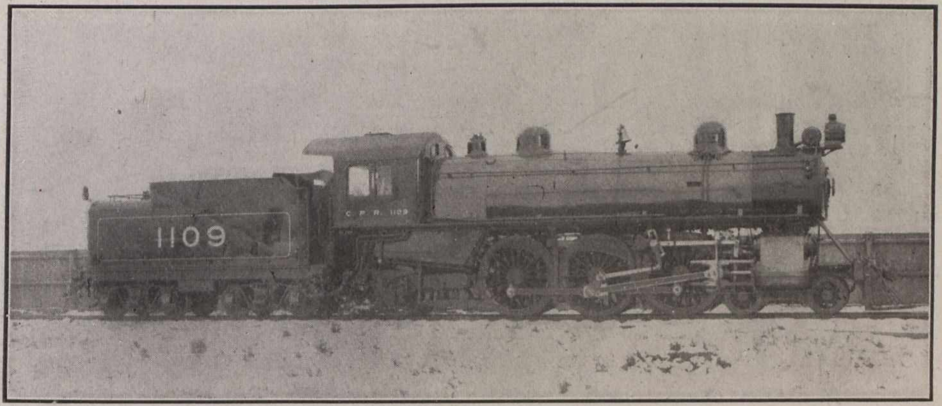


Mogul Type, Three Pair D. Wheels.

cipal factor, and on sections of roads where a level track or slight gradients are met with, and for this purpose are equipped with driving wheels of large dimensions varying from 69 inches to 84 inches.

In ordinary heavy freight service the conditions are entirely changed, instead of speed, enormous hauling power is required, and to meet this the consolidation or 2.8.0, Fig. 8 type, has been designed and proved to be very satisfactory both for prairie and mountain service, although, of course, for climbing heavy mountain grades, their weight and power are increased proportionably. On some of the large roads in the United States, engines of the Prairie 2.8.2 type have been constructed for heavy passenger service, and Decapod 2.10.0, and Mastodon 2.12.0 type for freight service, but so far have not shown themselves on Canadian roads; recently, however, the Canadian Pacific constructed, and has in operation in the Rocky Mountains, an Articulated Compound Engine of the Mallet 0.6.6.0 type, Fig. 3, which is giving an excellent account of itself, assisting heavy freight trains over the heavy grades, and it will, no doubt, prove the fore-runner of a large number of this class for this kind of service.

Engines for switching or yard service are built with very little idea for speed, but are designed to move a large number of cars short distances, generally from one side track to another smartly, or a small number of cars, perhaps only one, and yet be easily handled, started, and stopped in a moment, without doing any material damage to the engine itself or the cars it is handling, consequently there are fewer frills and accessories on a switching engine than on any ordinary road engine,—then again as they do not get very far away from the water and coal supply, their tenders carry less water and coal than road engines, in fact on many roads they carry their water in tanks either saddle wise on the boiler, or on the sides of boiler. This system has its advantages, and disadvantages; one great disadvantage is that its tractive power decreases as the water is used from the tanks. (Fig. 4). Switching engines are usually built without a leading or trailing truck, as then the whole weight of the engine is utilized for traction purposes—they are generally of the six-wheeled coupled 0.6.0, or the eight-wheeled coupled 0.8.0 type, either with or without tenders.



Ten Wheelers, 4.6.0.

Since the introduction of the powerful labor-saving machines used to-day in construction work, the ponderous steam navvies or diggers which will fill a car with earth rock, etc., with three bucketfuls, and the immense winding engines for unloading and distributing the ballast cars, capable of automatically unloading themselves by means of compressed air in a few moments, neither a railway company or firm of contractors can afford to use old worn-out or small power locomotives, in fact the best and most powerful are none too good directly the track is sufficiently supported to carry them.

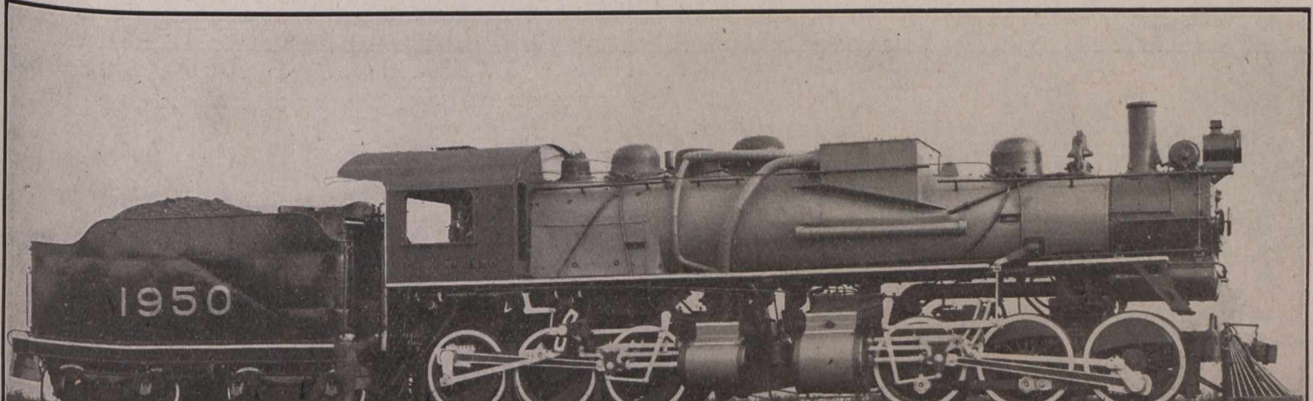
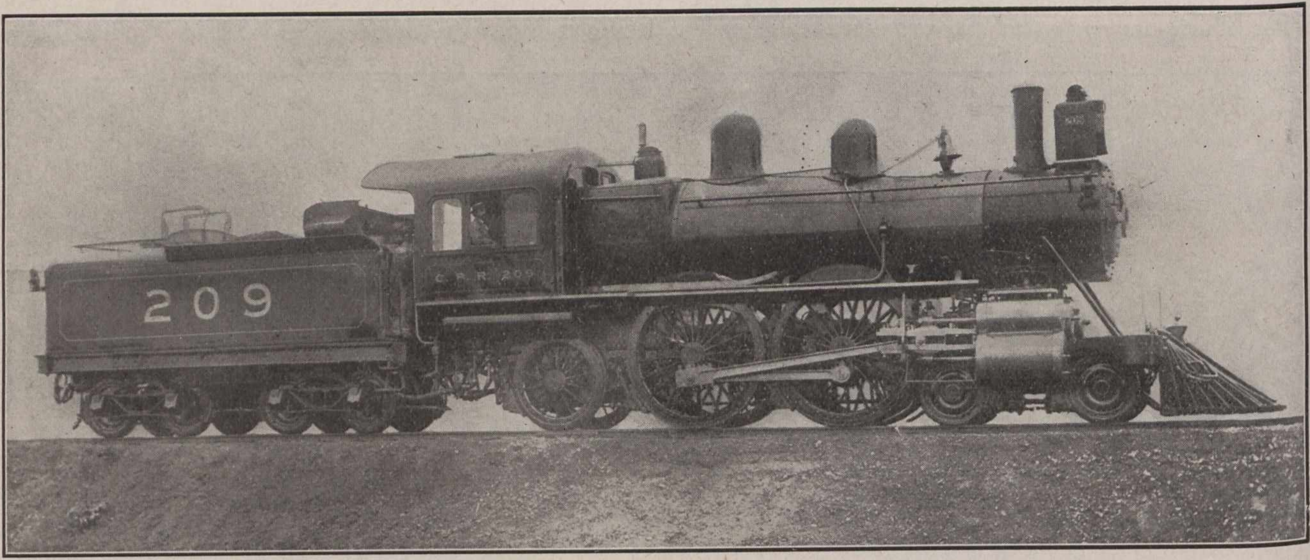


Fig. 3.

For general road service in order to economize in the consumption of steam and consequently water and fuel, several different types of Compounds have been introduced, with more or less success; that most commonly used is known as the Crossover compound, having a high-pressure cylinder on one side, and a low-pressure cylinder on the opposite side, with a receiver in the smoke box, consisting of a pipe or chamber into which the exhaust steam from the high-pressure cylinder is received, and from which the low-pressure cylinder draws its supply, it being exhausted into the atmosphere when it has done its work, as in a simple engine. With this class of engine, in order to get over the difficulty of starting a train with probably the low-pressure cylinder in action and no steam in the receiver, an intercepting valve is fitted between the two cylinders, which is so designed as to act also as a reducing valve, allowing live steam from the boiler to enter both cylinders direct as in a simple engine, only that the steam for the low-pressure cylinder in passing through this valve is reduced in pressure in the proper ratio, so as to equalize the power developed in the two cylinders, and so to equalize the strain on the crank pins on both ends of the driving axle as much as possible. There are several different systems of cross compound in use, the principal differences consisting of variation in the design and manipulation of the intercepting valve or simpling device. Then there are "Four Cylinder Compounds," having a high and low-pressure cylinder, one over the other in one casting on each side of the engine, designed and patented by Mr. Vauclaim, of the Baldwin Locomotive Works, in which the steam after accomplishing its work in the high-pressure cylinder is exhausted directly into the low-pressure cylinder, doing away with the necessity of an intercepting valve; the diameter of the high and low-pressure cylinder being so proportioned as to equalize the total power exerted by the steam, as high and low pressure on the two pistons, this requires very careful calculation, as both the high and low-pressure pistons are connected to one cross-head, so it will be readily seen that an unequal power exerted by the two pistons would result in destroying the cross-head or breaking the piston rods at their connection to the cross-head. In order to make use of the advantages of the compound system on very heavy power in freight and mountain service without using the enormous low-pressure cylinders which would be necessary on a "cross compound," and which would exceed the limit of width available, what are known as "Tandem Compounds," have been designed, having a high and low-pressure cylinder, one in front of the other, or tandem, on each side of the engine, with the high and low-pressure pistons attached to a common piston rod. They, of course, are really "Four Cylinder Compounds," but known as the tandem type. The latest type of heavy compound locomotive, is that known as the "Mallet Articulated Compound," which is really two complete and distinct engines coupled together under one boiler, giving a



Compounds.

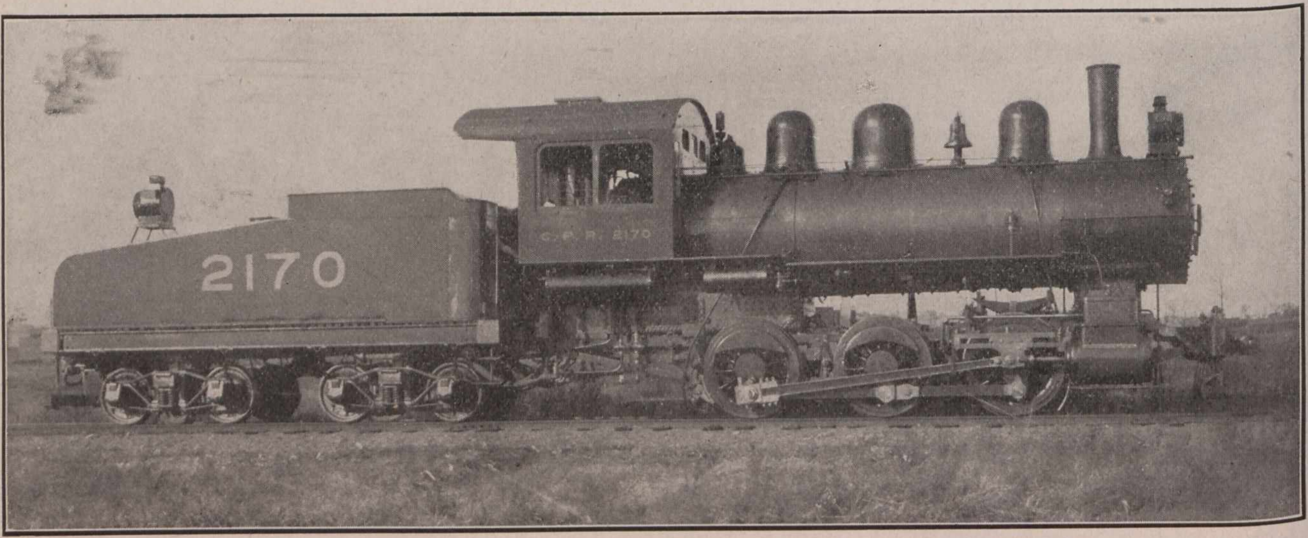


Fig. 4.

flexibility of wheel box otherwise impossible with a locomotive of such extreme weight and length, opening up quite a wide field for future development. They are designed with both high-pressure cylinders on one engine, and both low-pressure on the other, in order to simplify the piping arrangement and to reduce the number of flexible joints to a minimum.

During the last few years, a great deal of attention has been paid to the use of superheated steam in locomotives. It is by no means a new idea, having been used as far back as the use of the steam engine itself in marine and stationary practice, but its use was discontinued, mainly on account of the difficulty experienced in satisfactorily lubricating the walls of the cylinders with animal oils at the high temperature of the super-heated steam. This trouble, however, has been eliminated by the use of high-flash mineral oils. Messrs. McPhail & Thompson, a firm of English engineers, were the first to re-introduce the use of superheated steam for stationary and locomotive engines, and later still, Mr. Schmidt, a German engineer, invented and patented a system of superheating, specially designed for use in locomotives. It consisted of a number of pipes bent to the radius of the smoke-box, and lined, so to speak, the sides of the smoke box, and connected to headers or receivers top and bottom, through which the steam passed on its way from the boiler to the cylinders, taking up the heat of the gases from the fire box after having passed through the tubes, thereby utilizing a great deal of the heat which would otherwise be wasted by being carried into the atmosphere by the action of the exhaust. This heat in the smoke box was supplemented by the use of a large tube in the centre of the boiler, thereby allowing a bigger flow of the hot gases from the fire than would be possible through the smaller tubes, though this, of course, decreased the efficiency of the boiler to a certain extent by the corresponding decrease in the heating surface—however, the system gave very satisfactory results, and the more recent designs are mostly modifications of the Schmidt system, with this difference, that instead of the superheated tubes being confined to the smoke box, they are run part of the way through the boiler tubes, a certain number of the boiler tubes being made larger in diameter to accommodate them, thereby coming in contact with the furnace gases earlier in their passage from the fire to the atmosphere, and consequently while at a much higher temperature; all the superheated tubes being connected to a header in the smoke box, the steam passing through the tubes and header on its way from the boiler to the cylinders. As these tubes are continually exposed to the action of the hot gases from the fire, and as they are only filled with steam during the time the throttle is

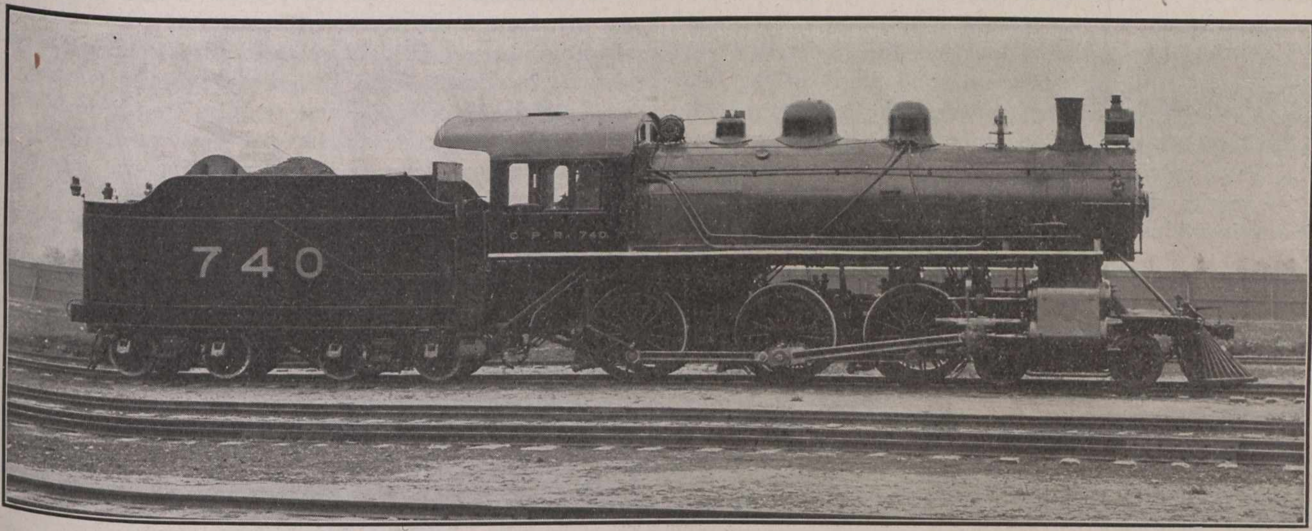


Fig. 5.

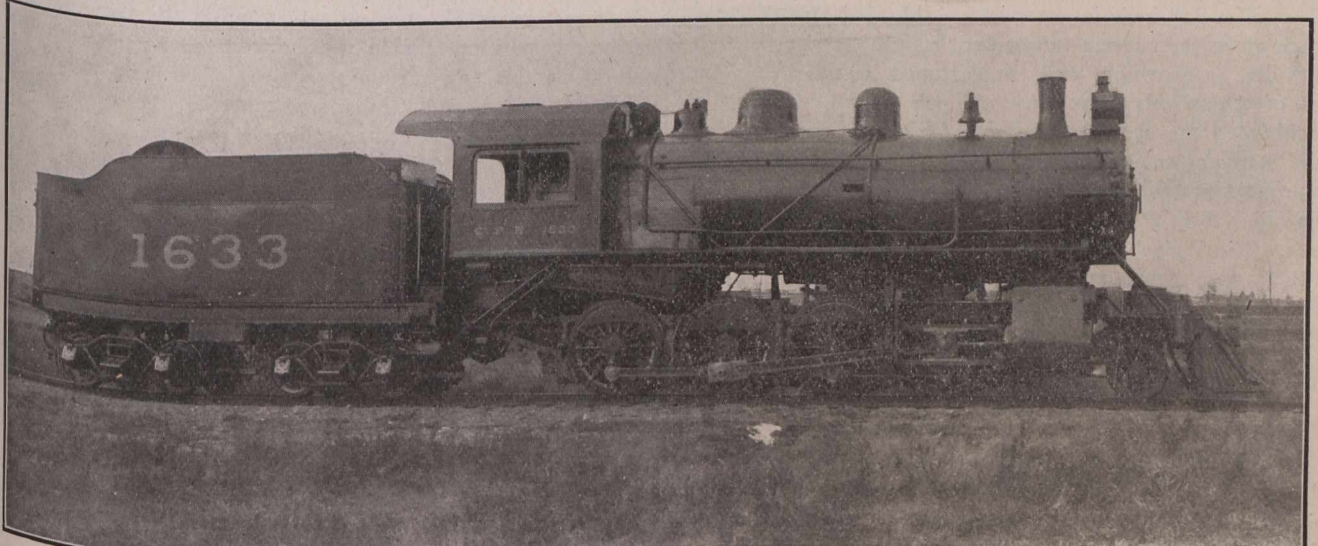


Fig. 8.

open, and the engine working steam, a damper is fitted in the smoke box and actuated automatically by a small steam cylinder, which shuts off the draught on the superheated tubes when the throttle is closed. A great economy of fuel and water is effected by the use of superheated steam, and locomotive designers all over the world are to-day giving it serious attention, with the result that some very novel designs are being brought out, but the above remarks about cover those in use in Canada to-day.

Another recent departure in locomotive design is the introduction into Canada and the United States of the Walscheart Valve gear, (Fig. 9), superseding very largely the Stephenson Link gear on modern engines. There is a great difference of opinion amongst locomotive designers as to the relative merits of the two gears, advocates of each system claiming individual merits of the one over the other, but as it is not the intention that this article should champion any particular system or design, it may be stated that the locomotives of to-day have increased in weight and size of details to such an extent, necessitating such enormous sizes of axles and width of bearings, and the distance between the inner faces of the wheels remaining the same, and thereby encroaching on the space on the axle for the eccentric sheaves of the Stephenson gear, which in themselves also increased in size proportionately, that it became absolutely necessary to adopt some other form of gear to give the necessary motion to the valves. The Walscheart gear meets all, or at any rate nearly all, the requirements, and possesses the advantages of having only one eccentric in the form of a crank fitted to the main crank pin of the engine, and the whole of the gear being fitted outside of the main frames, makes it very accessible for inspection and repair, and easy to handle, in fact, take it all round, it gives very good satisfaction.

In order to get over the difficulty in the balancing and lubricating, the large flat sliding surface of the flat slide valves when using the high boiler pressure and high temperature of superheated steam on a modern locomotive, piston valves have been introduced which readily accommodate themselves to large port areas, both for steam and exhaust, and being practically in equilibrium, require very little power to move them, thereby releasing the valve motion of a great deal of strain, and consequently cost of maintenance. The piston valves are made with either inside or outside admission, those with inside admission being the most popular as the glands and steam chest joints are only exposed to low-pressure steam, and therefore less liable to leak.

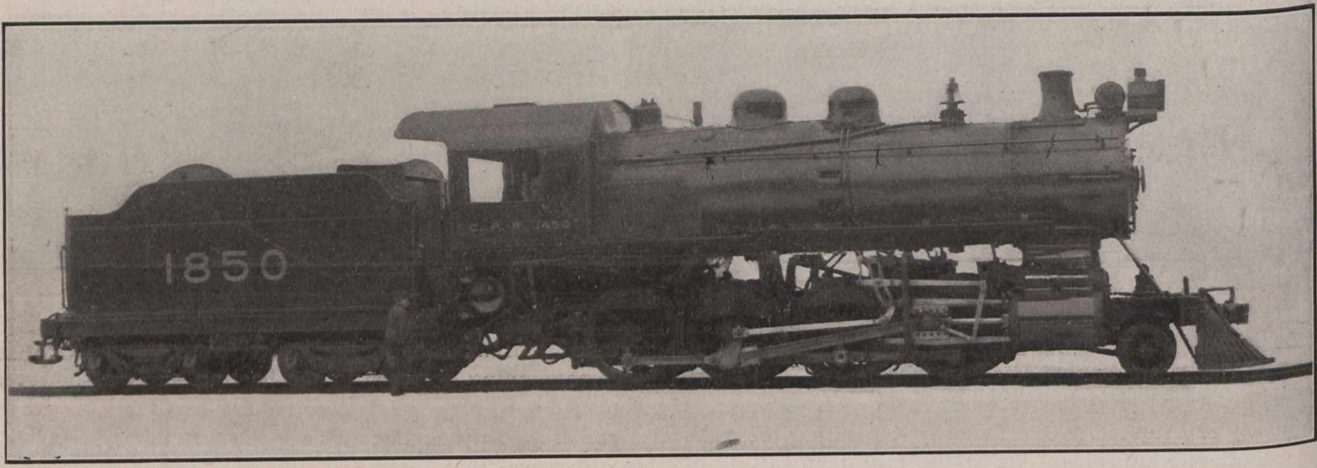


Fig. 9.

It is remarkable that notwithstanding the fact that locomotives have increased in weight from 30 tons to 110 tons, and in tractive power from 10,000 to 40,000 lbs., and in face of the increased cost of labor and material, the locomotive of to-day costs very little more than its smaller brother of 30 years ago, and in addition to this, the modern Mastodon is so designed, and the boiler efficiency so high, that still only one fireman is required and one engineer handles not only the main engine, but also the numerous accessories or auxiliary devices which are found to-day on the modern locomotive.

THE MODERN LOCOMOTIVE REPAIR SHOP.

A. D. Porter, Assoc. Mem. Can. Soc. C.E.

At the present rate of building trans-continental railways and extensive railway construction in all branches, the problem to the motive power engineer of how he shall lay out and equip an up-to-date locomotive repair shop, on the most economical and efficient lines possible for handling a given number in a definite time, of the present day locomotives, is at present commanding a considerable amount of attention from engineers who are interested in this question.

The term locomotive repair shop does not refer in this case to the locomotive works or principal shops of a railway where the engines are manufactured and built, and where necessarily the shops and equipment for handling that class of work must be of the heaviest and most expensive construction, but to the divisional shop where all classes of repairs are handled, short of entirely renewing and rebuilding.

On another page will be found a ground plan, Fig. 1, showing the general lay-out of locomotive repair shops which are well able to take care of from ten to twelve locomotives for general repairs, classed one and two repairs, per month per ten hours day. At the same time there are handled repairs too heavy for round houses, classed number three repairs, also running repairs, and repairs to engine parts sent in from outside round houses.

The shops put through altogether on an average about thirty locomotives per month.

It is the intention in this article to describe a modern locomotive repair shop, utilizing the transfer table in place of the overhead, expensive, traveller which requires expensive masonry and steel work in the construction of the building, to carry the enormous weights that our present day locomotives have attained within recent years.

The shops consist of erecting shop, machine shop, tender shop, boiler shop, blacksmith shop and stores department, with petty stores inside the main building. Adjoining the shops is a thirty-two stall round house for freight locomotives, where a special round house staff, independent of the shop staff, handle running repairs. A through track connects the erecting shop and round house, and on this track are located the thirty-ton jacks for lifting the locomotives, and also the drop-pit jacks, for removing wheels.

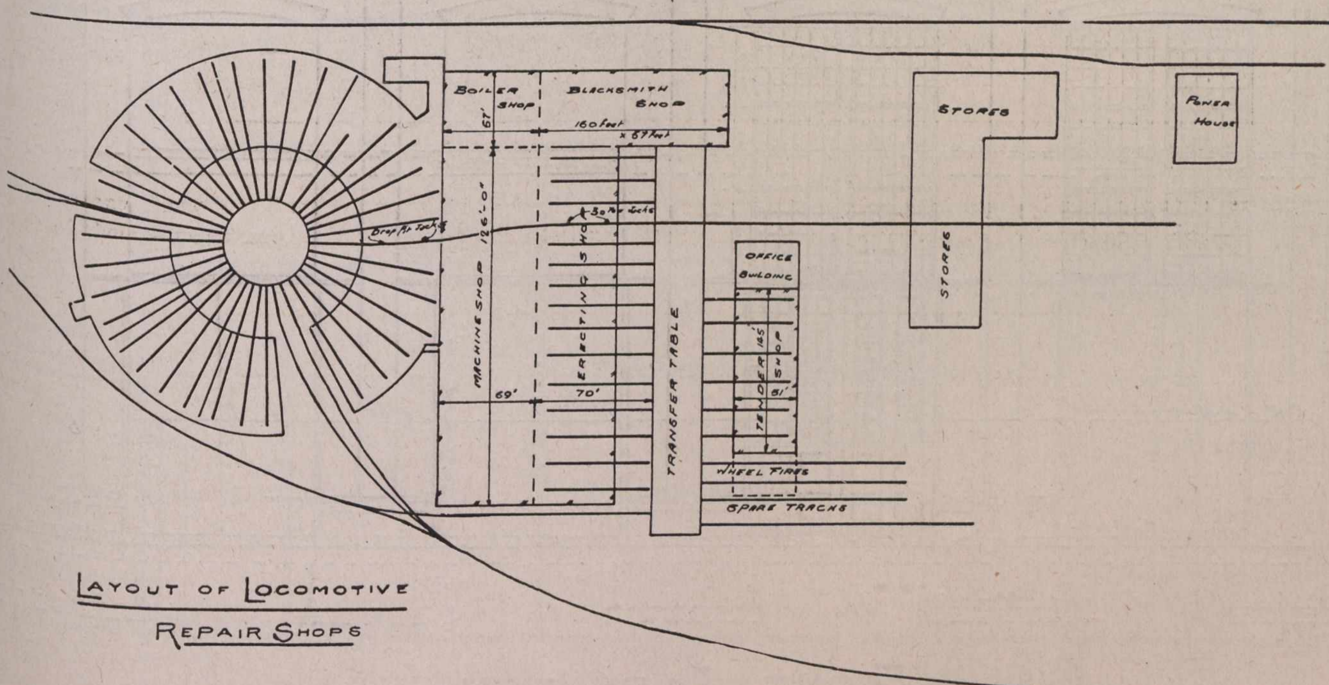
On referring to the ground plan, Fig. 1, it will be seen that the transfer table runs the whole length of the shops between the tender and erecting shop. The engines coming in for repairs, having had their fires dumped and all coal removed from the tender, are run on to the transfer table, under their own steam, along the track at the end of the shops, the tender having first been uncoupled and left clear of the table to be handled later and placed in the tender shop.

The transfer table is propelled by means of a 20 horsepower motor, the electric power being obtained from overhead motors, also lighting purposes. The shop is served with a 5-ton overhead electric traveller, which handles all classes of work required in this shop, such as moving wheels, engine and boiler parts, loading and unloading material for outside points.

In this shop the engines receive complete repairs of all kinds; broken frames are welded by means of the Thermit process, and tube sheets and broken bridges are repaired by means of oxy-acetylene process. A cylinder boring machine and a movable 5 horse-power motor driving bolt lathe which can be moved round the shop in close proximity to engines requiring turned bolts, take care of all cylinder boring, piston valve steam chest boring, and all bolt work in engine frames, cylinders, etc.

In addition to the above equipment the following list of air tools are required, to carry out efficiently, all fitting, erecting, and boiler work handled in this shop.

16 Air motors,
13 Air hammers,
4 Rivetting hammers,
1 Air holder-on.



Layout of Locomotive Repair Shops

wires and trolleys erected at one side of the transfer table pit. The motor is also connected by means of clutches, to a winding drum which carries a steel cable, used for moving the engines from their respective pits, to the lifting jacks near the centre of erecting shop, and by using a snatch block arrangement they can be moved back into the shop as required.

Erecting Shop.

The erecting shop, as will be seen from the plan, Fig. 1, is of cement and brick construction, 126 feet long by 68 feet wide. Some idea of the construction of the building can be obtained from the part elevation, Fig. 2, and cross-section, Fig. 3, shown below, these drawings or cuts also show the method of supporting the girders carrying the rails for the overhead traveller, and details of lighting, engine pits, etc.

The shop is laid out with a series of sixteen engine pits, 16 feet long by 4 feet wide, one pit being equipped with 30-ton electrically-driven jacks, for removing wheels from under engines. Each engine pit is equipped with compressed air connections and electric connections for air and electric

Two charge-hands superintend all engine work carried out in this shop, and look after the following total staff of workmen:—

30 Fitters,
14 Fitter's helpers,
4 Apprentices,
7 Engine truck men,
2 Jacket men,
2 Shop laborers.

This staff handle on an average, 30 locomotives per month, for number one, two, and three repairs, and running repairs.

By a number one repair is meant a general or thorough overhauling, a number two repair means tyres turned and not so heavy machinery repairs; a number three repair means minor repairs to engine parts requiring to be looked after. All steamfitting, coppersmith work, babbit work, is taken care of by the following staff:—

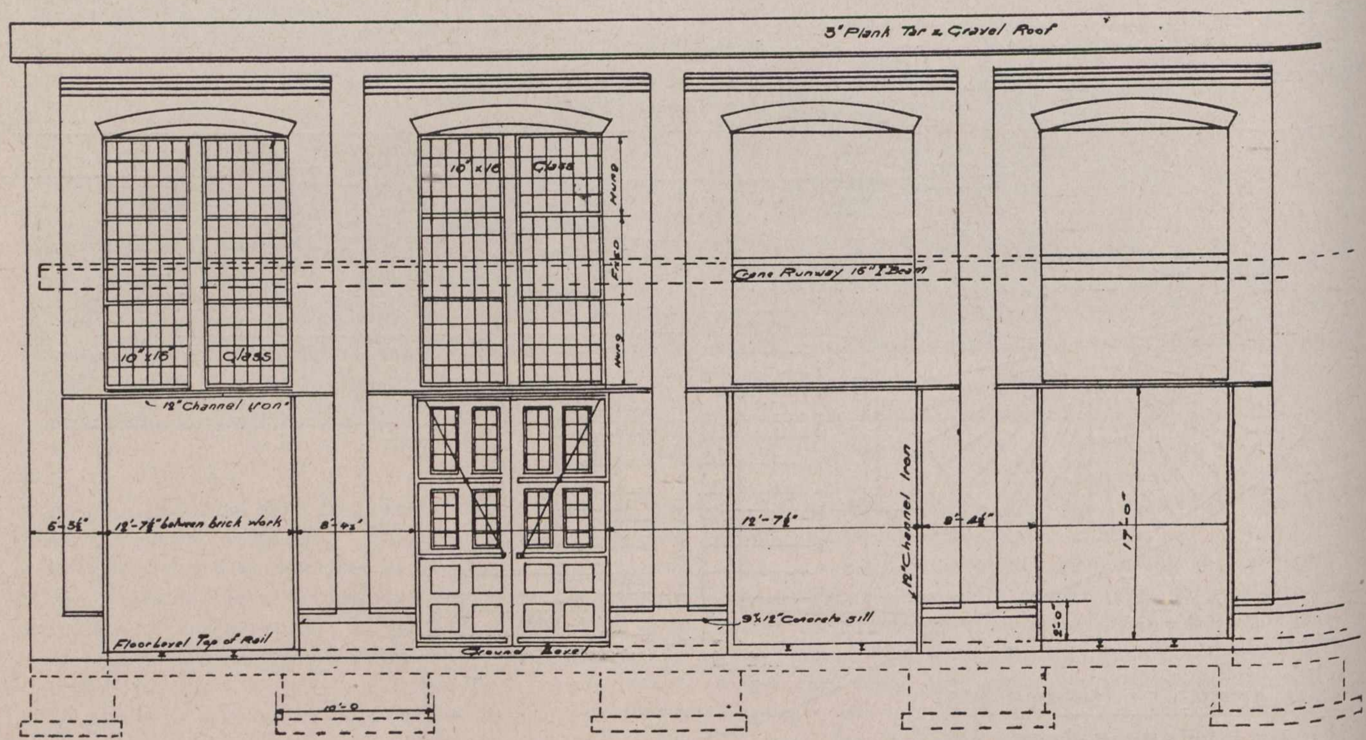
2 Coppersmiths,
1 Babbit man,

3 Steam-fitters,
1 Helper.

A 25 horse-power motor supplies the power necessary for operating the 30-ton jacks.

Machine Shop.

The machine shop as will be seen from the plan, adjoins the erecting shop and measures 126 feet long by 69 feet wide. The various machineries are driven from line shafting which runs the full length of the shop, on each side. The shafting, which runs in roller bearings, is in turn driven by five, 30 horse-power motors, placed at intervals to suit the various grouping of the machines. The engine wheel lathe is motor driven, being equipped with two motors, one 30 horse-power motor for handling wheels, and a small 10 horse-power motor for boring out crank pin holes. The 300-ton wheel press is also motor-driven, a 10 horse-power motor being connected to the pumps.



— FRONT ELEVATION —

The machineries are arranged in six groups and a complete list is given below.

Group 1.

20" lathe,
Centering Machine,
10" single drill press,
Wet emery,
Pipe cutter,
2 spindle drill,
30 H.P. motor.

Group 2.

2' 6" radial drill,
Guide bar grinder,
60" by 40" by 12" planes,
18" slotter,
18" milling machine,
24" single spindle drill press,
60" boring mill,
Driving Wheel Lathe,
Dry emery.

Group 3.

20" double head shaper,
28" Gap lathe,
42" lathe,
24" lathe,

Group 4.

Horizontal boring mill,
30" lathe,
Gap lathe,
Double Head bolt cutter,
24" shaper,
16" lathe,
36" heavy drill press,
Bushing press,
24" wet emery,
30 H.P. motor.
Dry emery,
36" throat punch and shears,
Plate roller,
30 H.P. motor.

Group 5.

16" lathe,
Landis Grinder,
3" turrett lathe,
16" brass lathe,
19" brass lathe,
48" coach wheel lathe.

Group 6.

300-ton wheel press,
30" engine lathe,
16" lathe,
18" lathe,
Nut facing machine,
Crank planer,
Planer, 10' 6" by 2' 6",
42" boring mill,
18" lathe,
14" lathe,
24" drill,
24" shaper,
30 H.P. motor.

In the machine shop all bench repairs to engine parts, such as, main and side rods, motion, driving boxes, brass work, air-brake work, are carried on; all parts being thoroughly overhauled and where necessary brought up to standard.

Instructions regarding limit of wear, etc., are issued from headquarters on Maintenance Regulation Cards, and are supplied to the various shop foremen.

All machines for handling heavy work are equipped with air hoists and an overhead air traveller handles all main and side rods from the through track to and over the rod benches.

Located near the centre of the shop is the tool store and petty stores, for supplies. An air compressor testing plant is located between machine and erecting shops so that the overhead traveller can be used for lifting the compressors on and off the test plate.

The following staff is required to handle work done in this department:—

18 machinists,
10 fitters,
6 helpers,
6 specialists,
8 apprentices,
1 machine shop foreman.

Boiler Shop.

The boiler shop as will be seen, is located along with the blacksmith shop at the north end of the machine and erecting shops, it is 70 feet long by 57 feet wide.

In this shop all repairs to boiler parts, plate work, flanging, tube-plate work, boiler tube work, ash-pan work, etc., etc., are handled.

Here the boiler tubes are cleaned, cut, welded and tested ready for application to boilers again.

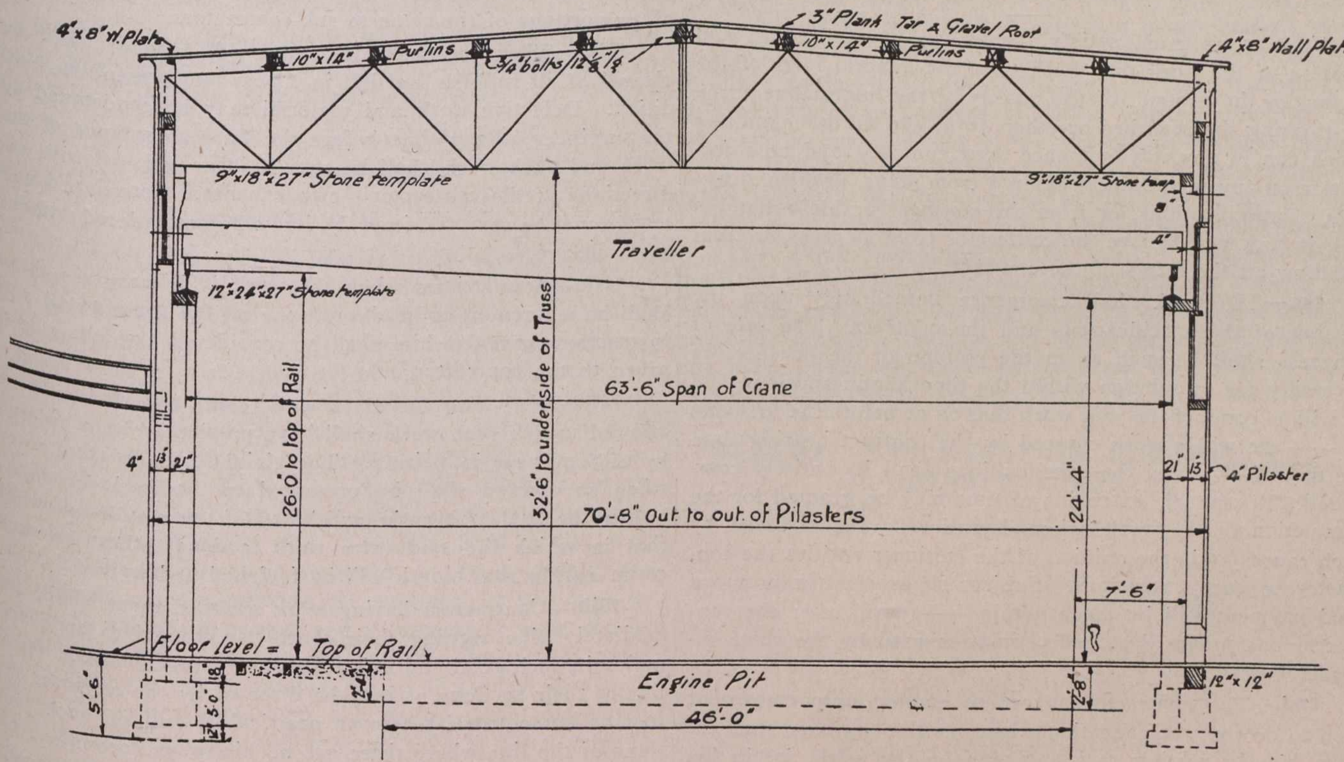
The following list of boiler shop machines, some of which are included in the machine shop groupings, are necessary for carrying on the work.

24 helpers,
3 rivet boys,
1 foreman boilermaker.

Blacksmith Shop.

The blacksmith shop is a building 160 feet long by 57 feet wide, and has ample space for the 12 fires with which it is equipped. Here all smith work, spring work, bolt work, etc., etc., are carried on and the shop is equipped with the following tools for handling the work:—

1,800-lb. steam hammer,
600-lb. steam hammer,
Bradley cushion hammer,
1½-in. iron shears,
Acme bolt machine, capacity up to 1½-inch diameter.
3 head bolt screwing machines,
1 spring furnace,
1 bolt furnace,
2 air fans.



Section. of Erecting Shop

36" throat punch and shears,
Plate rolls,
Tube cutter and reamer,
Tube cleaner,
Tube welding hammer,
Other appliances required here are,—
Oil tube furnace,
Tube testing plant and storage racks,
Flanging fires and blocks,
Plate clamps, etc.,

All boiler work is handled by the following staff:—
9 first-class and 8 second-class boilermakers,
5 boilermaker's apprentices,
7 tubers,

The following staff are required in this shop:—
11 blacksmiths,
18 blacksmith's helpers,
2 springmakers,
1 boltmaker,
1 specialist,
1 hammer-man,
1 hammer-boy.
1 foreman blacksmith,

Tender Shop.

The tender shop is a building 145 feet long by 51 feet wide, and is laid out with pits for 6 tenders. Here all truck work under frame work, tank work, etc., is looked after by a staff of six truck repairers, 1 laborer, 1 boilermaker and helper, and 1 tender shop foreman.

Part of the shop is occupied by the painters, of which there are a staff of 4 painters, 3 helpers, and 1 foreman painter, 5 carpenters, and one foreman carpenter look after all carpenter work to engines and tenders.

All wheel work is handled in covered-in space at the end of the tender shop, tyres being taken off and applied here. An overhead air hoist loads and unloads wheels for outside points, and handles the wheels to and from the wheel fires. Storage tracks are provided for engines out of service waiting repairs.

A staff of three men look after wheel work required for the engines handled in the shops. All foremen report direct to the superintendent of shops.

SPECIFICATIONS FOR GRADING RAILWAY.

General Provisions Applicable To All Work Under These Specifications.

Contractors must satisfy themselves of the nature and location of the work they bid for on the general form of the surface of the ground, of the quality of the material required for forming the road bed or other work, and all other matters which can in any way influence their contract, and no information on any such matters derived from maps, profiles, drawings or specifications, or from the engineer or his assistants will, in any way, relieve the contractor from all risks or from fulfilling all the terms of the contract.

1st.—The work shall commence immediately upon the signing of the specifications and the contract. The rate of progress shall be such as in the opinion of the engineer is necessary for completion within the time herein specified and he will so conduct the said work that on or before the first day of —— the whole work covered by the contract bearing date the day of —— and the specifications shall be entirely completed. Reasonable extension of time may be granted for the completion of the work, when detentions are occasioned by such causes as in the opinion of the engineer entitles the contractor to such extensions. Subject as hereinafter provided final payment will be made within —— days, after the contractor has procured a final estimate signed by the chief engineer.

2nd.—The contractor agrees to employ only competent men to do the work and that whenever the engineer shall inform him in writing that any man on the work, is, in his opinion, incompetent, unfaithful or disorderly, such man shall be discharged from the work, and shall not be employed again on it.

3rd.—The contractor is to use suitable methods and appliances for the performance of the work. The engineer reserves the right to determine as to this and give such orders as in his opinion will facilitate the progress of the work and the contractors must conform with such orders.

4th.—An approximate estimate will be made at the end of every month for the work done during the current month as provided for in the contract, reserving to the contractor the right to inquire into the correctness of the estimate. Fifteen per cent. (15%) of the monthly estimates will be reserved as a reserve fund until the final completion of the work as provided for in the contract.

5th.—Final estimates will be made for the work with reasonable diligence when completely performed and the engineer reserves the right to reject the whole or any portion of the said work should it be found inconsistent with the specifications. The engineer's measurements and classifications shall be final and conclusive.

6th.—The contractor agrees that he will pay punctually the workmen employed upon the work and persons furnishing the material therefor, and will, if and when required by the engineer, furnish satisfactory evidence that this has been done and if such evidence is not furnished the engineer reserves the right to pay such persons and charge the amount thereof upon his contract and until all such persons shall have, in fact, been paid in full, the contractor will not be entitled to final payment.

7th.—The contractor will be required to protect the work and will be held responsible for any injury or damage which the work may sustain from any source before final acceptance thereof.

8th.—The contractor will be held responsible for any injury or damage to persons or property received or sustained in the execution of the work, and shall indemnify and save harmless the company from all such damage or loss.

9th.—The contractor will not be released from the faithful performance of the work by reason of his having let all or portions of the same to sub-contractors.

10th.—When the work is completed, roadbed shall be cleared of all rubbish and left in a neat and presentable condition. Defective work and material may be condemned by the engineer at any time before the final acceptance of the work and such work shall be rebuilt in accordance with his directions at the contractor's own expense. Condemned material must be removed from the line when so ordered without extra charge.

11th.—At all times when the work is in progress there shall be a foreman or head workman **on the ground** and any instructions given to him shall be considered as having been given to the contractor.

12th.—No claim for extra work shall be considered or allowed unless such work shall have previously been ordered by the engineer in writing. The claim for such extra work when so ordered shall be presented to the engineer on or before the twenty-seventh (27th) day of the month following that in which the said extra work is done, otherwise such claim during that month will be forfeited and waived.

13th.—Contractors having work awarded them, shall, immediately after signing their contracts, proceed to open and maintain such good and safe roads and paths along the whole line of their sections as may be directed by the engineer for foot or horse travel wherever practicable, and on such portions of the line where there are no highways convenient for wagoning supplies, they must open and maintain such roads without charge therefor and in their proposals must take this into consideration.

14th.—Any person having permission from the engineer, shall be allowed to pass along or haul material required for the road over any section, such persons not interfering with nor impeding the work of the contractor. In the case of a separate contractor using the road he shall pay such proportion of the cost of said road as the engineer may deem just. Right-of-way and necessary land for borrow pits, spoil banks, channels, roads, ditches, etc., will be provided by the railway company as promptly as possible, but it is not to be held responsible in any claim for damages made by the contractors for delays in obtaining the same or from legal proceedings or any other causes beyond the control of the railway company.

15th.—The quantities marked on profiles are only approximate and will have no bearing on either monthly or final estimates.

16th.—Contractors must carefully preserve bench marks and stake and in case of wilful or careless neglect will be charged accordingly.

Alterations.—The engineer shall, at any time, either before the commencement or during the construction of any part of the work, be at liberty to make any alterations, substitution or change that he may deem advisable either in the grade or alignment, the width of cuttings or embankments, the dimensions or character of structures or in any other thing connected with the work, whether the same increases or diminishes the quantities, and the contractor shall only be allowed at the same rate as his schedule of prices attached and no extras of any description or claims for damages will be allowed. The rates and prices in the schedule must be understood to include not only the particular work or material mentioned, but also all and every kind of work, labor, tools, plant and materials of whatsoever kind necessary for the full execution and completion ready for use, of the respective portions of the work to the satisfaction of the engineer, and it is further agreed and understood that any such changes in alignment, grades or character of structure as mentioned above shall in no wise render the contract void.

Manner of Carrying on the Work.—Contractors shall carry on the work at such places and in such manner as he shall be directed from time to time by the engineer.

The contractor will be held responsible for all work that may prove defective owing to bad material supplied or performed by him or through want of proper precaution previous to the granting of the final estimate.

Insufficient Workmen or Material.—If at any time the number of workmen or horses, or the amount of material or other plant shall, in the opinion of the engineer, be insufficient for the due completion of the work in the time specified, or if the works are, or some part of is, not being carried on with due diligence, then in every said such case the said engineer shall have the power to notify the contractor in writing to employ or provide such additional workmen, horses, material or plant as the said engineer may think necessary, and in case the said contractor shall not thereupon within three days or such longer time as may be fixed by any such notice, in all respects comply therewith, he, the said engineer, shall have the power to provide any workmen, horses, material or plant he may think proper, and all moneys so expended by the company shall thereupon be paid by the contractor or may be deducted out or retained out of all moneys due or to become due to the contractor, and should these moneys be insufficient, the balance shall be recoverable in the usual way as a debt due by a contractor to the company.

Removal of Condemned Material.—In case any material is, in the opinion of the engineer, not in suitable accordance with the terms of the contract and is condemned as unsuitable or inferior, it shall at once be removed by the contractor from the work, or should this not be done, the engineer may, on giving three days' notice, cause the same to be removed and the cost of such removal shall be deducted from any money due or to become due to the contractor.

Work not Mentioned in Schedule of Prices.—If any work or service be required to be done which is not named in the schedule of prices, the engineer shall be at liberty to direct the contractor to perform the same, paying him the actual cost of any such work and material with an addition of 10 per cent. to cover the use of tools and profit.

Land by Whom Provided.—The company will provide the necessary land for the right-of-way of the railway, but the contractor will have to provide, at his own cost, any land required for procuring material or conducting his operations.

Power to Enter Upon the Works.—The company retains the right to enter upon the works at any time and to carry on any work that may be considered necessary by the engineer in order to erect the iron super-structure of the bridges or any other work that may be required by the company and it is understood that this taking possession of the piers and abutments as they are ready for the super-structure or other portions of the work is not to be considered the final acceptance of the work thus taken possession of.

Damages to Adjoining Property.—The contractor will be held responsible for any damage done by himself or parties in his employment to property adjoining the railway.

Sub-letting.—The contractor will not be permitted to sublet any portion of this work without the consent of the company and their approval of the sub-contractor, which consent and approval, however, shall, by no means, be considered a recognition of such sub-contractor. The contractor shall be bound at all times, to have an office on the works or at —— where by himself or some authorized agent, all notices or requisitions from the company or engineer may be received or acknowledged.

Stakes and Bench Marks.—All grades, dimensions, etc., will be given by the proper stakes and bench marks; such stakes and bench marks must be preserved by the contractor until the prosecution of the work requires their removal. If the contractor, in careless or wilful manner, removes, or causes to be removed, any of the said stakes or bench marks before the prosecution of the work requires it the expense of replacing them will be charged to the contractor and the amount deducted from the amount due on the final estimate.

The Word "Engineer."—The word "Engineer" shall mean the chief engineer having control over the work in behalf of the company, who may, however, especially authorize any other person to perform any of the functions or exercise any other power allotted to or conferred upon him as such engineer.

GENERAL SPECIFICATION FOR RAILWAY CONSTRUCTION.

General

1. This specification refers to all works required for the construction of that portion of the —— Railway between —— and —— a distance of about —— miles.

2. **Work to be Done.**—The works to be done comprise slashing, clearing, close cutting, grubbing, fencing, earth and rock excavation, bridge and culvert masonry, iron, tile or concrete pipes, concrete in piers, pedestals, abutments, culverts and foundations, rip-rap, public road and farm crossings, cattle guards, piling and trestles, and all work necessary to fully complete a first-class single-track railway to sub-grade level between the above-mentioned points, but not including the furnishing or erection of steel span and trestle bridges.

3. **Line.**—The centre of the finished roadbed shall strictly conform to the centre stakes, as set by the engineer.

4. **Grade.**—The grade line shown on the profiles will represent sub-grade which is one and a half feet below the base of rail or finished grade.

5. **Roadbed.**—The roadbed shall be formed for a single track and when finished and properly settled, must truly conform to the grade levels set by the engineer, and must be of the following dimensions:

In embankments, fourteen feet wide on top; and in excavation, clay, twenty feet wide at sub-grade, rock, eighteen feet wide at sub-grade.

6. **Slopes.**—Earth embankment, cutting and side ditches to ordinarily have slopes of one and one-half to one (1½ to 1).

Solid rock excavation will ordinarily have slopes of one fourth to one (¼ to 1) to one and one-half to one (1½ to 1).

All slopes to be as above unless otherwise instructed by the engineer.

Grading

7. **Definition.**—Under this head will be included excavations and embankments for the formation of the roadbed; all diversions of roads and streams; all borrow pits and ditches; foundation pits for bridges, trestles, culverts, buildings and structures, and all similar works connected with and incident to the construction of the roadbed.

8. **Large Blasts.**—The use of powder in large blasts, as in seams, drifts, shafts, pits, coyote holes, is prohibited unless on written authority of the engineer.

9. **Clearing.**—The right-of-way will be in general, ninety-nine (99) feet wide forty-nine and one-half (49½) feet on each side of the centre line, and must be cleared the full width. Places at which additional right-of-way has been acquired may or may not be cleared as the engineer directs. All material that is cut down or found on the right-of-way must be piled and burned to the entire satisfaction of the engineer. All trees, stumps, undergrowth and brush within such clearing, must be cut so that the tops of same shall not be over eighteen (18) inches above surface of the ground.

Clearing will be paid for by the acre where actually performed.

All timber and wood on the right-of-way along the line of the road is the property of the railway company.

10. **Grubbing.**—In all excavations, including borrow pits, on all ground to be covered by embankments less than two feet high, and from all ditches, drains, new channels for water ways, and other places where required, all stumps and large roots must be grubbed out and burned. Grubbing will be paid for by the acre where actually performed in excavations of four feet or less, under embankments of two feet or less, and in ditches, drains, water courses and borrow pits when required to be done.

11. **Close Cutting.**—All stumps must be cut close to the ground and part cut off, burned or removed from the right-of-way where embankments are less than four feet and more than two feet in height. No top of stump to come within four feet of sub-grade.

Close cutting will be paid for by the acre where such work is actually performed.

12. **Cross-waying or Corduroy.**—Cross-logging or corduroy will be placed under embankments where deemed necessary by the engineer, and will consist of such timber as will be suitable of not less than four (4) inches in diameter or more than twelve (12) inches, stripped of all branches and laid in a regular manner as directed by the engineer, with a layer of brush laid on top of such thickness as the engineer may direct. If, in the judgment of the engineer an additional layer is required, it will be paid for at the same price as the first layer.

Cross-logging will be estimated and paid for by the square (100 sq. ft.)

13. **Embankments.**—The embankments must be formed of suitable material to be judged by the engineer, and made in accordance with his instructions, either by material from excavations, borrowing or casting up from the sides. No large stones will be allowed in the bank within a depth of two feet below the sub-grade. The contractor will be required to carry the embankment to such a height above the sub-grade as the engineer may deem necessary to provide for shrinkage, compression, washing and settlement, and they must be maintained at their proper height, width and slope, until accepted by the engineer, as finished embankments.

No soft mud or muck will be allowed to enter into the composition of the embankments, and wherever new water courses or channels for rivers or streams are required to be formed, they shall be put at such distance from the foot of the slope as the engineer may direct.

The embankments above masonry shall be built at such times and in such manner and of such material as the engineer may direct. A crown of four (4) inches will be required on common excavation embankments to provide for surface drainage. A berme of four (4) feet must be left at the foot of the slope, on all embankments where material is taken from the side. Care must be taken to exclude all perishable material from the embankments.

Except when otherwise ordered by the engineer, all excavation must go into the embankment, and in case of waste from any cause whatever, such waste may, in the discretion of the engineer, be deducted from the estimate. Where there is an excess of excavation the surplus must be used for widening the embankments or for such purposes as the engineer may direct.

In forming embankments, great care must be taken to place against the backs of all walls exposed to the action of frost, rip-rap backing, consisting of small stones, spawls or coarse gravel, to prevent the retention of moisture and the action of frost thereon. The engineer to decide in each case the depth and thickness to such rip-rap. In forming embankments between wing wall against the abutments of bridges, viaducts or culverts, and over arches, the earth filling must be carefully packed in thin layers and a proper quantity of material must be carefully placed equally against each side of and over all arches, culverts and other work before the embankment approaches it; and in forming embankments the greatest care must be observed and every precaution must be taken to load the structures evenly.

The price for excavation to cover the cost of packing or tamping. The loose stone backing to walls above referred to will be paid for as loose rip-rap.

14. **Classification.**—Grading will commonly be classified under the following heads: "Solid rock," "Loose rock," and "Common excavation," and will be paid for by the cubic yard.

15. **Solid Rock.**—"Solid rock" will include all detached rock or masses measuring more than one cubic yard, and all hard rock in place which cannot be removed without blasting.

16. **Loose Rock.**—"Loose rock" will include all detached rock or boulders measuring more than one cubic foot and less than one cubic yard, and all shale, slate, soap stone, disintegrated granite, and other rock which can be removed without blasting, though blasting may be occasionally resorted to.

17. **Common Excavation.**—"Common excavation" will include all other material of every description not specially classified. Under this head should be classified all material commonly called earth, loam, clay, sand, gravel, gumbo, hard pan, cement, small boulders or angular rock fragments.

18. **Additional Classification.**—Additional classification will be established only when material in quantities is encountered of such character and quality, that it cannot be conveniently classified under the ordinary heads.

19. **Classification of Borrow.**—Material borrowed for embankment will not be classified higher than loose rock, without prior written authority of the engineer.

20. **Over Break.**—No rock excavation will be allowed for beyond the limits of the base and slopes as specified. All rock loosened by explosives beyond the slope must be removed at the expense of the contractor; if required to make up the embankment will be paid for at the price for excavation.

21. **Overhaul.**—The price for said excavation in all the several classes thereof will be understood to cover and pay for the entire expense of the removal of material excavated by any method whatever, including loading, unloading, transportation and deposition in the manner prescribed in these specifications, and in the location designated by the engineer, provided the average haul of the material so transported does not exceed five hundred (500) feet, and beyond that distance one cent (1c) per cubic yard per each additional hundred feet will be allowed when such overhaul is ordered by the engineer.

22. **Drainage and Precaution on Side-hills.**—On all side-hills where embankments are to be built and upon which the new work would, in the opinion of the engineer, have a tendency to slide, the surface shall be stepped or deeply plowed before commencing the embankments. On all side-hill ground that is wet or spongy or likely to be affected by water, the ground must be thoroughly under-drained so that no water will lie between the new bank and the old ground. The drains are to be put in as directed by the engineer, and must be in every respect satisfactory for the purpose intended. Similar drains to these must be put in wet cuttings where directed by the engineer. They will be paid for by the lineal foot including excavations and back filling.

23. **Finishing and Dressing the Grade.**—The roadbed must be finished in all cuts, embankments and along the berme in a workmanlike manner, perfectly even and regular, according to grade stakes as set from time to time by the engineer, and to be exactly of the width directed. All slopes to be formed even and straight according to slope stakes and to such incline as specified or as the engineer may direct.

24. **Borrow Pits.**—In all cases where the excavation of the regular slope and widths is insufficient to make the embankment, the deficiency will be supplied by widening the excavation or from borrow pits as directed by the engineer. Wherever necessary, additional land for borrow pits will be provided by the railway company. All such borrow pits must be formed and drained as the engineer may direct.

25. **Rip-Rap.**—When the engineer so directs, rip-rap will be used to protect the slope of an embankment from the action of water and for other purposes. It shall consist of loose stones of different sizes which shall be placed carefully upon the slope in a firm and substantial manner without being laid up in the wall.

Rip-rap shall be estimated and paid for by the cubic yard, the measurement being made in place.

26. **Building and Culvert Materials.**—In case of embankments contiguous to streams all stone found in excavations in the vicinity of such embankments suitable for the protection thereof, or for use in the construction of masonry culverts, shall be saved out of the cutting for such use as directed by the engineer.

27. **Service Roads.**—Roads constructed to and from any point of the line of the railway for the convenience of the contractor or for the conveyance of material or otherwise must be at his own risk, cost and charges.

28. **Road Crossings.**—Wherever the line is intersected by public or private roads, the contractor must keep open at his expense convenient passing places, and he shall be held responsible for keeping all crossings, during the progress of the work, in such condition as will enable the public to use them with perfect safety and such as will give rise to no just grounds of complaint.

29. **Ballast.**—Whenever any material is met with in the excavations, which the engineer may consider suitable and required for ballast, the same shall at his discretion be reserved for that purpose.

30. **Method of Measurement.**—All work to be paid for by the cubic yard. The measurement of quantities shall invariably be made in excavation, unless in special cases where this may be found impossible; in such cases the engineer will determine the quantities in embankment after making all proper deductions for shrinkage of which he shall be the judge. If the contractor shall make excavation or embankment in excess of the directed width, such excess shall not be paid for.

The prices stipulated for excavation of the several denominations together with the price of haul shall be the total prices for excavating, loading, removing and depositing all the materials, in a word; the rates and prices stipulated in the contract must be understood to cover every contingency, the finishing up of cuts and embankments, the dressing and draining of borrow pits when required, the dressing of slopes to the required angle and the completing of everything connected with the grading of the roadbed in a creditable and workmanlike manner in accordance with the directions and the satisfaction of the engineer.

PILING.

31. **Timber.**—Piles may be of oak, rock elm, douglas fir, tamarac or cedar, to be straight, or reasonably straight grained sound live timber, free from all bad knots, wind shakes, or other defects. All diameters must be measured inside the bark.

32. **Dimensions.**—Standard dimensions for piling are as follows:

Minimum length in feet 15, 20, 25, 30, 35, 40, 45, 50, over 50.

Diameter in inches at small end 10, 9, 9, 9, 9, 9, 8, 8, over 7¼.

Butt diameter to be not less than 12 inches or more than 20 inches at five feet from butt.

33. **Lengths.**—Piles will only be accepted in lengths which are multiples of five.

34. **How Driven.**—Unless otherwise directed, all piles shall be sharpened and driven with the small end down, and shall be capped with a suitable iron ring to prevent spreading or brooming while driving and, if required, shall be shod with an iron shoe of approved design.

35. **Driving.**—Piles for bridges shall be driven until the fall of a hammer weighing 2,000 lbs., with a clear fall of 25 feet or an equivalent blow, causes a penetration not to exceed 10 inches under the last ten blows, or to such further limit as directed.

36. **Broken Piles.**—Should any piling be broken in the driving, another sound pile shall be driven in its place.

37. **Batter Piles.**—All piles must be driven vertically, unless otherwise shown on the plan. Batter piles will preferably be driven at the batter shown on the plans or at part of that batter, and then sprung over to proper position; no sawing of piles to make them spring will be allowed.

38. **Extra Lengths, How Attained.**—When necessary to drive to a great depth and piles of adequate length cannot be obtained, one shall be spliced on top of another. The first pile having been driven as far as practicable, it shall be cut off square to receive the following pile, which also must be squared and set on top of the one already driven. The piles are then to be squared on four sides and fastened together by spinking on pieces of scantling.

39. **How Paid For.**—Piling will be paid for under the head of "Piling driven."

"Piling driven" will be paid for at the specified rate per lineal foot in the finished structure, which will include all

(Continued to Page 376.)

THE ELECTRIFICATION OF STEAM ROADS.

R. R. Keely.*

That our steam roads will ultimately be electrified is generally to be admitted and the question is, "What system shall we choose?" rather than, "Shall we electrify?" Electrification will be made necessary because of the demand for a service at greater frequency, speed, safety and comfort, and, if possible, at a less cost, than by steam.

President Westinghouse, of the American Society of Mechanical Engineers, before the recent London meeting, dwelt on the subject of choosing a standard. He pointed out the difficulties of the steam roads in the early days, which they encountered because of the lack of standards in their equipment and the great expense in which they were put in standardizing their rolling stock. In 1878, there were in the United States eleven different gauges of track on steam roads.

Large amounts of capital are invested in Europe and America in electric railways, many of which have replaced steam locomotives, and the actual working of these systems, in supplying information, is of great value as a guide to electrification problems now before us. The electric installations now in successful operation have demonstrated conclusively that an equally reliable and efficient system can be secured by electric operation, so that the chief difficulty is not one of engineering, but a broader question of finance. The chief objection to electrification at the present time is the great capital outlay necessary to change from steam to electric operation and the question in the minds of railway men is, "Will the increased earning capacity pay interest on the money invested?" At the present time, electrification is going on rapidly in countries having cheap water power and expensive coal, as in Italy, Switzerland, Norway, Australia, etc.

The advantages of electrification may be summarized as follows:—

(1) The elimination of smoke, steam and noise nuisance, making possible tunnels, subways, and permitting double-decking of the tracks and reclaiming the space above the tracks for buildings, as in the New York Central and Pennsylvania Railroad terminals.

(2) Increase in the capacity of line by higher acceleration and speed of trains and the reducing of switching operations and shorter block signal spacing and increasing the loading and unloading capacity of station platforms.

(3) Economy of operation by reducing the cost of fuel one-half; eliminating the time spent in watering and coaling of train locomotives, watering and coaling stations, turn tables, firemen, making fires, cleaning grates, boilers, etc., reducing cost of maintenance of locomotives and cleaning and depreciations of cars due to smoke and dirt.

(4) Greater possible mileage per train or locomotive per day, enabling about 65 electric to do the work of 100 steam locomotives.

(5) More frequent train service.

(6) A reduction of deterioration of steel structures due to locomotive smoke.

(7) Uniform speeds for grades and greater tractive power, making possible longer trains.

The disadvantages are:—

(1) Large capital outlay in changing from steam locomotives to electric traction.

(2) Displacement of the thoroughly reliable steam locomotive and the derangement of the system during change.

The interest on the large capital investment necessary for electrification, at the present time, would probably be larger in most cases than the increased revenue due to electrification, therefore, the replacement of the steam locomotive will probably be slow. In the near future, probably all large cities will require the electrification of terminals within their limits, and this will mean the electrification of trunk lines between all large cities, for it will not be practicable to attempt the frequent changing from steam to electric locomotives in this case.

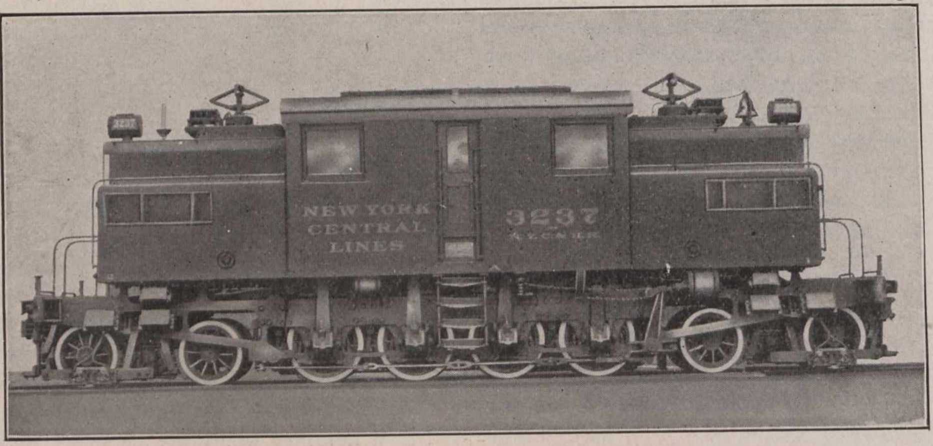


Fig. 1.

We may expect first the electrification in our cities of the railroad terminals, then the trunk lines, whose density of traffic makes electric traction desirable, followed by the electrification of mountain divisions where water power is available and grades heavy, giving the electric locomotive advantages.

In suburban work, it is necessary to accelerate quickly and the best that is secured by the steam locomotive is about 27 miles per hour in 50 seconds, while with the electric locomotive, 30 miles per hour in 30 seconds is easily attained and, considering the comfort of the passenger, this is as high as we can go.

It is usually considered that electrification is profitable only on passenger terminals where traffic is heavy and service frequent, and this probably is generally true at the present time, although in his annual report of 1903, the

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President of the Pennsylvania Railroad said that the conjested condition of their system had brought about a large increase in the ton mile cost which, for 1903, was 25 per cent. greater than for 1899. "In order to prevent this increase in ton mileage cost, it is necessary to move freight trains faster in places where traffic is dense, and for such cases the electric locomotive is most efficient."

According to the Wall Street Journal, the present bonds call for an expenditure of $60,000,000 for the electrification of steam roads in the vicinity of New York.

Pennsylvania R. R., 3rd rail	$20,000,000
N. Y., N. H. & H. R. R., overhead trolley	18,000,000
Long Island R. R., 3rd rail	11,000,000
New York Central, 3rd rail	11,000,000
	$60,000,000

There are available for electrification three systems. These are the direct current, the single-phase alternating current, and the three-phase alternating current systems. Any electric system requires a power house, line equipment and electric rolling stock. The last is the counterpart of the steam locomotive and the other two are not present in steam. The three systems have each been in operation long enough to have demonstrated their usefulness and reliability in practical railway service.

The direct-current system has been quickly evolved with the great urban and interurban railway systems that have sprung up on all sides. It was only thirty years ago that the first electric railway in America was put in operation in Richmond. The direct-current system has been used almost exclusively and has reached a high state of efficiency and perfection. The direct-current motor automatically adjusts its speed to the load, but with a given load the speed can only be changed temporarily by inserting external resistance, or it may be halved or quartered by throwing two or four motors in series. The speed also varies with the voltage and may drop at the end of long lines and heavy load. Due to the mechanical structure of the armature, the speed cannot be allowed to go much above normal. For urban work and light traffic, the current is easily conveyed by overhead trolley and for heavy traffic by a third rail at 600, 1,200 or 2,000 volts pressure. The necessary parts of the system are: step-up transformers, transmission line of three wires, sub-stations requiring attendance, step-down transformers, rotary converters for changing to direct current, the third rail conductor, which may require copper

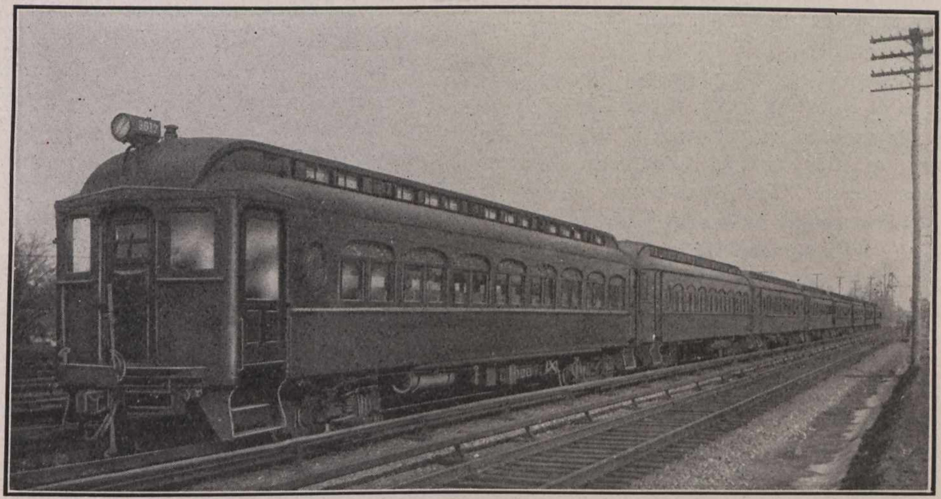


Fig 2.

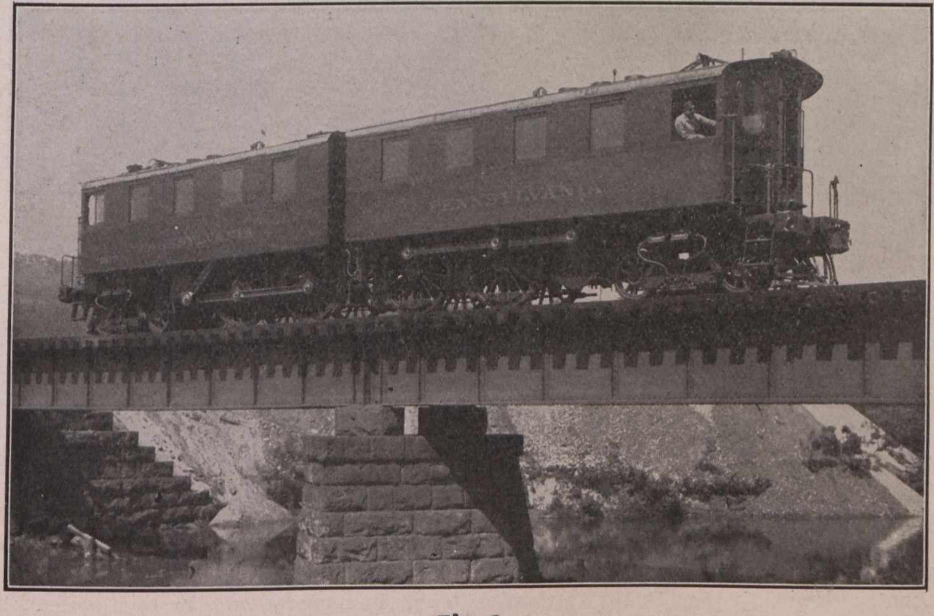


Fig. 3.

feeders and the track return circuit, which requires bonding, and in some cases feeders.

The performance of the single-phase is similar to the direct current where the speed varies with the load, but it also varies with the voltage and the voltage is made variable by the auto-transformer carried on the car, which reduces the usually high voltage trolley pressure to any desired pressure at the motor terminals. Then any desired speed can be efficiently maintained. The necessary parts of the system are: step-up transformers, transmission line of two wires and sub-stations widely spaced, containing step-down transformers, a single trolley wire and track return, usually requiring bonding only.

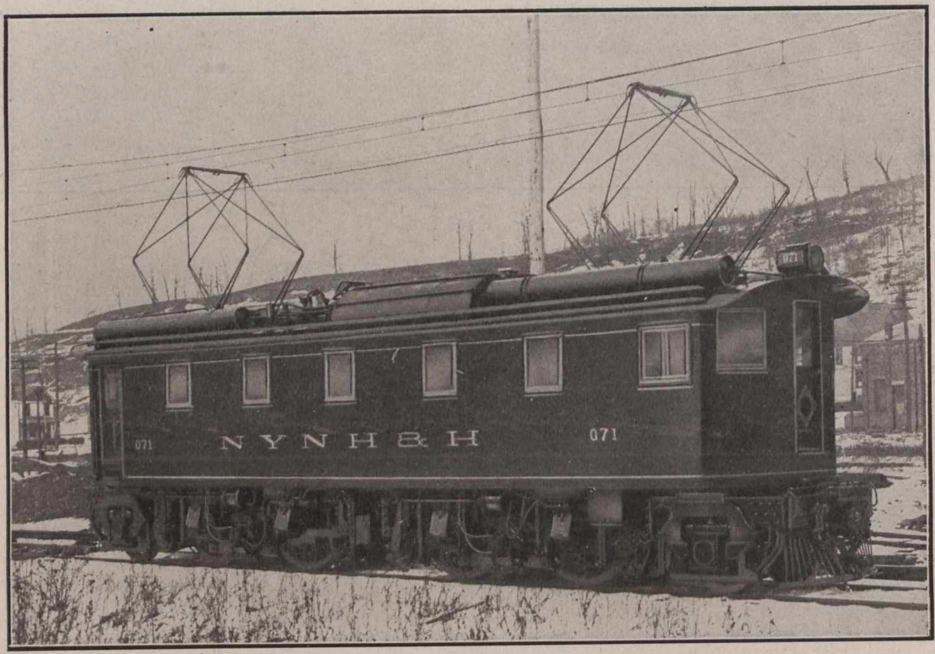
The three-phase system is suited to trunk line service. The motors tend to run at constant speed, regardless of load, but in starting, the speed can be temporarily adjusted by an external resistance, or the speed is sometimes adjusted by the "Cascade" connection. The three-phase motor is efficient and strong mechanically. It has no commutator and heat is generated in the outside winding so as to be easily dissipated. The necessary parts of the system are: step-up transformers, transmission line of three wires, sub station with step-down transformers, two overhead trolley wires and track return, usually requiring bonding only.

As to the relative merits of the three systems, the direct-current system is generally recognized to be best adapted to heavy traffic for short distances requiring frequent service, such as terminals of our great railway systems in large cities. The single-phase system has not met with favor on the American continent. While it has many attractive features in the elimination of the rotary converter sub-stations, making use of high voltage trolley, variable voltage speed control, and its ability to operate either direct or alternating current, it has its disadvantages, chief of which are its great weight and cost. It is used to a greater extent in Europe than in America. The three-phase system has many desirable points in its favor, and is meeting with much success in Europe. In Italy it has been in successful operation for over fifteen years. The motor is light, simple and efficient. It is strong mechanically and has no exposed or rubbing contacts, as in the other systems. It seems to be especially suited to trunk line operation. The Italian Government, with their wide experience, are rapidly extending the system. Many of their roads have steep grades and sharp curves, making conditions severe. Like the single-phase system, it eliminates the rotary converter sub-station and permits distribution of three-phase high voltage, which may be lowered by static transformers to trolley voltage, which in some cases is as high as 16,000. It has the disadvantage of requiring two trolley wires and the speed is almost constant for all loads, but the latter may not be a disadvantage, for it is easy to maintain schedules and on down grades, not only may power be returned to the system, but there is a material saving in the wear and tear on the brake shoes and tyres, and in the reduction of wrecks due to over-heated tyres.

While meeting with considerable success in Europe, some American engineers go to the extreme of predicting the elimination of the single-phase system for railroad work. As shown by Table IV., many of the recent European electrifications have adopted the single-phase system.

The three-phase system is lower in first cost, maintenance and operation and higher in efficiency than either of the other two.

From the above it will be clear that the logical solution of the problem would be the direct-current system for railway terminals and the three-phase alternating current for trunk line operation. In this system, all power would be generated and transmitted at high voltage, three-phase to rotary converter sub-stations, and then to the third rail for the direct-current suburban traffic, using multiple unit trains and, through the three-phase, step-down transformers to the two over-head trolleys of the three-phase locomotives, which would take the through traffic. As suggested above, this combination offers many attractive features. The direct-current system is recognized by most engineers to be the

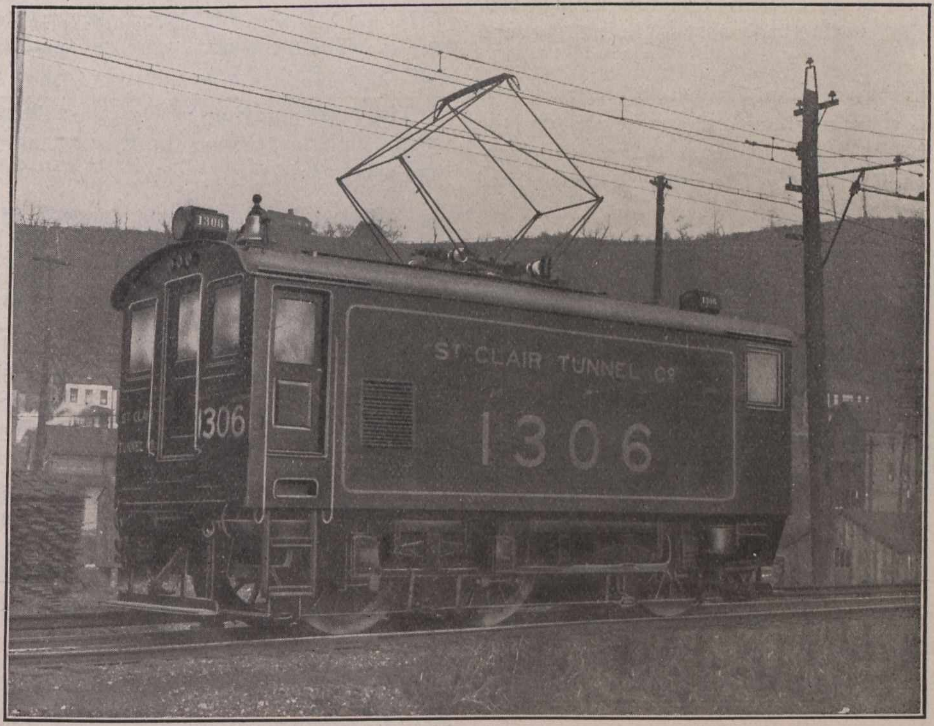


New York, New Haven and Hartford direct current railroad, simple phase in locomotive for freight and passenger service, spur geared motors and placed directly over driving axles.

best suited to suburban heavy traffic over short distances and the power supply would be confined exclusively to the third-rail system. The three-phase system is suited to through traffic, as demonstrated by the operation of the Italian lines and the recent experiments made in Switzerland. In the combination above suggested, the power for the through traffic would be supplied by two over-head trolley wires which would in no way interfere with the third rails.

The New York Central is one of the largest and most interesting examples of railway electrification. Because of the necessity for the elimination of noise and smoke, the increase in capacity of the terminal tracks and station and the opening of Park Avenue, through which they enter the city, they were forced to adopt electric traction. The system chosen was three-phase, 11,000 volts, 25 cycles transmission to rotary converter sub-stations, where it is delivered to the under-running contact third-rail at 650 volts d.c. pressure. motor is mounted above the frame and operates through a connecting rod and side rods. The locomotive is made up of two units, each having a motor and permanently coupled together. It is expected that their system will be opened for traffic in September next. The selection of their system was made after a systematic study for two years and an expenditure of over $200,000.

The New Haven terminal in New York City is an interesting example of single-phase electrification. They have, no doubt, been put to a great disadvantage by having to enter New York City over the New York Central tracks, using 650 volts direct-current. However, this speaks well for the flexibility of the single-phase system. Their equipment consists of 43 locomotives (Fig. 5) and 6 motor cars. They leave the Grand Central station on 650 volts, direct current, third-rail, then shift to their own line of 3,000 volts, alternating current, overhead catenary trolley, and finally to a steam locomotive. They chose single-phase, as they



C. T. R. single phase locomotive for passenger and freight service in St. Clair Tunnel.

Duplicate power houses and transmission lines are provided. The equipment consists of thirty-five locomotives (Figs. 1 and 2) weighing 94½ tons each, and rated capacity of 2,200 horse power. The motors are two-pole, mounted directly on the axle. The flat face poles allow the armature to drop out easily without disturbing the rest of the motor. The centre of gravity is low and the construction rather rigid, making it rather hard on the track. The management have been well pleased with the operation, and Third Vice-President Smith has said that it has been the salvation of their road.

The Pennsylvania Railroad, in order to get into New York City, and Long Island, had to pass under the Hudson and East Rivers in tubes, which made necessary the electrification of their terminal. They generate, transmit and distribute power in a similar way to the New York Central, using 650 volts, direct-current, through top contact third-rail. The locomotives (Figs. 3 and 4) are of a different design, as shown by the photograph. The 2,000 horse-power

considered it best adapted to the operating of their entire system, of which this terminal is only the first step.

The first single-phase electric railway in Canada was the Windsor, Essex and Lake Shore Railway, which has twenty-eight miles of track, and current is generated and delivered to the trolley at 6,600 volts, 25 cycles.

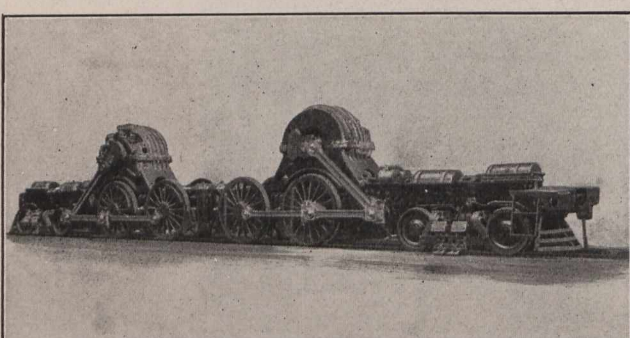
The first three-phase road to be equipped was the Burgdorf-Thun. This equipment was supplied by Messrs. Brown, Boveri Co. Failure was predicted because of the small clearance of the three-phase motors, the low power factor, the constant speed of the motors and the complications due to two trolleys, but these difficulties have never materialized and the road is giving good satisfaction. A report says that in seven years not a single motor had to be changed or repaired.

The Italian Government have been the first to adopt electrification of trunk lines on an extensive scale. Their Valtellina line, using three-phase, 3,000 volt trollery pressure at a frequency of 15 and a feeder pressure of 15,000, 20,000 or 25,000 volts, according to distance has proven very successful. The locomotives are 60 ton, 5 driving axles and two 1,000 horse-power three-phase motors. The electrical equipment was by Messrs. Ganz and Co., of Buda-Pest. The last Budget of the Government set aside $15,000,000 for electrification, and they now have under way 247 miles of line, having 337 miles of track. According to their records, since the present lines were electrified, four times the number of trains have been run and two and one-half times the number of passengers carried as in steam days.

The possibilities for electric traction for high speed was demonstrated in the Berlin-Zossen tests, in which a three-phase car, weighing 94½ tons, with four 250 horse-power, three-phase motors, taking trolley current at 10,000 volts, reached a speed of 130 miles per hour.

The Prussian Government have shown by experiment that only 64 per cent. of their steam locomotives are in operation at one time and that 64 electric locomotives will do the work of 100 steam locomotives. They have decided to electrify their entire system at an estimated cost of $50,000,000. They have adopted the single-phase system in and around Hamburg.

The Swedish Government have decided to electrify their Government railways, selecting the single-phase system, the equipment being furnished by the British Westinghouse Company and the A. E. G. Company. The power is transmitted



Pennsylvania double articulator locomotive for New York tunnel service—View of under frame, motors and driving mechanism.

from a water fall at 10,000 volts, single-phase, and 6,000 volts used on the trolley.

The Swiss Government engineers are also favorable to the single-phase system.

The Bavarian Government have been conducting careful investigations and have let contracts for the equipment of a portion of their railways by the single-phase system.

In Norway, the British Westinghouse Company have installed a single-phase railway under very stringent conditions. Power and light will be supplied to the towns along the road. The transmission is at 15,000 volts, three-phase, 50 cycles, through motor generators to 6,000 volts, single-phase, 25 cycles. Both locomotives and cars are used. The locomotives weigh 20 tons and have four 40 horse-power motors. The motor cars have two motors, 40 horse-power each, identical with those of the locomotive.

In England there are eighteen electric railways, covering 200 miles of route and 400 miles of track, using 90 locomotives and 825 motor cars. Of this number, thirteen are in or near London, three in Liverpool, one in Newcastle, and one in Lancaster.

In Germany the Boden Railway have let contracts to the Siemens-Schukert Company, of Berlin, for the electrification of their line. Power is taken from their power station on the Rhine at three-phase, 6,800 volts, 15 cycles, to substations at Basel, where, through rotary converters, it is changed to single-phase, 15 cycles, 10,000 volts.

The German Government have taken considerable interest in connection with the electrification of steam railways. The Government of Bavaria, one of the largest states of the German Empire, bordered on two sides by mountains where much water power is available, is also investigating the problem. The Minister of Transportation has submitted to the Government a detailed report recommending the electrification of State Railways. He favors the single-phase alternating-current system, transmitting at 50,000 volts and using 10,000 volts on the trolley.

In Switzerland water power is cheap and coal is expensive. In 1894 the Government called a commission of experts to report on the electrification of all Government lines. There is a tendency for their Government to acquire all water powers. The prospects seem to indicate the electrification of all Swiss Railways in the near future.

The accompanying tables give tabulated lists of the important electric railways in Europe and America using the three systems:—

Table I.—Continuous Current Electrification.

Name of Line.	Length in miles.	Length of single track.	Line voltage.	No. of motor cars and H.P. of each.	No. of locomotives and H.P. of each.
New York Cent. R. R. ..	33	132	650	137-400	47-2200
Pennsylvania R. R.	20	75	650	180-400	24-4000
West Shore R. R.	44	106	650	20-360	......
Long Island R. R.	42	125	650	137-400	2-1200
West Jersey and Seashore R. R.	75	150	650	68-400	......
B. & O. R. R.	3.7	7.4	600	......	2.5-1600
					5-1100
Northeastern Railway ..	37	...	600	300	2-600
Mersey Tunnel	4.8	...	600	24-400	......
Lancashire and Yorkshire Ry.	18	60	600	600	......
Great Western Ry. .. .	5	...	600	600	......
Metropolitan Ry.	..	67	600	56-600	10-800

Table II.—Car Equipment of Subway and Elevated Systems in American Cities.

The direct-current third-rail 600 volt system is used in all cases.

Name of Line.	Miles of Single Track.	Motor Cars. No.	H.P.
Boston Elevated Ry..	19	219	320
Brooklyn Rapid Transit	71	558	300
		101	400
Interborough Rapid Transit (New York).	190	969	250
		764	400
Hudson and Manhattan (New York)	12	140	320
Chicago and Oak Park	19.4	65	320
Metropolitan West Side (Chicago)	51.1	15	400
		210	320
Northwestern Elevated (Chicago)	25.5	20	250
		128	320
Southside Elevated (Chicago)	36.5	150	180
		70	150
		150	110
Philadelphia Rapid Transit	11	100	250

Table III.—Single Phase Electrification in America.

Name of Line.	Length in Miles.	Frequency.	Line voltage.	No. of motor cars, and H.P. of each.	No. of Locomotives, and H.P. of each.	Date of opening.
Westinghouse:—						
Indianapolis & Cincinnati Trac. Co.	116	25	3300	......	......	Dec. '04
		D.C.	550			
Westmoreland Trac. Co.	6.6	25	1200	......	......	Mar. '05
San Francisco Vallejo, Benecia & Napa Valley Railway Co.	34	25	3300	......	......	June '05
Atlanta Northern Trac. Co.	18.2	25	2200	.. ...	......	July '05
Warren & Jamestown Street Ry. Co.	22.5	25	3300	......	......	Aug. '05
Long Island Ry. Co.	5	25	2200	......	......	Sept. '05
Spokane & Inland Ry. Co.	129	25	6600	28-400	6-500	Nov. '06
		D.C.	550		5-720	
Erie Railroad Co.	34	25	11000	6-400	......	Dec. '06
Fort Wayne & Springfield St. Ry. Co.	21.5	25	6600	.. ...	......	Jan. '07
Pittsburg & Butler St. Ry. Co.	33	25	6600	......	......	Mar. '07
		D.C.	550			
N. Y., N. H. & H. R. R.	29	25	11000	6-600	43-1400	July '07
Windsor, Essex & Lake Shore Rapid Ry.	28	25	6600	..... .	......	Sept. '07
Grand Trunk Railway, Sarnia Tunnel	3.5	25	3300	......	6-900	
Visalia Elec. Ry. Co.	23	15	3300	......	......	Under
Chicago, Lake Shore & South Bend Ry. Co.	78	25	6600	......	......	
		D.C.	575			Con-
Denver & Interurban Ry. Co.	46	25	11000	8-500	......	
		D.C.	575			struc-
Hanover & York St. Ry.	20	25	6600	......	......	
			575			tion.
Shore Line Elec. Ry.	12	25	6600	.... .	......	
Maryland Elec. Ry.	24	25	6600	......	......	
General Electric:—						
Bloomington, Pontiac & Joliet Ry. Co.	19	25	3300	......	......	In
Toledo & Chicago Ry.	43	25	3300	......	......	
		D.C.	575			Opera-
Milwaukee Elec. Ry.	59	25	3300	......	......	
		D.C.	575			tion.
Central Illinois Const. Company	80	25	3300	......	.. ...	In
		D.C.	575			Operation.
Washington, Baltimore & Annapolis Ry.	60	25	6600	12-400	......	Under
		D.C.	575			Construc-
Snawinigan Ry. Co.	60	30-15	6600	......	......	
		D.C.	600			tion.
Richmond & Chesapeake Bay Ry. Co.	15	25	6600	......	......	Under
Anderson Traction Co.	20	25	3300	.... .	......	Construc-
		D.C.	575			tion.

Table IV.—Single Phase Electrification in Europe.

Name of Line.	Length in Miles.	Frequency.	Line voltage.	No. of motor cars, and H.P. of each.	No. of Locomotives, and H.P. of each.	Date of opening.
Bergame-Valle Brembana	19.0	25	6000	......	5-300	Dec. '07
Blankenese-Ohlsdorf	41.5	25	6600	6-250	......	Jan. '07
		25	6000	51-345		
Borniage	13.0	40	600	20-80	......	Apr. '05
Compagnie Generale Parisienne de Tramways	1.0	..	500	2-50	......	Exper'l.
Murnau-Ober-Ammergau	15.0	16	5000	4-160	......	Jan. '05
Spindlersfeld	26.0	25	6000	2-200	......	Aug. '03
Prussian State Ry.	1.5	25	6600	......	......	Exper'l.
Rome-Civita Castellana	34.0	25	6000	15-80	......	Mar. '07
Stubaital	11.75	42	2500	4-160	......	Aug. '04
Swedish State Railways	12.0	25	20000	......	1-330	July '05
Vienna-Baden	17.0	15	10000 A.C.	13-100	......	Jan. '07
			500 D.C.			

Locarno-Bignasco	17.0	20	5500	4-160	......	Sept. '07
Seebach-Wettingen	12.0	15	15000	......	2-400 1-225	Dec. '07
Midland Railway	16.6	25	6600	3-350	......	Apr. '08
Brighton Line	17.2	25	6000	......	......	
Parma Provincial	26.5	25	4000	17-120 1-60	......	Not yet
Rotterdam-Hague	45.0	25	10000	27-350	......	opened
St. Polton-Mariazell	66.5	25	6000	......	23-350	for
Tergnier-Anizy	20.0	25	3300	......	......	traffic.
Exper'l. Locomotive Wiesental Ry.	....	15	10000	.....	......	In Prep'n.
Basel-Schopfheim	34.0	15	10000	......	.. ...	"
Spiez-Frutigen	12.3	15	15000	......	......	"
Vacz-Budapest-Godollo	35.9	15	10000	......	.....	"
Padua-Fusina Railway, Italy	21.7	25	6000	......	......	"
Lotschbergbahn, Switzerland	....	15	15000	......	......	"
Menzelschacht, Germany	3.1	40	220	......	......	"
Midi Railway, France	75	..	12000	30-500	2-1600	"

Table V.—Three-Phase Electrification.

Name of Line.	Length in miles.	Frequency.	Line voltage.	No. of motor cars and H.P. of each.	No. of locomotives and H.P. of each.
Great Northern R. R.:—					
Cascade Tunnel	4	......	6600	......	4-1900
Italian State Railways:—					
Valtellina Railway	66	......	3000	10-400	2-800 7-1500
Giovi Ry.	12.4	......	3000	......	20-2000
Mt. Cenis Tunnel	4.4	......	3000	......	10-2000
Savona Ceva	....	.....	3000	......	10-2000
Swiss Federal Railways:—					
Simplon Tunnel	13.7	.....	3000	......	2-1100 2-1300
Gergal Santa Fé (Spain)	13.1	.. ...	5500	......	5-320

PROMOTION OF INTERURBAN AND BRANCH RAILWAYS.

J. Stanley Richmond.

General.

Travel, trade and prosperity follow the lines of least resistance; which statement constitutes the inexorable and fundamental law not only of progress but also of all finance. Thus it is that if in any naturally valuable section we find stagnation, lack of development or retrogression as the effect of circumstances and make a careful investigation we will invariably find that the value of the local transportation facilities are away below par. For instance, if one man possessed the whole wealth of the world and he were located on an island in mid-ocean, at which no vessel ever called, of what value would the wealth be to him? The only possible answer to this question is that the billions of collateral which he owned would be valueless and, provided that food were not obtainable on the island, he would die of starvation due to his inability to purchase even a crust of bread at the price of all his possessions. This, of course, is an extreme illustration; but the principle involved always applies in a varying lesser degree. It can be understood, therefore, that the value of rich mines, extensive timber limits, square miles of excellent agricultural lands and magnificent natural surrounding is directly proportional to the facility for ingress and egress with which we are supplied in so far as these natural resources are concerned.

Civilization is the giving up of wildness and the adoption of cultivation, necessitating the surrender of a greater or lesser amount of personal freedom and the acceptance of community control. This is how we have, through many stages, commencing with the method of a headman or leader of a crowd of savages, gradually arrived at our modern system of community direction by means of elected governments. Now governments are composite in character, and not only must, but also do, vary in the methods they adopt when directing public affairs. Wise, however, is that government which fully appreciates the significance of broadminded instead of restrictive legislation in respect to the promotion, development and operation of railway enterprises. That in Canada we have been represented by governments considerate of the welfare of the country in so far as 'trunk railways are concerned is allowed. But that our provincial governments have always been broadminded in the treatment of small railway enterprises is questionable, and this although the promotion of a small railway enterprise is a much more difficult undertaking to finance than is, proportionately, that of a trunk railway.

Every council, whether elected to conduct the public affairs of a county, or a township, or a city, or a town, or a village, is fundamentally a government and, although the powers and resulting responsibilities of any one of these councils are not as great as those of a Provincial or the Dominion Government, the remarks which have been made in regard to the treatment accorded by provincial governments to railway enterprises apply equally to these council governments. Apropos of which, it must be remembered, in respect to any particular small railway enterprise that, if any one or more of the governing bodies (whether provincial, county, township or municipal) takes the position that all the assistance given to the enterprise ought to be provided by the remaining government bodies, the almost invariable result is that the remaining government bodies refuse to help the enterprise. To bring about the construction and operation of a small railway, therefore, requires the united efforts and assistance of all the public bodies controlling the communities of the localities through which it is intended to operate the railway; and it is this united action on the part of our western public bodies as contracted with the disunited action on the part of our eastern public bodies which makes it so much easier in the West than it is in the East to successfully promote a small railway enterprise.

It would be foolish, of course, to assume that the majority of the public is opposed to the building of railways. But they are, as a rule, strongly adverse, especially in the eastern half of Canada, toward the principle of providing bonuses and the guaranteeing of bonds. In plain English, the public generally want something for nothing, which is the reason why "get-rich-quick" and "wild-cat mining" companies, to say nothing of gambling houses and lottery promoters, find such a profitable market amongst the average run of mankind. But the desire of the public to obtain a railway does not justify the expectation that it will be provided free of any payment by the public of a portion of its cost. For with level-headed business men the "Sine qua non" when considering the advisability or otherwise of undertaking any enterprise is a just "Quid pro quo," which means that capitalists are not warranted to undertake the expenditure necessary to build, equip and operate a railway to provide transportation facilities wanted by the public unless there is a reasonable certainty that the revenue which will be obtainable will prove sufficient not only to meet all operating and fixed charges but also permit the payment of reasonable dividends on all outstanding stock, whether preferred or common.

Other factors which make it difficult to educate the public up to the point of understanding how necessary it is for them to encourage small railway enterprises by providing financial assistance are that nearly every individual of the section interested believes.

First:—That an interurban or branch railway can be built for a much less sum per mile than that actually required.

Second:—That a railway can be operated for a "mere song."

Third:—That the revenue obtainable from a small railway enterprise, like that obtainable by a trunk steam or city railway, is enormous.

That this misunderstanding exists cannot be denied, and the writer feels convinced that it is mainly due to the fact that for several years the "Press" has profusely written on corporate matters based on information which has, practically speaking, been limited to a collection of details more or less incorrect of but a few phases of the operation of only large corporations controlling city and trunk railway systems. As an illustration, the writer remembers one time when the head of the largest store in one Ontario provincial municipality remarked, in regard to a railway charter the writer was interested in, that a railway line could be built between two points located about thirty-two miles apart for $30,000, which is at the rate of less than $1,000 a mile. Now, no harm would result if a ridiculous remark like the one mentioned simply ended with the making of it. But, unfortunately, business men of the type referred to always control a considerable number of the votes which have to be polled when a bonus or bond guarantee by-law is submitted to the electorate, while the success or failure of the by-law to pass is determined, as a rule, not by the total number of votes polled, but by how a few of them are cast. Inhabitants of small municipalities, provincial governments and councils ought not, therefore, to apply to small railway undertakings those newspaper verdicts which are rendered in respect to city street railways and trunk steam railway systems.

Government Regulations.

To provide a complete criticism of the Railway Act of any government would require more space than that available in any ordinary publication. To be brief, however, it may be said that it appears as if the average Railway Act has been the outcome of the consideration of the factors governing the construction and operation of large railway systems only. It must also be remembered that, when the grant of a railway charter is being considered, several matters, such as bonuses and land grants, which are not taken care of in a Railway Act, have to be discussed. The result, at least in the case of charters for small railway systems, is that conditions which can hardly be termed just are often imposed upon the promoters of these small enterprises. A good illustration of this finding relates to the maximum rate chargeable per mile for passenger transportation as provided for in the Railway Act of the Province of Ontario.

Now, the old method of track-work adopted when constructing an interurban railway was to lay the track on the streets and highways. Modern practice, however, calls for a private right-of-way for the railway except where it passes through cities, towns and villages, and the use of rails as heavy as those used for a well-built branch steam railway. The cost for the railway is, therefore, the same whether it is fundamentally an electric interurban or steam line. It must not be forgotten, also, that a steam railway requires no overhead equipment and no track-bonding, while an electric railway requires both of these items. It may safely be assumed, therefore, provided that only a very moderate service is required, that a steam railway will prove to be a more economical undertaking than would an electric railway. For the steam railway using one locomotive and one car will require one locomotive driver, one fireman, one conductor and one brakeman, or a total of four men; while an electric railway will require the same number of men, that is, one motorman, one conductor and two power-house attendants, when using one car and one power-house. But one second-hand locomotive and car, in quite a good enough condition for the service intended, will cost considerably less than one electric car and one power-house; and, unless a producer-gas prime mover is used, it may be taken for granted that the cost for coal in the power-house will be equal to that incurred with the locomotive. Thus, while the rate regulation of the Act referred to, which provides for an allowable maximum rate for passengers of two cents per mile on electric railways and three cents on steam railways, appears to be a reasonable one when applied to steam and city street railways, it does appear to be equivalent to the placing of a tax of thirty-three and one-third per cent. on the passenger receipts of an electric railway located in a district where it is more expensive to provide electric railway facilities than it is to provide steam railway facilities. Summed up, therefore, the regulation referred to does, in some cases at least, appear to be nothing more or less than the placing of a premium on old-fashioned methods. It does seem reasonable, therefore, to expect that the Government ought, in certain cases, to waive this clause in their Railway Act.

Another regulation of the Government of Ontario which, though not "Lex scripta," appears to be "Lex non scripta" is the apparent determination not to make any land grant to assist railway enterprises, or, anyway, small railway enterprises. As an illustration, the Ontario Interurban Railway Company received a charter from the Government of Ontario for a proposed railway in Prince Edward County, with an entrance into Hastings County. Now a considerable portion of the western shore land of Prince Edward County was, at the request of one man, reserved before Confederation, the effect being that the progress of a large portion of the county has been greatly retarded. A small portion of the shore land so reserved lies south-east from and adjoins the village of Wellington, is about five miles in length, cannot be cultivated, consists of high hills of drifting sand or gravelly beach flooded at high water, and is unsuitable for building purposes without undertaking a considerable amount of grading and the building of a lake-wall. Further, there is only width enough of land along quite a portion of it for a railway right-of-way. The charter included the right to build a railway over this shore land and financial circumstances necessitated that this section ought to be the first built. As the promoters of the proposed railway found as a result of a thorough and expensive investigation that they were not warranted to construct this section of the railway unless the shore lands to be traversed by it were simultaneously developed for building purposes, an application was made to the Government for a grant for this portion of the reserved land; and, as the inhabitants of the surrounding districts were exceedingly anxious that the railway should be built and the shore land developed, four public petitions were drawn up and forwarded to the Government with the company's application and a large scale plan of the land showing its topographical features. One of the petitions was signed by every member of the county council; another one, by every member of the township council; another one, by nearly every voter in the village of Wellington; and another one, by nearly every voter in the district joining the south end of the land asked for. The M.P.P. for the county also wrote privately to several of the leading men of the district and, in reply, was informed that it was to the interest of the public that the asked for grant should be made. The grant was refused, and the only logical explanation which the writer can offer for the refusal is that the Crown Lands Department wanted to handicap the company by making them pay for the land or that the Department failed to make the necessary steps to obtain that amount of unbiased information which could easily have been obtained and which would have proved to them that the ends of justice would have been best satisfied by making the asked for grant. And herein lies the crux of the whole question. For if it costs, as it did in the case mentioned, $3,000, to prepare for and make an application of this sort without convincing the Government of the reasonableness of the request, how much would it cost to convince the Government that it would be just to make a grant such as the one asked for? Now, as any average man can understand, $3,000 is quite a large sum for a struggling enterprise of the class mentioned to spend without any certainty of success, to say nothing of it being first-class evidence of good faith on the part of the promoters; anyway, it is a larger sum than any resident of Prince Edward County who is familiar with the land in question would pay for it if offered for sale. In so far as the request referred to is concerned, the writer may say that he offered to pay the expenses which would be incurred by the Government in order to make an impartial enquiry into the matter in Prince Edward County; and it does appear as if the Ontario Railway and Municipal Board or some other Department of the Government ought to have been asked to make this enquiry and submit a report on the matter. If this policy had been followed, the writer feels certain that the grant would have been made.

Another apparent "Lex non scripta" regulation of the Government of the Province of Ontario seems to be the determination not to grant more than one year's "extension of time" in any one "Bill." This, again, is a just regulation in respect to charters granted for proposed railways which would be extensions or branches of existing railway systems. But it is not a just one in so far as the promotion of a small and struggling independent railway enterprise is concerned. For a "Bill" respecting a railway generally receives its third reading about the end of March, while railway construction usually finishes about the end of October, which allows only about eight months during which to obtain the money for and make the necessary surveys, plans and estimates for the Railway and Municipal Board and the contemplated financial brokers. Further, small municipalities will not, as a rule, submit by-laws for bonuses and bond guarantees until the following winter. As a result, financial brokers will not attempt to float the bonds and sell the stock because, as construction cannot be commenced before the middle of the coming April, they say that the charter will elapse before the company can complete a sufficient amount of the railway to keep the charter in force. For brokers will take no chance as to the Government granting another extension of time during the coming March.

In the case of the Ontario Interurban Railway Company, an application was made for two years' "extension of time," and the first and second readings of the "Bill" were passed granting only one year. The matter was at once taken up by the local public bodies of Prince Edward County and communications were forwarded from them to the Railway Committee, stating that, for the reasons before given, one year would be useless and that two years were necessary. The Minister of Crown Lands, who was Chairman at the time of the Railway Committee, absolutely refused, however, to make it two years, saying that if the company required more time they must apply for a further extension at the next session of the Legislature. So the company put out its best endeavors but, as expected, were unable to complete more than the surveys, plans, estimates and some other matters before the middle of December. Then, later, the request for the grant of land was refused, two or three weeks after which refusal the charter expired before weather conditions permitted even the commencement of work; which work, any way, could not have been commenced even had the weather permitted, because no broker would undertake to finance a charter which, so they said, expired in so short a time. As there was no local opposition to the granting of two years' "extension of time," the writer feels justified in remarking that the Government of the Province of Ontario were surely not in so bad a financial state that they felt compelled to force a small, struggling and much-needed enterprise to pay two payments for what could as easily have been granted for one payment; anyway, two payments and two "extensions of time" would not have much facilitated the arrangements desired with brokers.

Summed up, why do provincial governments apparently endeavor to block the promotion of small railway enterprises instead of doing all that is reasonable to assist their promotion? Surely provincial governments recognize that the more mileage of railways in a province the better off is the province.

STATISTICS OF RAILWAYS IN THE UNITED STATES FOR YEAR ENDING JUNE 30, 1909.

The statements in this preliminary abstract are based upon complications for the Twenty-second Annual Statistical Report of the Interstate Commerce Commission covering the fiscal year ending June 30, 1909, and revised returns may slightly affect some of these advance figures before final publication. The arrangement of the complete report will be similar to that of the 1908 report, which differed considerably from prior reports.

Except where specifically mentioned, the following statements do not include data from reports of companies classed as switching and terminal.

Mileage.

The summaries show that on June 30, 1909, there was a total single-track railway mileage in the United States of 236,868.53 miles, indicating an increase of 3,215.18 miles over the corresponding mileage at the close of the previous year. An increase in mileage exceeding 100 miles appears for the States of Arkansas, California, Idaho, Minnesota, Mississippi, Montana, Nevada, Oregon, Texas, Virginia, and Washington.

Substantially complete returns were rendered to the Commission for 235,402.09 miles of line operated, including 9,396.35 miles used under trackage rights. The aggregate mileage of railway tracks of all kinds covered by operating returns was 342,351.24 miles. This mileage was thus classified: Single track, 235,402.09 miles; second track, 20,949.41; third track, 2,169.55; fourth track, 1,453.56; yard track and sidings, 82,376.63. These figures indicate an increase of 8,705.38 miles over corresponding returns for 1908 in the aggregate length of all tracks, of which increase 2,923.99 miles, or 33.59 per cent. represent yard track and sidings.

The number of railways for which mileage will be included in the report is 2,196. During the year railway companies owning 2,706.56 miles of line were reorganized, merged, or consolidated.

In addition, the returns of companies classed as switching and terminal covered a total mileage owned on June 30, 1909, of 4,007.36 miles, of which 1,622.85 miles were assigned as main track and 2,384.51 as yard track and sidings.

Equipment.

It appears that there were 57,212 locomotives in the service of the carriers on June 30, 1909, indicating an increase of 479 over corresponding returns for the previous year. Of the total number of locomotives, 13,317 were classified as passenger, 33,935 as freight, and 8,837 as switching, and 1,123 were unclassified.

The total number of cars of all classes was 2,218,280, or 12,901 less than on June 30, 1908. This equipment was thus assigned: Passenger service, 45,584 cars; freight service, 2,073,606; and company's service, 99,090. The figures given do not include so-called private cars of commercial firms or corporations.

It appears that the average number of locomotives per 1,000 miles of line was 243, and the average number of cars per 1,000 miles of line was 9,423. The number of passenger-miles per passenger locomotive was 2,185,877, and the number of ton-miles per freight locomotive was 6,447,708.

The returns indicate that the number of locomotives and cars in the service of the carriers aggregated 2,275,492, of which 2,214,907 were fitted with train brakes, an increase of 10,460 over the previous year, and 2,260,777 were fitted with automatic couplers, a decrease of 10,178. Nearly all the locomotives and cars in passenger service were equipped with both train brakes and automatic couplers. Substantially all the freight locomotives had train brakes and automatic couplers. Of the 2,073,606 cars in freight service on June 30, 1909, the number fitted with train brakes was 2,039,219, and the number fitted with automatic couplers was 2,061,473.

Employees.

The total number of persons reported as on the pay rolls of the steam roads of the United States on June 30, 1909, was 1,502,823, or an average of 638 per 100 miles of line. As compared with returns for June 30, 1908, there was an increase of 66,548 in the total number of railway employees. There were 57,077 enginemen, 60,349 firemen, 43,608 conductors, 114,760 other trainmen, and 44,698 switch tenders, crossing tenders, and watchmen.

The total number of railway employees (omitting 42,342 not distributed) was apportioned among the six general divisions of employment as follows: To maintenance of way and structures, 459,069; to maintenance of equipment 299,381; to traffic expenses, 20,178; to transportation expenses, 604,867; to general expenses, 52,457; and to outside operations, 24,529.

The complete report will include summaries showing the average daily compensation of eighteen classes of employees for a series of years, and also the aggregate amount of compensation reported for each of the several classes. The total amount of wages and salaries reported as paid to railway employees during the year ending June 30, 1909, was $988,323,694.

The total number of persons reported by switching and terminal companies as on their pay rolls on June 30, 1909, was 25,985. The total amount of wages and salaries reported by this class of companies for 1909 was $17,026,264.

Capitalization of Railway Property.

On June 30, 1909, the par value of the amount of railway capital outstanding, according to the returns of the companies filing reports with the Commission, was $17,487,868,935. Of this amount, $13,711,867,733 was outstanding in the hands of the public, representing a capitalization of $59,259 per mile of line.

Of the total capital outstanding, there existed as stock $7,686,278,545, of which $6,218,382,485 was common and $1,467,896,060 was preferred; the remaining part $9,801,590,390, represented funded debt, consisting of mortgage bonds, $6,942,012,066; collateral trust bonds, $1,147,377,191; plain bonds, debentures, and notes, $803,537,301; income bonds, $284,497,531; miscellaneous obligations $316,297,240; and equipment trust obligations, $307,869,061.

Of the total capital stock outstanding, $2,766,104,427, or 35.99 per cent, paid no dividends. The amount of dividends declared during the year (by both operating and lessor companies) was $321,071,626, being equivalent to 6.53 per cent. on dividend-paying stock. No interest was paid on $718,351,332, or 7.57 per cent. of the total amount of funded debt outstanding, omitting equipment trust obligations.

Public Service of Railways.

The number of passengers carried during the year ending June 30, 1909, was 891,472,425. The corresponding number for the year ending June 30, 1908, was 890,009,574. The increase in the number of passengers carried during the year over 1908 was 1,462,851.

The number of passengers carried one mile, or the passenger-mileage, as compiled for 1909 was 29,109,322,589. The corresponding return for 1908 was 26,485,645 less. The number of passengers carried one mile per mile of road was 127,299.

The number of tons of freight shown as carried (including freight received from connections) for the year ending June 30, 1909, was 1,556,559,741, while the corresponding figure for the previous year was 1,532,981,790, the increase being 23,577,951 tons

The ton-mileage, or the number of tons carried one mile, as shown for the year ending June 30, 1909, was 218,802,986,929 ton-miles. The total ton-mileage as reported for the year ending June 30, 1908, was 218,381,554,802, from which it will be seen that the increase in the ton-mileage for the year ending June 30, 1909, over the return for 1908 was 421,432,127. The decrease in the number of tons carried one mile in 1908 under 1907 was 18,153,419,370. The number of tons carried one mile per mile of road for the year 1909 was 953,986.

The average receipts per passenger per mile, as computed for the year ending June 30, 1909, were 1.928 cents; the average receipts per ton per mile, 0.763 cent. The passenger service train revenue per train-mile was $1.26.958; the freight revenue per train-mile was $2.76.450. The average operating revenues per train-mile were $2.16.789. The average operating expenses per train-mile were $1.43.370. The ratio of operating expenses to operating revenues was 66.16 per cent.

Revenues and Expenses.

It should be noted that the following figures under the heading of revenues and expenses exclude returns for a few small roads because of deficiencies in their reports. For the year ending June 30, 1909, the operating revenues of the railways in the United States (average mileage operated, 232,981.11 miles) were $2,418,677,538; their operating expenses were $1,599,443,410. The corresponding returns for 1908 (average mileage operated, 227,257.02 miles) were: Operating revenues, $2,393,805,989; and operating expenses, $1,669,547,876. The following figures present a statement of the operating revenues for 1909 in detail:

Freight revenue	$1,677,614,678
Passenger revenue	563,609,342
Mail revenue	49,380,783
Express revenue	59,647,022
Excess baggage revenue and milk revenue (on passenger trains)	13,694,171
Parlor and chair car revenue and other passenger-train revenue	3,989,612
Switching revenue	21,599,256
Special service train revenue and miscellaneous transportation revenue	7,833,852
Total revenue from operations other than transportation	19,756,577
Joint facilities revenue—Dr.	500,301
Joint facilities revenue—Cr.	2,052,546
Total operating revenues	$2,418,677,538

The operating revenues averaged $10,381 per mile of line.

Operating expenses, as assigned to the five general classes, were:

Maintenance of way and structures	$ 308,450,105
Maintenance of equipment	363,912,886
Traffic expenses	49,287,148
Transportation expenses	814,088,149
General expenses	63,677,378
Total operating expenses (including $27,744 undistributed)	$1,599,443,410

The operating expenses averaged $6,865 per mile of line.

The total number of casualties to persons on the railways for the year ending June 30, 1909, was 104,348, of which 8,722 represented the number of persons killed and 95,626 the number injured.

The number of passengers killed in the course of the year 1909 was 253 and the number injured 10,311. During the previous year 381 passengers were killed and 11,556 injured. There were 86 passengers killed and 4,805 injured because of collisions and derailments. The total number of persons other than employees and passengers killed was 5,859, injured 10,309. These figures include the casualties to persons trespassing, of whom 4,944 were killed and 5,759 were injured.

In 1909, 1 passenger was killed for every 3,523,606 carried, and 1 injured for every 86,458 carried. For 1908 the figures show that 2,335,983 passengers were carried for 1 killed, and 77,017 passengers were carried for 1 injured. With respect to the number of miles traveled the figures for 1909 show that 115,056,611 passenger-miles were accomplished for each passenger killed, and 2,823,133 passenger-miles for each passenger injured. For 1908 the figures were 76,332,905 passenger-miles for each passenger killed, and 2,516,687 passenger-miles for each passenger injured.

RAILWAY TAXATION IN THE UNITED STATES.

Average of $382 Per Mile.

According to statistics published by the Interstate Commerce Commission the railways operating in the United States paid $84,563,565 in taxation in 1908. This was an average of $382 per mile.

In 1901, seven years before, the total was $49,726,000, or $261.36 per mile; in 1905, three years before, total was $63,324,000, or an average of $303 per mile. There has been an increase of $79 per mile in three years, and of $121 per mile in seven years.

The highest rate per mile in railway taxation in the United States in 1908, the latest year for which figures are available, was paid in New Jersey, where a total of $4,198,431 or $1,926 per mile, was collected. Connecticut came next in the rate per mile with $1,593, Massachusetts third, with $1,394 and Rhode Island fourth with $1,204.

The lowest rate per mile was in Arizona—$148.

Pennsylvania, because of the greater mileage, although charging a much lower rate per mile than some of the other states, came first in the total amount of taxation collected—$5,896,956. There were four states all told in which upwards of $5,000,000 was received in railway taxation, these being Pennsylvania, already named, New York with $5,552,431, Illinois with $5,205,961, and Ohio with $5,102,702.

No less than thirty states collected over a million dollars each in railway taxation.

In Texas, the rate of taxation is $243 per mile. Texas forms part of a group of states in which the average revenue per mile of railway is only $5,972. That is more than a thousand per mile less than the average earnings of the whole Grand Trunk system in Canada; it is less than two thirds the earnings of the whole Canadian Pacific system, and both the Grand Trunk and Canadian Pacific earn more per mile in Ontario than they do any other part of their lines. The earnings of the Canada Southern in lower Ontario are about $20,000 per mile—more than three times the earnings per mile in Texas, where taxation per mile is $243 against $100 here.

The following is a detailed statement of the total sum collected in railway taxation in each state and the average rate per mile:

State	Amount	Per mile of line
Pennsylvania	$5,896,956	$ 554
New York	5,552,431	672
Illinois	5,205,961	441
Ohio	5,102,702	576
New Jersey	4,198,431	1,926
Indiana	3,585,182	490
Michigan	3,422,858	396
California	3,195,314	494
Minnesota	3,144,571	388
Texas	3,098,759	243
Kansas	3,060,247	343
Wisconsin	2,965,945	409
Massachusetts	2,913,032	1,394
Iowa	2,254,019	230
Washington	1,933,175	549
Nebraska	1,858,096	309
Connecticut	1,609,895	1,593
Virginia	1,569,136	385
Missouri	1,471,194	187
Colorado	1,440,719	289
West Virginia	1,391,699	471
Alabama	1,369,057	295
Georgia	1,281,106	196
Kentucky	1,104,258	333
Louisiana	1,091,021	245
North Dakota	1,074,277	265
Arkansas	1,055,652	241
Oklahoma	1,046,490	187
Tennessee	1,038,629	298
Montana	1,001,225	298
Maryland	910,245	675
North Carolina	870,207	211
Mississippi	825,268	214
South Carolina	711,405	224
Florida	708,563	187
Utah	686,266	381
Maine	654,090	314
Idaho	579,193	312
Oregon	527,342	297
South Dakota	525,505	153
Nevada	502,088	283
New Hampshire	467,327	379
New Mexico	445,753	154
Wyoming	336,089	216
Arizona	279,332	148
Rhode Island	248,382	1,204
Vermont	210,260	205
Delaware	114,538	340
Dist. of Columbia	29,675	944

RAILROAD DEVELOPMENT COMPARISONS.

The capacity of a country to market its products cheaply makes the railroad an important economic factor. M. Thery, a French writer, has just published some striking statistics dealing with railway development in Europe during the past fifty years. His figures alone are interesting, and more so when we compare them to development in our own country. The total railway equipment of all European countries is calculated by M. Thery as having been for 1858, 51,483 kilometers; for 1883, 185,442 kilometers, and for 1908, 318,312 kilometers. Put into English miles in round figures, these amounts represent for 1858, 32,000 miles; for 1883, 115,000 miles, and for 1908, 198,000 miles.

The country first in the matter of actual trackage increase is Russia. In ratio of mileage, either to population or to area, Russia is surpassed by Germany, France, Austria-Hungary, England, and many of the smaller countries. The following table shows the increase in trackage, in English miles, for each of the last two quarter centuries for the leading countries. We have taken M. Thery's statistics, figured them into English miles and added the Canadian statistics:—

Country	1858.	1883.	1908.	Percentage increase 1858 to 1908.
Russia	988	15,342	36,257	+ 3,559
Germany	7,280	22,864	36,042	+ 396
France	5,444	18,452	30,029	+ 451
Austria-Hungary	2,811	12,737	25,836	+ 819
Great Britain	10,430	18,656	23,089	+ 121
Italy	1,117	5,615	10,306	+ 822
Spain	1,190	6,092	9,221	+ 674
Sweden	329	3,974	8,316	+ 2,427
Canada	1,863	9,577	22,966	+ 1,132

Examining the railroad development in Europe for the quarter century, Russia increased its mileage in that period by 136 per cent., Germany by 57 per cent. Canada stands in front of all European countries with an increase of 139 per cent. The following table shows the railway mileage of Canada compared with that of the other countries cited by the French statistician:—

Country	Inhabitants per mile of line.
Russia	2,941
Germany	1,587
France	1,333
Austria-Hungary	1,854
Great Britain	1,912
Italy	3,119
Spain	1,960
Sweden	621
Canada	300

Canada, therefore, has the largest railway mileage in proportion to population, while in relation to area it has the smallest. This record not only applies when compared with the mileage of the above countries, but still holds good compared with that of any country in the world.

The history of the construction and operation of the European lines shows a steady tendency, outside of Great Britain, towards government ownership. Bismarck took energetic steps to unify the German lines through a central administration, and had the best of them purchased by the different German states. Almost all the lines of Austria-Hungary belong to the State, and in Italy, after the large purchase of private lines about 1905, 7,910 miles belonged to the State in 1908 out of a total trackage of 10,306 miles.

CANADIAN PACIFIC'S FIRST TWENTY MILLIONS OF STOCK.

Twentieth century critics of our present-day corporations, which have grown with and helped to make the country, often forget the risk assumed by the original promoters. Our pioneer railroad companies, trading and other concerns were by no means sure of success when they commenced business half centuries and centuries ago. It was but a short time back when men dubbed Manitoba, Saskatchewan and Alberta a howling wilderness, provinces which to-day are producing millions of bushels of wheat and supporting thriving communities. The following list shows the allotment of the earliest issue of stock of the Canadian Pacific Railroad. It was allotted to the promoters and their friends and taken up by them at twenty-five cents on the dollar. It indicates how much each got, what was paid for it, and shows also that in five years the entire investment and much more had been returned to the investor in dividends, while the $20,000,000 worth of stock was still held at its face value. The list is interesting, showing as it does who were the men who had faith in our country and a big railroad enterprise, and acting as it also does as an excellent reminder that capital well invested in Canada brings ample reward:—

Name.	No. of shares.	Face value.	Amount paid for stock.	Aggregate dividends in 5 years.
Geo. Stephen (Lord Mount Stephen)	223,411	$2,341,100	$558,275	$652,330
D. McIntyre	975	97,500	24,375	29,200
D. McIntyre & Company	18,534	1,853,400	463,350	556,020
J. S. Kennedy & Company	17,558	1,755,800	438,950	526,740
J. J. Hill	19,509	1,950,900	487,725	585,270
R. B. Angus	19,509	1,950,900	487,725	585,270
H. S. Northcote	3,004	300,400	75,100	90,120
D. A. Smith (Lord Strathcona)	19,509	1,950,900	487,725	585,270
Boissevin & Company	1,950	195,000	48,750	58,500
Lake Bros. (Boston)	975	97,500	24,375	29,250
R. Donaldson	1,560	150,000	39,000	46,800
J. S. Kennedy	975	97,500	26,375	29,250
J. K. Todd	1,365	136,500	34,125	40,950
D. W. James	1,950	195,000	48,750	58,500
C. J. Osborn	1,950	195,000	48,750	58,500
C. H. Northcote	390	39,000	9,750	11,700
W. Trotter	780	78,000	19,500	23,400
Morton, Rose & Company	29,364	2,936,400	731,600	880,920
F. Greininger	3,901	390,100	97,525	117,030
L. Cohen & Son	3,901	390,100	97,525	117,030
Sulzbach Bros.	1,268	126,800	31,700	38,040
S. Propper	585	58,500	14,625	17,550
J. De Reinach	1,658	165,800	41,450	50,240
E. Kohn	780	78,000	19,500	23,400
O. De Reinach	877	87,700	21,925	26,310
C. Kolt	97	9,700	2,425	2,910
H. Finlay	390	39,000	9,750	11,700
M. Springer	1,365	136,500	34,125	40,950
Euphrussi & Company	1,950	195,000	48,740	58,500
Banque Parisienne	5,579	557,900	139,475	172,360
C. Morawitz	390	39,000	9,750	11,700
P. du P. Grenfell	975	97,500	24,375	29,250
C. D. Rose	975	97,500	24,375	29,250
E. Cassel	1,755	175,500	48,875	52,650
Lord Elphinstone	1,950	195,000	48,750	58,500
Goet, Sons & Company	390	30,000	9,750	11,700
A. S. Thompson	195	19,500	4,875	5,850
J Billitzer	195	19,500	4,875	5,850
H. Puffel	195	19,500	4,875	5,850
C. Rosenraad	97	9,700	2,425	2,910
G. Levy	97	9,700	2,425	2,910
A. S. Schaw	1,950	195,000	48,750	53,500
Morton, Rose & Company (in trust)	390	39,000	9,750	11,700
W. C. Var Horne	3,905	390,500	97,625	117,000

Taking market value as $200 for every $100 share; that is to say, for an initial cash investment of $5,000,000, all of which was paid back to the investors in five years in the form of dividends, there can now be obtained $40,000,000; while it is to be remembered that during all these years dividends have been paid and are still being paid on $20,000,000 at the rate of 6 and 7 per cent. per annum.

RAILROAD EARNINGS

Show Big Gains Over Previous Year—Construction Work—Mileage Additions.

	C. P. R.	G. T. R.	C. N. R.	T. & N. O.	Montreal Street.	Toronto Street.	Halifax Electric.
Population ...	....	....	....	....	355,000	350,000	45,000
Mileage .. .	10,326	3,536	3,180	264.74	141.79	114	13.3
Capital:							
Paid-up	$150,000,000	$226,000,000	....	(Gov't. Road)	$18,000,000	$8,000,000	$1,400,000
Earnings:							
January, 1908 ..	$4,458,000	$2,768,408	$ 578,200	$ 54,370	$280,437	$269,325	$12,920
" 1909 ..	4,761,860	2,641,031	526,200	85,010	291,698	287,981	13,785
Difference ...	303,860	127,377	*52,000	30,640	11,261	18,655	865
February, 1908..	4,561,160	2,399,435	485,600	41,396	265,179	260,834	12,272
" 1909..	4,966,208	2,529,471	506,600	101,813	280,989	274,844	12,536
Difference	405,048	130,036	21,000	60,417	15,810	14,010	*263
March, 1908	5,424,951	3,030,301	625,300	65,810	282,776	272,407	12,718
" 1909	6,518,763	3,181,462	738,700	142,006	295,979	297,742	13,558
Difference	1,093,832	151,161	113,400	76,196	13,203	25,334	839
April, 1908	5,390,000	2,976,664	686,100	64,562	277,001	272,929	13,303
" 1909	6,384,038	3,142,748	741,200	161,869	290,050	297,858	14,495
Difference	994,038	166,084	55,100	97,307	13,048	24,929	1,192
May, 1908	6,333,000	3,096,224	654,900	79,213	306,768	295,809	13,147
" 1909	5,338,000	3,239,791	730,100	130,536	322,410	323,322	14,620
Difference	995,000	143,567	75,200	51,323	15,642	27,513	1,473
June, 1908	5,458,000	3,422,858	682,400	82,074	321,906	301,842	16,215
" 1909	6,354,000	3,506,056	805,000	131,850	342,293	330,207	17,300
Difference	896,000	83,198	122,600	49,776	20,386	28,365	1,084
July, 1908	6,196,000	3,320,114	728,500	83,049	313,353	299,245	19,188
" 1909	7,004,000	3,491,184	843,500	145,634	334,237	329,403	20,125
Difference	808,000	171,070	115,000	62,585	20,884	30,158	936
August, 1908 ...	6,234,000	3,573,244	747,400	96,068	319,300	299,532	20,052
" 1909 ...	7,152,000	3,789,948	807,100	143,088	344,513	332,823	21,370
Difference	918,000	216,704	59,700	47,020	25,213	33,290	1,317
September, 1908.	6,317,000	3,534,830	911,700	86,839	313,921	353,695	21,084
" 1909.	8,148,000	3,959,004	1,076,000	151,787	342,452	379,581	21,020
Difference	1,831,000	424,174	164,300	64,948	28,531	25,885	63
October, 1908 ..	7,349,000	3,786,170	1,172,700	91,276	312,432	306,457	14,901
" 1909 ..	9,684,000	4,043,361	1,384,200	161,366	336,765	332,576	17,803
Difference	2,335,000	257,191	211,500	70,000	24,332	26,119	2,901
November, 1908.	7,106,000	4,839,761	1,156,900	77,813	292,848	286,557	12,929
" 1909.	8,868,000	3,545,458	1,517,600	155,347	323,446	325,016	14,603
Difference	1,762,000	1,294,303	360,700	78,534	30,597	38,459	1,674
December, 1908.	6,878,000	3,185,287	916,200	71,126	235,577	295,000	13,377
" 1909.	8,112,000	3,563,580	1,220,900	137,402	328,573	345,000	14,554
Difference	1,234,000	378,293	304,700	66,276	92,996	50,000	1,177
January, 1910 ..	6,104,426	3,532,992	792,200	90,514	297,723	326,708	15,458
" 1909 ..	4,761,860	2,641,031	526,200	85,010	291,698	287,981	13,785
Difference	1,342,566	891,961	266,000	5,504	6,025	38,727	1,673
February, 1910..	5,992,052	2,965,699	698,900	*96,841	375,461	307,774	14,071
" 1909..	4,966,208	2,529,471	506,600	101,813	280,989	274,844	12,536
Difference	1,025,844	436,228	192,300	4,972	94,472	32,930	1,535
March, 1910	7,796,337	3,793,156	934,100	69,510	365,347	342,000	15,966
" 1909	6,518,763	3,181,462	738,700	142,006	295,979	297,742	13,558
Difference	1,277,574	811,694	195,400	72,496	69,368	44,258	2,408
April, 1910	7,985,230	3,567,307	1,153,100	*126,863	311,200	329,941	16,113
" 1909	6,384,038	3,142,748	741,200	161,869	290,050	297,858	14,495
Difference	1,601,192	424,559	411,900	34,006	21,150	32,083	1,618
May, 1910	8,378,115	3,830,920	1,224,900	*115,921	408,502	361,254	*10,672
" 1909	5,338,000	3,239,791	730,100	130,536	322,410	323,322	14,620
Difference	3,040,115	591,129	494,800	14,615	86,192	37,932	3,948
June, 1910	8,404,000	3,965,062	1,228,600	*84,868	*248,281	362,371	23,255
" 1909	6,354,000	3,506,056	805,000	131,850	342,293	330,207	17,300
Difference	2,050,000	459,006	423,600	46,982	94,012	32,164	15,955

*Denotes the only decreases in the table.

STEAM RAILWAYS OF CANADA

Operating 100 or more Miles of Track

NAME OF COMPANY	Capitalization in 000's	Mileage of Road	Capitalization in 000's per mile of Road	GENERAL MANAGER	HEAD OFFICE	CHIEF ENGINEER	PURCHASING AGENT	Total Earnings per Train Mile
Alberta Ry. and Irrigation Co.	$ 1,844	113.42	16.4	P. L. Naismith	Lethbridge, Alta.	....	W. W. Neilands	3.37
Atlantic and Lake Superior	1,941	100.00	19.4	Chas. R. Scoles	New Carlisle, Que.	....	....	.97
Algoma Central and Hudson Bay	17,703	89.64	145.0	W. C. Franz	Sault Ste. Marie, Ont.	C. N. Coburn	T. H. McGillivray	6.74
Bay of Quinte	2,275	108.37	24.3	E. Walter Rathbun	Deseronto, Ont.	J. W. Evans, Deseronto, Ont.	The Rathbun Co., Desronto, Ont.	1.15
Brockville, Westport and Northwestern	1,350	45.00	30.0	C. Heilshorn, 80 Broadway, N.Y.	New York, N.Y.	W. B. Smellie, Brockville, Ont.	W. J. Curle	6.17
Canada Southern	35,130	382.19	91.9	R. H. L'Hommedieu	St. Thomas, Ont.	F. B. Marble	F. H. Greene	2.18
Intercolonial	Gov. Rd.	1,490.67	Gov. Rd.	A. W. Campbell	Ottawa, Ont.	W. B. Mackenzie, Moncton, N.B.	L. E. Lavoie, Ottawa, Ont.	1.27
Prince Edward Island	Gov. Rd.	269.33	Gov. Rd.	A. W. Campbell	Ottawa, Ont.	....	L. E. Lavoie, Ottawa, Ont.	.96
Canadian Northern	98,113	3,096.42	38.7	M. H. MacLeod, Winnipeg, Man.	Toronto, Ont.	T. Turnbull, Winnipeg, Man.	F. Langham, Winnipeg, Man.	2.32
Canadian Northern, Ontario	8,110	336.53	24.6	....	Toronto, Ont.	A. F. Stewart, Toronto, Ont.	L. W. Mitchell, Toronto, Ont.	.80
Canadian Northern, Quebec	16,275	266.80	61.0	W. D. Barclay	Toronto, Ont.	H. K. Wicksteed	L. W. Mitchell, Toronto, Ont.	1.59
Canadian Pacific	372,878	9,645.60	38.1	D. McNichol	Montreal, P.Q.	J. E. Schwitzer J. G. Sullivan	E. N. Bender	2.06
Central Ontario	4,348	149.73	31.0	G. Collins, Trenton, Ont.	Toronto, Ont.	J. D. Evans, Trenton, Ont.	J. W. Collins, Trenton, Ont	.29
Dominion Atlantic	7,821	293.29	31.7	P. Gifkins	Kentville, N.S.	W. Gould, Kentville, N.S.	P. Gifkins	1.43
Grand Trunk (in Canada)	356,794	3,122.15	121.0	C. M. Hayes	Montreal, P.Q.	H. G. Kelley	A. Butze, Montreal, Que.	1.67
Grand Trunk (Canada Atlantic)	....	456.26	....	C. M. Hayes	Montreal, P.Q.	H. G. Kelley	A. Butze, Montreal, Que.	1.42
Grand Trunk Pacific	86,391	15.00	....	E. J. Chamberlin	Winnipeg, Man.	B. B. Kelliher	G. H. McNicholl	......
Halifax and Southwestern	5,341	372.11	14.4	W. D. Barclay, Quebec, Que.	Toronto, Ont.	A. F. Stewart, Toronto, Ont.	L. W. Mitchell, Toronto, Ont	1.20
Kingston and Pembroke	3,965	109.80	36.1	W. R. Baker	Montreal, Que.	G. G. Hare, Kingston, Ont	F. Conway, Kingston, Ont.	1.22
Lake Erie and Detroit River	4,432	335.59	22.2	W. Cotter	Detroit, Mich.	J. F. Deimling	W. C. Atharton	......
Montreal and Atlantic	4,265	163.40	43.5	....	....	....	....	1.52
Quebec Central	9,250	222.00	41.6	J. H. Walsh	Sherbrooke, Que.	....	J. H. Walsh	1.64
Quebec and Lake St. John	12,226	286.50	42.6	W. D. Barclay	Quebec, Que.	....	L. W. Mitchell, Toronto, Ont.	1.45
Quebec, Montreal and Southern	1,000	191.91	5.2	D. I. Roberts	Montreal, Que,	F. D. Anthony	D. I. Roberts, Montreal, Que.	2.12
Temiscouata	4,096	113.00	36.2	G. G. Grundy	Riviere du Loup, Que.	....	G. G. Grundy	1.43
Temiskaming and Northern Ontario	Gov. Rd.	264.74	....	J. H. Black	Toronto, Ont.	S. B. Clement, North Bay, Ont.	W. A. Graham, North Bay, Ont.	2.48
Vancouver, Victoria and Eastern	50,000	179.97	.28	L. W. Hill	St. Paul, Minn.	A. H. Hougeland	H. James	2.27

BRITISH RAILWAYS IN 1910.

The result of English railways for the first half of 1910 has been very satisfactory from every point of view. The trade depression and tariff difficulties of the last few years in Great Britain hit the railways very hard. Not only were the gross earnings affected, but the net earnings showed this depression even more.

For the first half of 1910 the gross earnings have shown more than an average improvement, so have the net earnings and the profits have increased considerably. The most gratifying conditions in connection with the whole improvement have been that while the railways have given more attention to traffic and tariffs and have also been more considerate of their employees, as well as giving better service to the public, their financial standing has improved.

One of the noticeable things in connection with railway operation during the past few months has been the tendency to the construction of larger locomotives, larger freight cars and longer trains. A beginning has been made in the more rapid handling of suburban traffic. Electrification has been introduced for suburban train service at Liverpool, Newcastle and London, and the innovation has been received with such favor as would indicate the extension.

In the past half-year the 19 principal English railways secured an increase in their gross earnings of £1,419,000, or 3.3 per cent., but the increase in expenses was only £364,000, or 1.3 per cent., and the gain in net earnings was £1,055,000, or about 7 per cent. The increase in the fixed charges, including the dividend upon new Ordinary stock, was only £40,000, and, including the increase in miscellaneous income, the expansion in net profit for dividend was as much as £1,074,000, or 27 per cent. And this result was obtained after devoting money still more liberally to improvements. In the past half-year an additional £51,000 has been spent upon maintenance of way, and an extra £155,000 upon maintenance of equipment, and there can be no doubt that the greater portion of these expenditures was of the nature of betterments, as they were made mainly by a few companies who derived the greatest advantage from the economies effected. It may be calculated that the real increase in profit, allowing for additional betterments for the half-year, has been upwards of 30 per cent.

In comparing the improvements in the net earnings for the past half-year with improvements in former years, account has to be taken of the fact that the economy in expenditure of the past half-year was not due to lower prices of coal or materials. In former years, when the profits showed large expansion, the increase mainly resulted from a fall in the price of coal. For instance, in the first half of 1902, with an expansion of £766,000 in the gross earnings, there was a reduction of £264,000 in expenses, and the net earnings gained £1,030,000, but the saving then was in consequence of the great fall in prices of commodities which took place at the close of the war. The satisfactory character of the results for the past half-year, both from the point of view of gross and of net earnings, will be apparent from the following statement:—

Gross and Net Earnings, 19 Principal English Railways.

June Half	Gross Earnings. £	Expenses. £	%	Net Earnings. £	%
1910...	+1,419,000	+ 364,000	+1.3	+1,055,000	+ 6.9
1909...	— 265,000	— 963,000	—3.3	+ 698,000	+ 4.7
1908...	— 553,000	+ 698,000	+2.5	—1,251,000	— 7.9
1907...	+1,502,000	+1,195,000	+4.4	+ 307,000	+ 2.0
1906...	+1,556,000	+ 990,000	+3.8	+ 566,000	+ 3.8
1905...	+ 95,000	+ 63,000	+ .2	+ 32,000	+ .2
1904...	+ 398,000	+ 236,000	+ .9	+ 162,000	+ 1.1
1903...	+ 824,000	+ 336,000	+1.3	+ 488,000	+ 3.4
1902...	+ 766,000	— 264,000	+1.0	+1,030,000	+ 7.7
1901...	— 224,000	+1,262,000	+5.2	—1,485,000	—10.1
1900...	+1,318,000	+1,797,000	+8.0	— 479,000	— 3.1
1899...	+2,152,000	+1,513,000	+7.2	+ 639,000	+ 4.4
1898...	+ 992,000	+1,234,000	+6.3	— 242,000	— 1.6
1897...	+1,154,000	+ 892,000	+5.0	+ 262,000	+ 1.9

The increase in gross receipts is greatest in the merchandise traffic, which expanded 4.7 per cent. Passenger

(Continued on page 368,)

INCOME STATEMENTS OF THE 19 PRINCIPAL ENGLISH RAILWAY COMPANIES

For the half-years ended June 30th, 1909 and 1910

Name of Company	Route Miles Maintained: June 30, 1910	Route Miles: Inc. or Dec.	Capital Expended [000's omit'd]: To June 30, 1910	Capital: Inc. or Dec.	Gross Earnings: June Half, 1910	Gross: Inc. or Dec.	Operating Expenses: June Half, 1910	Operating Exp.: Inc. or Dec.	Ratio: June Half, 1910	Ratio: Inc. or Dec.	Net Earnings: June Half, 1910	Net Earnings: Inc. or Dec.	Misc. Income: June Half, 1910	Misc. Income: Inc. or Dec.	Net Income: June Half, 1910	Net Income: Inc. or Dec.
	M. Ch.	M. Ch.	£	£	£	£	£	£	%	%	£	£	£	£	£	£
Furness	138:60	—	6,917	+ 39	272,336	+ 42,475	142,743	+ 18,117	52.41	—1.80	129,593	+ 24,358	—	—	129,593	+ 24,358
Great Central	626:00	—	55,312	+ 318	2,154,501	+101,891	1,407,417	+ 63,748	65.32	—0.14	747,084	+ 38,143	123,009	+12,387	870,093	+ 50,530
Gt. Eastern	1,178:20	+ 16:60	53,504	+ 39	2,777,931	+ 90,669	1,808,488	+ 28,595	65.10	—1.13	969,443	+ 62,074	6,538	+ 97	975,981	+ 62,171
Gt. Northern	752:52	+ 5:01	52,704	+ 86	2,951,820	+ 75,959	1,919,524	+ 15,620	65.03	—1.17	1,032,296	+ 60,339	32,680	+ 4,553	1,064,976	+ 64,892
Gt. Western	2,975:20	+ 15:20	108,554	+1,046	6,634,897	+147,390	4,319,249	+ 36,131	65.09	—0.93	2,315,648	+ 111,259	15,980	— 780	2,331,628	+ 110,479
Hull & Barnsley	87:70	+ :71	8,586	+ 242	358,914	+ 47,319	194,637	+ 16,113	54.21	—3.08	164,277	+ 31,206	104	+ 104	164,381	+ 31,310
Lanc. & Yorks.	589:60	+ 4:40	62,479	+ 340	2,901,756	+ 45,784	1,756,394	+ 24,017	60.52	—0.14	1,145,362	+ 21,767	6,920	— 1,450	1,152,282	+ 20,317
London & N.W.	1,962:20	+ 2:00	119,714	+ 489	7,501,587	+219,312	4,760,165	— 8,256	63.45	—1.11	2,741,422	+ 227,568	78,930	+ 6,581	2,820,352	+ 234,149
L. & S. W.	952:13	+ 3:42	47,921	+ 518	2,669,562	+ 80,982	1,760,069	+ 30,576	65.93	—0.90	909,493	+ 50,406	7,537	+ 1,027	917,030	+ 51,433
L., Brighton	454:20	—	32,149	+ 214	1,607,947	+ 50,282	1,008,465	+ 35,038	62.71	+0.23	599,482	+ 15,244	—	—	599,482	+ 15,244
L., Chat. & D.			30,387	+ 64	949,347	+ 34,389	614,851	+ 6,371	64.77	—1.73	334,496	+ 28,018	3,416	+ 870	337,912	+ 28,888
L., Tilbury	81:22	—	5,727	+ 49	290,581	+ 20,500	188,183	+ 11,252	64.76	—0.77	102,398	+ 9,248	3,595	+ 582	105,993	+ 9,830
Metropolitan	27:43	—	12,493	+ 60	391,488	+ 12,001	194,020	+ 777	49.56	—1.36	197,468	+ 11,224	53,888	+ 4,832	251,356	+ 16,056
Metro. District	24:24	—	12,221	+ 94	300,047	+ 26,728	143,331	— 4,765	47.76	—6.43	156,716	+ 31,493	45,379	+10,787	202,095	+ 42,280
Midland	1,468:46	+ :68	121,216	+ 268	6,030,769	+201,568	3,716,311	— 34,849	61.62	—2.73	2,314,458	+ 236,417	182,274	+13,050	2,496,732	+ 249,467
North-Eastern	1,723:00	+ 19:00	82,867	+ 758	4,936,783	+142,960	3,240,903	+116,394	65.65	+0.47	1,695,875	+ 26,566	6,645	+ 4,193	1,702,520	+ 30,759
N. London	13:40	—	4,119	— 4	229,842	+ 2,022	126,288	— 12,718	54.95	—6.07	103,554	+ 14,741	849	+ 849	104,403	+ 15,590
N. Stafford	215:20	+ :60	9,035	+ 29	505,731	+ 27,042	312,788	+ 11,665	61.85	—1.05	192,943	+ 15,377	1,718	— 38	194,661	+ 15,339
South-Eastern	622:21	—	33,002	+ 75	1,429,253	+ 49,531	899,199	+ 10,203	62.91	—1.42	530,054	+ 39,328	18,891	+ 1,572	548,945	+ 40,900
Total ...; Inc. or dec. %	13,892:71	+ 68:42 + 0.5%	858,937	+4,724 +0.6%	44,895,092	+1,418,805 + 3.3%	28,512,830	+364,029 + 1.3%	63.29	—1.46	16,382,062	+1,054,776 + 6.9%	588,353	+ 59,216 + 11.2%	16,382,062	+1,113,992 + 7.0%

ELECTRIC RAILWAYS OF CANADA

Name of Road.	Location.	Kind.	Manager.	Chief Engineer.	Length in Single Track.	Voltage. Trans.	Voltage. Trolley.	Kind of Current.	No. of Phases.	Gauge of Track.	Weight of Rail.	Capital Stock in thousands
										ft. ins.	lbs.	$
NOVA SCOTIA.												
Halifax Electric Tramway Co.	Halifax	Urban	J. W. Crosby	P. A. Freeman	14.5	2,200 A.C.	575	Direct	3	4 8½	60	1,400
Egerton Tramway Co.	New Glasgow	Interurban	C. A. Flaherty	A. McDanniells	8.2					4 8½	60	300
Cape Breton Electric Co.	Sydney	Interurban	A. F. Townsend		31					4 8½	60	2,000
Yarmouth St Railway Co.	Yarmouth	Urban	B. A. Burrill	R. Blackburn	3	22,000	50	Direct and alternatin	3	4 8½	45	
NEW BRUNSWICK.												
St. John Railway Co	St. John	Urban	W. G. Earle.	T. Irwin	15					4 8½	74	800
St. Stephens St. Ry	St. Stephens	Urban	C. W. Young		7						48	100
QUEBEC.												
The Hull Electric Co	Aylmer	Suburban	W. R. Baker.	G. Gordon Gale	26	10,000	550		3	4 8½	56	300
The Levis County Ry	Levis	Interurban	A. K. MacCarthy	A. K. MacCarthy	10.25	2,200	550	Direct	3	4 8	60	250
The Montreal St. Ry	Montreal	Urban	W. G. Ross	R. M. Hannaford	30.21		575	Direct		4 8½	56.96	18,000
The Montreal Terminal Ry. Co.	Montreal	Suburban			142.11			Direct		4 8½	56-80	5,000
The Suburban Tramway and Park Co	Montreal	Suburban			6.06			Direct		4 8½		
The Montreal Park and Island Railway Co	Montreal	Suburban			49.25			Direct		4 8½		
ONTARIO.												
The Oshawa Ry. Co	Oshawa	Urban	E. Walter Rathbun	J. W. Evans	12	450	450	Direct		4 8½	60	200
Port Arthur and Fort William Electric Ry	Port Arthur	Interurban	N. C. Pilcher	N. C. Pilcher	22		550	Direct		4 8½	50-80	600
Hamilton St. Ry. Co	Hamilton		W. C. Hawkins			40,000	575	Direct		4 8½	93	205
Sarnia St. Ry. Co	Sarnia	Urban	H. W. Mills	J. R. Henderson	9¼	500 to 600	500 to 600	Direct		4 8½	56-70	70
Berlin and Waterloo Ry	Berlin	Urban	U. S. McIntyre	E. J. Philips	4½		550	Direct		4 8½	56-72	

Niagara, St. Catharines and Toronto Ry. Co	*St. Catharines*	*Interurban*	*E. F. Seixas*	*W. P. Chapman*	*50*	*12,000*	600	Direct	3	4	8½	80	925
The Peterborough Radial Ry. Co.	Peterborough	Urban	J. H. Larmonth	....	5.1	....	550	Direct	....	4	8½	60	500
Toronto Street Ry.	Toronto	Urban	R. J. Fleming	Wm. B. Boyd	114	12,000	600	Direct and Alternating	3	4	10⅞	90	8,000
The London, Lake Erie Transportation Co.	London	Interurban	S. W. Mower	....	28.50	10,000							
The Ottawa Electric Ry. Co.	Ottawa	Suburban	....	....	40	....	600	Alternating	....	4	8½	60	1,000
Toronto and York Radial	Toronto	Suburban	W. H. Moore	Wm. B. Boyd	81	16,000	600	Direct	....	4	8½	80	2.000
Kingston, Portsmouth & Cataraqui Ry. Co.	Kingston	Interurban	H. C. Nickle	Jno. Evans	8	500	550	Direct and Alternating	....	4	8½	60	2,000
International Transit Co.	Sault Ste. Marie	Urban	W. C. Franz	R. S. McCormick	8	500	500	Direct	....	4	8½	60	40
London Street Ry.	London	Urban	C. B. King	H. Welburn	33.25	550	500	Direct	3	4	8½	60	150
Galt, Preston & Hespeler Ry.	Galt	Interurban	M. N. Todd	Jno. Johnson	21	....	550	Direct	....	4	8½	73	750
Guelph Radial Ry. Co., Ltd.	Guelph	Urban	J. J. Hackney	....	8.5	550	....	Direct	3	4	8½	70	100
Chatham, Wallaceberg & Erie Ry. Co.	Chatham	Interurban	W. Norris	A. H. White	38	550	550	Direct	....	4	8½	60	200
Brantford & Hamilton Electric Railway	Hamilton	Interurban	E. P. Coleman	....	22.91	40,000	550	Direct	....	4	8½	60	1,000
Cornwall St. Ry.	Cornwall	Urban	W. Hodge	W. Hodge	6.5	550	600	Direct	3	4	8½	80	......
Hamilton Street Railway	Hamilton	Urban	E. P. Coleman	....	22.29	40,000	550	Direct	....	4	8½	60	100
Hamilton Radial Electric Ry.	Hamilton	Interurban	E. P. Coleman	....	30.11	40,000	600	Direct	....	4	8½	87-94	......
Hamilton & Dundas Electric Railway	Hamilton	Interurban	E. P. Coleman	....	6.98	40,000	600	Direct	....	4	8½	80	......
Hamilton, Grimsby and Beamsville Electric Ry. Co.	Hamilton	Interurban	E. P. Coleman	....	22.3	40,000	600	Direct	....	4	8½	65	......
							600	Direct	....	4	8½	70	......
MANITOBA.													
Winnipeg Electric Ry	Winnipeg	Urban	W. Phillips	W. Phillips	64	50,000	550	Direct	3	4	8½	55-70	6,000
SASKATCHEWAN.													
Moose Jaw Electric Street Ry.	Moose Jaw	Urban	....	J. B. McRae, C.E., Ottawa, Ont.	.....	....	....	....	....	....		......	400
ALBERTA.													
Calgary Street Railway	Calgary	Urban	T. H. McCauley	Jas. McCall	9	....	....	....	....	4	8½	......	Munic. owned
Edmonton Radial	Edmonton	Interurban	C. E. Taylor	C. E. Taylor	19.5	....	....	D. C.	....	4	8½	60-90	......
Strathcona Radial	Strathcona	....	....	....	......	....	....	....	....	....	......	......	......
BRITISH COLUMBIA.													
Nelson Electric Tramway	Nelson	Interurban	J. McPhee	Q. Weeks	3	....	....	....	....	4	8½	60	250
British Columbia Electric Ry.	Vancouver	Interurban	R. H. Sperling	C. Garden	40	....	....	....	....	4	8½	40-70	1

train earnings showed the satisfactory expansion of 3 per cent. The increase in mineral receipts was 2.2 per cent. It is evident that the improvement in railway earnings mainly resulted from the activity of our manufacturing industries. Had our cotton trade been able to obtain all the raw material it needed to meet the demand for cotton goods, the expansion in railway earnings would have been still more noteworthy. How large was the expansion in the goods receipts will be evident from the following statement:—

Gross Earnings, 19 Principal English Railways—June Halves.

	1910.	1909.	Inc. or Dec.		
	£	£		£	%
Passenger trains	18,761,000	18,220,000	+	541,000	+ 3.0
Merchandise and live stock	13,532,000	12,924,000	+	608,000	+ 4.7
Minerals	10,263,000	10,045,000	+	218,000	+ 2.2
Total freight trains	23,795,000	22,969,000	+	826,000	+ 3.6
"Railway" earnings	42,556,000	41,189,000	+	1,367,000	+ 3.3
Miscellaneous receipts	2,339,000	2,287,000	+	52,000	+ 2.3
Gross earnings	44,895,000	43,476,000	+	1,417,000	+ 3.3

The main item of railway expenditure is conducting transportation—in other words, "traffic" and "running" expenses. This comprehensive term includes the wages paid to the men at the stations, to the guards of the trains, to the engine crews, to signalmen, to shunters, and to others connected with the working and loading of the trains, also the sums paid for water, fuel, and stores. This important item of conducting transportation has increased only £85,000, or .6 per cent., in the past half-year, against an increase in gross receipts of 3.3 per cent. The total expenditure for repairs and renewals of equipment has increased £155,000, or 3.2 per cent. The expenditure upon carriages has been £74,000 greater than last year, an increase of 5.5 per cent.; the expenditure upon waggons has increased £43,000, or about 4 per cent., and the outlay upon locomotives nearly £38,000, or rather less than 2 per cent. The maintenance of way expenditures have increased £51,000, or 1.2 per cent. For the purpose of showing the economy effected in conducting transportation and the heavy additional expenditures upon the equipment we give the following comparison:—

Expenses, 19 Principal English Railways—June Halves.

	1910.	1909.	Inc. or Dec.		
	M. Ch.	M. Ch.		M. Ch.	%
Miles Maintained	13,892: 71	13,824: 29	+	68: 42	+ 0.5
	£	£		£	
Maintenance of way	4,279,000	4,228,000	+	51,000	+ 1.2
Do. equipment	4,979,000	4,824,000	+	155,000	+ 3.2
Cond. transportation	14,336,000	14,251,000	+	85,000	+ 0.6
General expenses	1,146,000	1,116,000	+	30,000	+ 2.7
Total "railway" expenses	24,740,000	24,419,000	+	321,000	+ 1.3
Compensation	313,000	293,000	+	20,000	+ 6.8
Rates and taxes	1,981,000	1,948,000	+	33,000	+ 1.7
Miscellaneous	1,479,000	1,489,000	—	10,000	—
Operating expenses	28,513,000	28,149,000	+	364,000	+ 1.3

The proportions of the gross earnings absorbed for maintenance and for conducting transportation will be apparent from the following:—

Ratios of "Railway" Expenses to "Railway" Earnings of the 19 Companies—June Halves.

	1910.	1909.	
	%	%	+ or —
Maintenance of way	10.05	11.26	— .21
Do. of equipment	11.70	11.70	—
Conducting transportation	33.69	34.61	— .92
General expenses	2.70	2.71	— .01
Total	58.14	59.28	— 1.14

The greater portion of the increased sum expended upon equipment has occurred in labor, but the total increase in the sum paid for wages in all departments, including the much heavier outlays upon the repairs and renewals of the carriages, is only £205,000, or 1.6 per cent. The additional outlay upon materials was £57,000, or 1.6 per cent. Coal cost £21,000 less than last year, a reduction of nearly 1 per cent., notwithstanding an increase of nearly 1 per cent. in the train mileage. The economy in coal has, we understand, arisen in some measure from an effort to diminish the time spent by locomotives waiting about under steam and wasting fuel and wages. We have previously referred to the improvement of 27 per cent. in the profit. The increase in dividend has not been equal to the increase in profit, as the companies have wisely decided to devote a portion of the large increase in profit to reserve. Still, the increase in the sum divided in dividend is as much as 17.2 per cent., and the average rate of return upon the Ordinary stocks is raised from 3.11 per cent. per annum for the June half of 1909 to 3.64 per cent. per annum for the past half-year, an improvement of 0.53 per cent. In the June half of last year the sum distributed in dividend was £221,000 greater than the profit earned in the period, and the balance was made good out of the sum brought forward from the previous half-year. In the past half-year there is a surplus, after paying the higher dividend, of £129,000. After devoting £310,000 to reserve fund, against only £51,000 last year, the balance carried forward to the December half-year is £601,000, against £471,000 carried forward at the end of June 1909.

The following statement gives a comprehensive view of the aggregate results of the 19 principal English railway companies in the past half-year in comparison with the results for the first half of 1909:—

Results of 19 Principal English Railway Companies.

June Half	1910	1909	Inc. or Dec.		
	M. Ch.	M. Ch.		M. Ch.	%
Miles maintained	13,892: 71	13,824: 29	+	68: 42	+ 0.5
Train miles	152,407,668	151,167,414	+	1,240,254	+ 0.8
	£	£		£	
Cap. expended	858,937,000	854,213,000	+	4,724,000	+ 0.6
Ordinary stock	270,541,410	270,368,519	+	172,891	—
Gross earnings	44,895,092	43,476,287	+	1,418,805	+ 3.3
Oper. expenses—					
Wages	12,558,148	12,352,738	+	205,410	+ 1.6
Materials	3,719,420	3,662,414	+	57,006	+ 1.6
Coal	2,549,623	2,570,643	—	21,020	— 0.8
Electric power	77,719	80,897	—	3,178	— 3.9
Rates & taxes	1,980,962	1,948,643	+	32,319	+ 1.7
Compensation	312,851	293,068	+	19,783	+ 6.7
Other	7,314,107	7,230,398	+	73,709	+ 1.0
Total	28,512,830	28,148,801	+	364,029	+ 1.3
Ratio	(63.29%)	(64.75%)	—	(1.46%)	—
Net earnings	16,382,062	15,327,286	+	1,054,776	+ 6.9
Misc. income	588,353	529,137	+	59,216	+ 11.2

Net income	16,970,415	15,856,423	+1,113,992	+ 7.0
Rentals & Deb. & other interest.	5,609,951	5,575,668	+ 34,283	+ 0.6
Balance	11,360,464	10,280,755	+1,079,709	+10.5
Preference divs..	6,302,784	6,300,262	+ 2,522	—
Balance	5,057,680	3,980,493	+1,077,187	+27.1
Div. on New Ord.	3,167	—	+ 3,167	—
Net profit	5,054,513	3,980,493	+1,074,020	+27.0
= % on Ord..	(3.74%)	(2.95%)	+ (0.79%)	—
Divs. on Ord. stks	4,925,000	4,201,613	+ 723,387	+17.2
Do. % per an..	(3.64%)	(3.11%)	+ (0.53%)	—
Balance ..Cr.	129,513	Dr.221,120	+ 350,633	—
= % on Ord. Cr.	(0.40%)	Dr. (0.16%)	+ (0.26%)	—
Brought forward.	782,269	737,461	+ 44,808	—
Surplus	911,782	516,341	+ 395,441	—
To reserve, &c..	310,745	51,535	+ 259,210	—
= % on Ord.	(0.23%)	(0.04%)	+ (0.19%)	—
From reserve, &c.	Nil	6,035	— 6,035	—
Carried forward.	601,037	470,841	+ 130,196	—

INTERURBAN RAILWAYS CENTERING IN TORONTO.

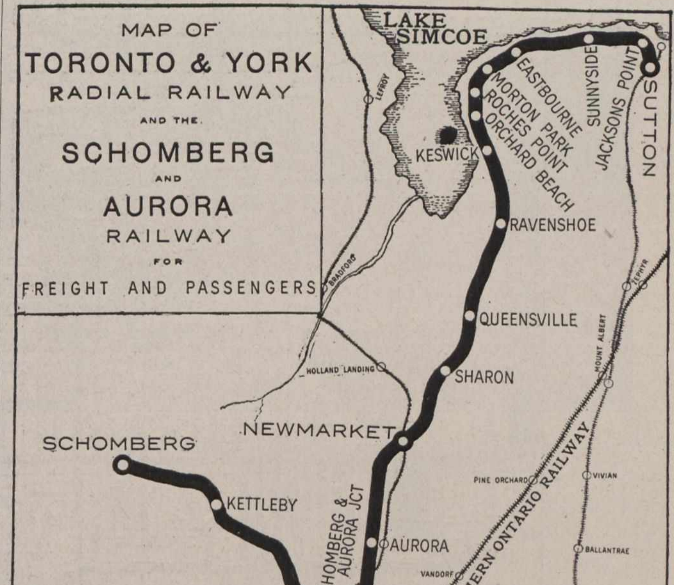
General.

The City of Toronto is favorably situated on the north shore of Lake Ontario and is the main business center of the Province of Ontario. Its harbor is the result of artificially improved bars formed by deposits of silt and sand known as Toronto Island. The population of the city has already passed the 400,000 mark, and is rapidly increasing, not only through emigration from other parts of the Province and abroad, but also due to the frequent annexation of suburban districts. Toronto has, therefore, a constantly increasing demand for transportation facilities other than those provided for by the trunk steam railway systems.

The additional transportation requirements of the city are now taken care of by the interests controlled by Toronto's local railway magnates, known as Mackenzie and Mann, the central enterprise of their local railway system being the Toronto Railway, which is a single-trolley electric street railway operated by the usual 500-550 volt method, the power being obtained from rotary converters located in 3 sub-stations with Niagara Falls as the point of generation. Contrary to the apparently popular conceived opinion, this railway, if the local conditions affecting it are compared with the local and other conditions affecting the many street railways which the writer has been practically familiar with, provides a means of city passenger transportation equal, if not superior, to those provided for any other municipality. Further, the Toronto Railway Company pays to the City of Toronto annually a handsome and yearly increasing sum equivalent to thirty-three per cent. of its net earnings, the last payment amounting to $558,153.83, and in addition to this sum a tax of $800 a year on each single mile of its track, or total of $82,127 in 1909. Nor must it be forgotten that the company subscribed the handsome sum of $15,000 to the Y. M. C. A. fund of this year. Apropos of all of which, the writer's father, when visiting Toronto last year, remarked, in reference to the growlings of Torontonians and the foregoing figures, that the ratepayers of Toronto would appreciate how well off they are if they had ever been in the fix which he and his fellow-ratepayers in an English town of over 100,000 are in, their tax rate for municipal matters only being half-a-crown on the pound (125 mills), due to municipal ownership and operation of an electric street railway.

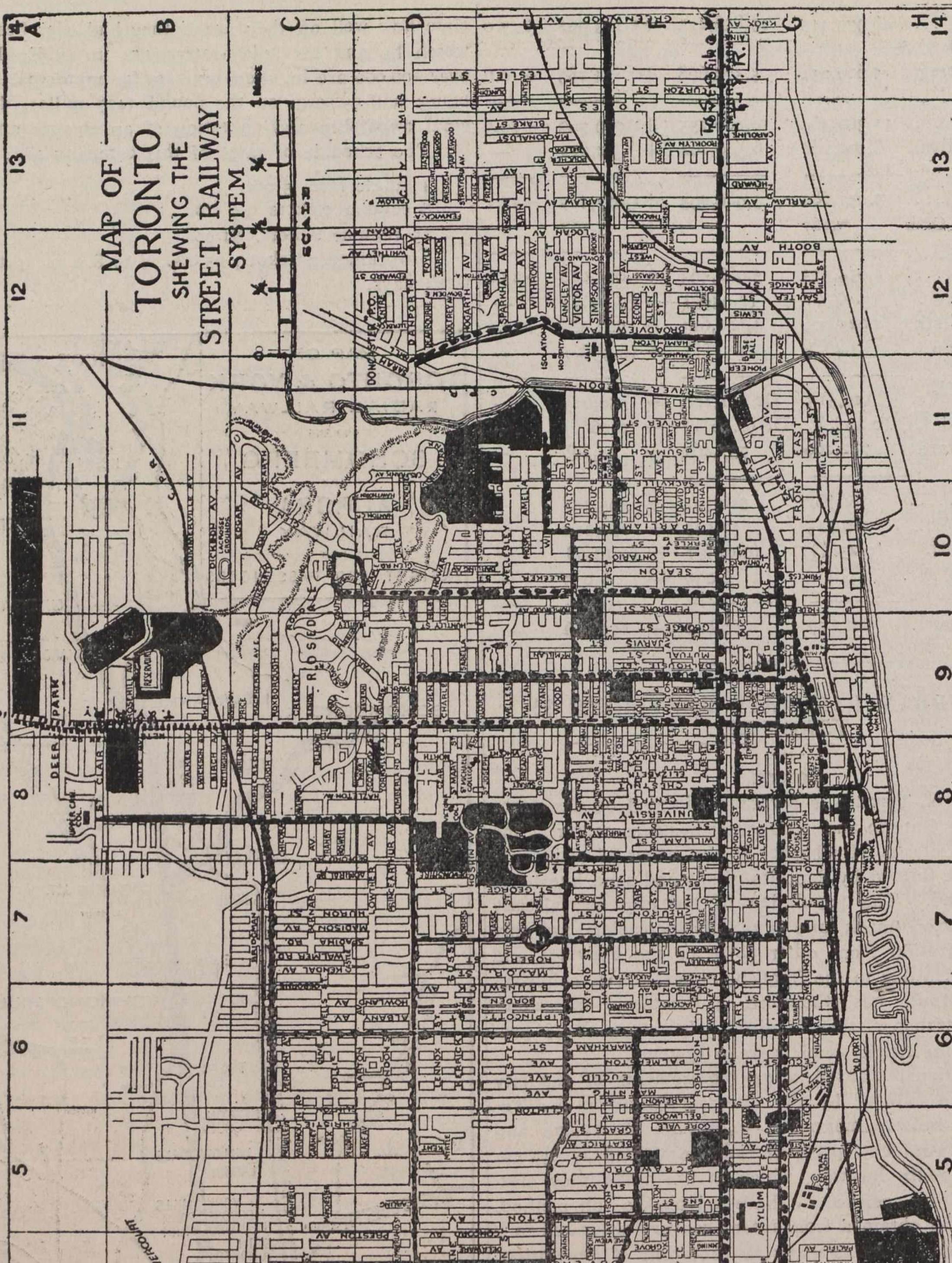
The schedule of rates of this company are:

1 single fare, 5 cts.
6 regular tickets, 25 cts.
25 regular tickets, $1.00.
8 workmen's tickets, 25 cts., 5 to 8 a.m., 5 to 6.30 p.m., week days.



7 Sunday tickets, 25 cents, 5 to 8 a.m., 5 to 6.30 p.m., week days.
10 school children's tickets, 25 cts., also good for half fare under 9 years.

The company also has a liberal system of transferring without extra payment, and its night service, from midnight to 5 a.m., is a frequent one, with an average headway of about 20 minutes. The track mileage is about 57 miles of double track, or an equivalent of about 114 miles of single track.


MAP OF
TORONTO
SHEWING THE
STREET RAILWAY
SYSTEM
SCALE
1 MILE

The number of passengers carried by this railway during twelve months ending 1909 were 98,117,991 revenue passengers and 38,151,596 transfers, and the gross receipts from passengers during this period were $3,878,145.82. The Company provides a living for about 2,100 employees, and its much criticized, though genial manager, Mr. R. J. Fleming, is one of the high salary railway officials of Canada.

The interurban lines entering Toronto are three in number, and are known, respectively, as the "Metropolitan," the "Mimico," and the "Scarboro"

Toronto and York Radial Railway.

The Toronto and York Radial Railway is, like that of nearly every railway, the outcome of the amalgamation of several small systems together with various subsequent extensions. The consolidation which resulted in the control under the present name was consummated on August 17th, 1904, the three divisions being respectively known as the Metropolitan, Mimico and Scarboro, and the mileage at which date amounted to 45 miles, while it now amounts to 80.85 miles.

Metropolitan Division.

This interurban electric railway connects, practically speaking, Lake Ontario with Lake Simcoe, having been constructed more or less on or adjoining the old military road laid out by Governor Simcoe in early colonial days. The track commences on Yonge Street at the northern boundary of Toronto and, if the Toronto Railway Company's track were built to standard gauge, it would, to all intents and purposes, constitute a continuation of that portion of the latter which starts on the same street near the wharf on Lake Ontario. The other terminal is located at Jackson's Point, on Lake Simcoe, the shores of which lake provide ideal spots for cottages occupied during the summer months by the families of several of Toronto's business men, as the satisfactory service obtainable on this division at reasonable rates permits the head of a family to frequently visit the other members of his household.

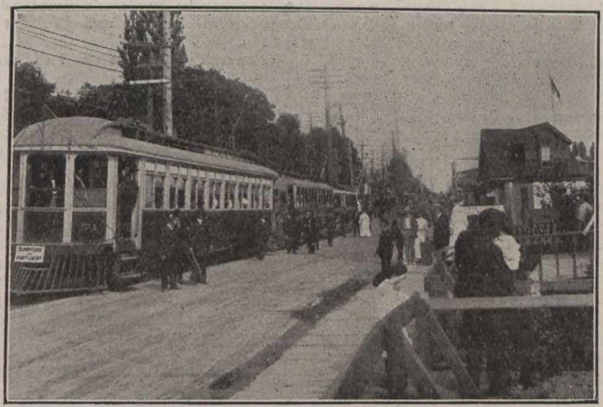
At the time that the consolidation was effected, this division extended to Newmarket only, and was the result of the original mileage having been extended no less than six times and amounted to 33.97 miles of track. The Lake Simcoe extension of an additional twenty-five miles was commenced during March, 1905, operation over which extension was inaugurated on June 15th, 1907. Fifty-six and sixty-pound rails have been used for the track constructed on 28.6 miles of private right-of-way and 30.37 miles of highway.

The method of operation is the 550-volt, single-trolley system, the requisite power being obtained for the first ten miles from the Toronto Railway Company, for the next fifteen miles from steam-driven dynamos installed in the company's powerhouse located at Bonk Lake Park, for the next ten miles from rotary converters installed at Newmarket, and for the remaining twenty-four miles from a small steam-driven plant installed at Keswick.

For the generation of the required power, the company has installed eight boilers, five Wheelock compound and Armington and Sims engines, and eight Westinghouse and General Electric generators of 250 and 275 kilowatts. The generators at the Bond Lake powerhouse are duplex transmission machines, providing for 550 volts direct and 275 volts alternating transmission, the latter being stepped-up at the Bond Lake powerhouse to 16,500 volts for transmission to Newmarket, where it is stepped-down and, by means of two rotaries of 250 kilowatts capacity each, rendered suitable for trolley feeding.

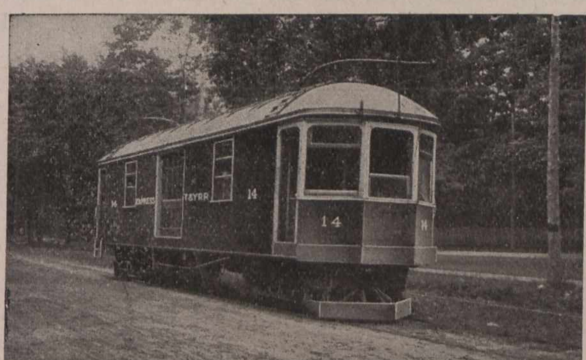
The demand for power on this division requires the supply of about 800 kilowatts from the Bond Lake powerhouse and about 500 kilowatts from the plant at Keswick. It can be understood, of course, that the present rather mixed-up plan of power supply is only temporary until such time as the Electrical Development Company, at Niagara, and the Toronto and Niagara Power Company, both of which undertakings are now controlled through the Toronto Railway Company, by Mackenzie and Mann, will be in a position to supply power for the whole system.

Transportation over this division is taken care of by twenty-two interurban passenger cars, three trailers, five freight cars of the passenger model and one electric locomotive, the running schedule for passenger traffic, as shown by the accompanying time-table, being a frequent one:



Sunnyside Terminal—Mimico Division.

An interesting feature of this portion of the Toronto and York Radial Railway is the interchangeable freighting carried on between it and the Canadian Northern Railway by means of interswitching arrangements located at Richmond Hill, whereby the freight cars of the latter are hauled not only north and over the Schomberg and Aurora Railway, but also south as far as Toronto, thus providing a satisfactory way of supplying to these districts coal shipped from the Pennsylvania mines via the Canadian Northern Railway. As an evidence of the value of an interurban railway service in times of emergency, it may be also mentioned that, during the late strike of the employees of the Grand Trunk Railway, a considerable amount of extra freight was carried over this division and transhipped to small steamers temporarily placed in commission on Lake Simcoe to supply the requirements of several of the affected districts.



Standard Express and Freight Car.

From July 1st, 1908, to June 30th, 1909, the weight of freight carried over this division amounted to 24,374 tons; and the gross receipts from this source were $44,155.74, or,

METROPOLITAN DIVISION.

NORTHBOUND CARS.

Stop	A.M.							P.M.										
		*											*					
Toronto ....Leave	6.30	7.30	8.30	9.30	10.30	11.30	12.30	1.30	2.30	3.30	4.30	5.00	5.30	6.00	6.30	7.30	8.30	10.00
24—Bedford Park P.O.	6.42	7.42	8.42	9.42	10.42	11.42	12.42	1.42	2.42	3.42	4.42	5.12	5.42	6.12	6.42	7.42	8.42	10.12
41—Thornhill	7.02	8.02	9.02	10.02	11.02	12.02	1.02	2.02	3.02	4.02	5.02	5.32	6.02	6.32	7.02	8.02	9.02	10.32
49—Richmond Hill	7.15	8.15	9.15	10.15	11.15	12.15	1.15	2.15	3.15	4.15	5.15	....	6.15	....	7.15	8.15	9.15	10.45
57—Schomberg Junction	7.32	8.32	9.32	10.32	11.32	12.32	1.32	2.32	3.32	4.32	5.32	....	6.32	....	7.32	8.32	9.32	11.02
63—Aurora	7.45	8.45	9.45	10.45	11.45	12.45	1.45	2.45	3.45	4.45	5.45	....	6.45	....	7.45	8.45	9.45	11.15
71—Newmarket	8.00	9.00	10.00	11.00	12.00	1.00	2.00	3.00	4.00	5.00	6.00	....	7.00	....	8.00	9.00	10.00	11.30
83—Keswick	8.36	....	†10.36	11.36	12.36	.....	.....	3.36	....	†5.36	6.36	....	....	....	8.36	....	†10.36	....
99—Jackson's Point ..	9.00	....	†11.00	12.00	1.00	.....	.....	4.00	....	†6.00	7.00	....	....	....	9.00	....	†11.00	....
100—Sutton ...... Arrive	9.10	....	†11.10	12.10	1.00	.....	.....	4.10	....	†6.10	7.10	....	....	....	9.10	....	†11.10	....

*Connect with Schomberg and Aurora Railway at Schomberg Junction. †Not in operation until May 21st.

Special Saturday Service.—Commencing April 23rd.

Half-hour service from Toronto to Newmarket and intermediate points from 12.30 to 7.30 p.m. Half-hour service from Newmarket to Toronto and intermediate points from 3.00 to 9.00 p.m.

Commencing June 4th.—Extra Service, Toronto to Jackson's Point and Sutton at 12.30, 2.30, and 7.30 p.m. Extra Service, Sutton and Jackson's Point to Toronto at 12.45, 2.45, and 7.45 p.m.

NOTE.—Special Saturday service will be in operation day before holidays.

Special Monday Service.—Commencing June 6th.

Limited Car will leave Eastbourne for Toronto at 6.45 a.m.

Commencing June 27th.—6.45 a.m., Car from Sutton will be a Limited Car from Newmarket to Toronto.

NOTE.—Special Monday Service will be in operation day after holidays.

SOUTHBOUND CARS.

Stop.	A.M.							P.M.								
100—Sutton ...Leave.	....	†5.45	6.45	7.45	.....	.....	10.45	......	......	1.45	......	3.45	†4.45	......	6.45	†8.45
99—Jackson's Point...	....	†5.49	6.49	7.49	.....	.....	10.49	......	......	1.49	......	3.49	†4.49	......	6.49	†8.49
83—Keswick	....	†6.11	7.11	8.11	.....	.....	11.11	......	......	2.11	......	4.11	†5.11	......	7.11	†9.11
			*										*			
71—Newmarket	6.00	7.00	8.00	9.00	10.00	11.00	12.00	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	10.00
63—Aurora	6.09	7.09	8.09	9.09	10.09	11.09	12.09	1.09	2.09	3.09	4.09	5.09	6.09	7.09	8.09	10.09
57—Schomberg Jnct. .	6.23	7.23	8.23	9.23	10.23	11.23	12.23	1.23	2.23	3.23	4.23	5.23	6.23	7.23	8.23	10.23
49—Richmond Hill ..	6.36	7.36	8.36	9.36	10.36	11.36	12.36	1.36	2.36	3.36	4.36	5.36	6.36	7.36	8.36	10.36
41—Thornhill	6.45	7.45	8.45	9.45	10.45	11.45	12.45	1.45	2.45	3.45	4.45	5.45	6.45	7.45	8.45	10.45
24—Bedford Park P.O.	7.08	8.08	9.08	10.08	11.08	12.08	1.08	2.08	3.08	4.08	5.08	6.08	7.08	8.08	9.08	11.08
Toronto ....Arrive	7.30	8.30	9.30	10.30	11.30	12.30	1.30	2.30	3.30	4.30	5.30	6.30	7.30	8.30	9.30	11.30

*Connect with Schomberg and Aurora Railway at Schomberg Junction. †Not in operation until May 21st.

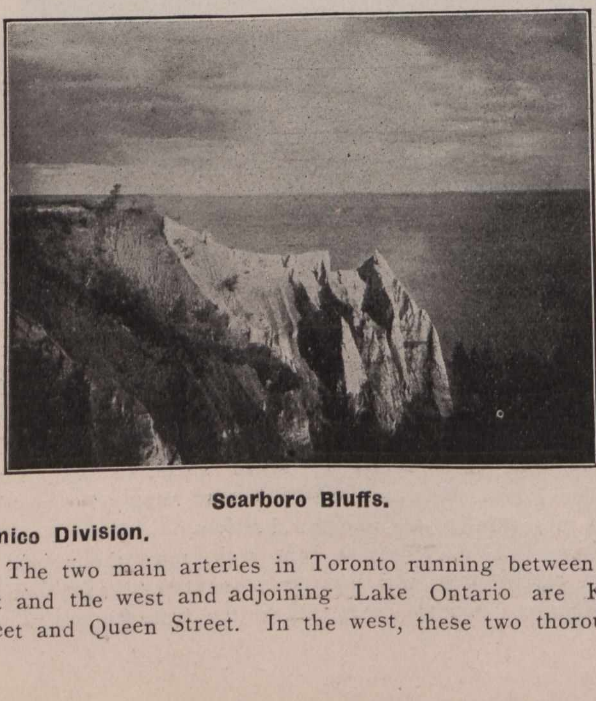
Special Holiday Service.—Half-hour service from Toronto to Newmarket 6.30 a.m., to 9.00 p.m. Half-hour service from Newmarket to Toronto 8.00 a.m., to 11.00 p.m. Hour service from Toronto to Sutton 6.30 a.m., to 11.30 a.m., and 1.30 p.m., to 8.30 p.m. Hour service from Sutton to Toronto 9.45 a.m., to 11.45 a.m., and 1.45 p.m., to 8.45 p.m.

Late Car every Wednesday and Saturday from Toronto to Newmarket and intermediate points at 11.45 p.m. Late Car every Wednesday and Saturday from Newmarket to Toronto and intermediate points at 11.00 p.m.

Schomberg and Aurora trains leave Schomberg for Schomberg Junction at 7.30 a.m., and 5.15 p.m. Schomberg and Aurora trains leave Schomberg Junction for Schomberg at 8.35 a.m., and 6.35 p.m.

on an average, about $1.81 a ton, or, allowing a probable average length of haulage of twelve miles, about 15 cents a ton-mile. During the same period, this division carried 1,520,374 passengers, while the three divisions carried a total of 3,595,892 passengers, the gross receipts from whom amounted to $282,763.02, or, approximately, eight cents per passenger carried. Assuming that the foregoing figures are correct, it appears reasonable to conclude that the majority of the passengers carried by the company are short-haul ones and that long-haulage passenger traffic on the system is hardly a paying proposition.

As a matter of general interest to interurban railway men, a table is given showing the particulars of the district through which the "Metropolitan," which is the longest electric railway in Canada, is operated:



Scarboro Bluffs.

Mimico Division.

The two main arteries in Toronto running between the east and the west and adjoining Lake Ontario are King Street and Queen Street. In the west, these two thoroughfares become one, and, at a short distance from the junction point, the Mimico division commences and thence continues westward.

Metropolitan Division Fares.

Miles.	Stations.	Single.	Return.	Excursion.	Population.
0.00	Toronto				
2.68	Glen Grove	0.05	0.10		2,500
3.75	Bedford Park	0.07	0.14		1,500
4.59	Melrose Park	0.07	0.14		...
....	York Mills P.O.	0.10	0.15		300
....	Lansing P.O.	0.10	0.15		200
....	Willowdale P.O.	0.14	0.25		200
7.44	Newton Brook P.O...	0.14	0.25		250
9.49	Thornhill	0.18	0.35		400
13.50	Richmond Hill	0.26	0.50		650
14.45	Elgin Mills	0.30	0.55		300
17.85	Bond Lake Park	0.34	0.65		...
18.68	Schomberg Junction.	0.34	0.65		100
22.33	Aurora	0.45	0.85		1,700
26.49	Newmarket	0.54	1.00		3,000
30.70	Sharon	0.60	1.15		250
33.24	Queensville	0.65	1.25		450
37.60	Ravenshoe	0.75	1.45		300
41.10	Keswick	0.80	1.55		190
42.27	Orchard Beach	0.84	1.60		...
43.96	Roche's Point	0.88	1.70		...
....	Morton Park	0.92	1.80		...
45.70	Eastbourne	0.92	1.80		...
....	Sunnyside	1.00	1.95		...
51.33	Jackson's Point	1.02	2.00		600
52.52	Sutton	1.05	2.05		600

Excursion: Special reduced rates when 100 or more passengers are guaranteed. Flat rates for private cars.

To conclude the foregoing brief account of this division, it may be mentioned that it provides employment for about 180 persons and that the method of dispatching is telephonic, carried out with a metallic circuit.

On August 17th, 1904, when the present company assumed control, this division was in operation with 5.83 miles of track and, during January of the succeeding year, an extension of 4.76 miles was commenced, the total length in operation in January, 1906, being 10.69 miles. Track construction was carried out on the highway with fifty-six and sixty-pound rails, and passenger traffic is taken care of with ten cars of the light interurban type. The method of operation is the 550-volt, single-trolley system, the power required being obtained from the Toronto Railway Company.

An interesting feature of the operation of this division is the method of dispatching. This is provided for by the installation of the Simmens Automatic System, a detailed account of which has appeared at an earlier date in the columns of The Canadian Engineer. The company's payroll shows that the number of employees on this portion of their system is 40.

Up to the present time, the Mimico division has not catered to the public for the haulage of freight, and it is doubtful if the heavy passenger traffic would allow of it unless the road were double-tracked. There is, however, quite a demand for light railway freight accommodation between the district west of Toronto and the city, which will probably be taken care of in the near future by other proposed companies.

Detailed figures in regard to the operation of this division are not obtainable because, as mentioned under the subheading of "Metropolitan Division," the accounts of the Toronto and York Radial Company are bunched together. The number of passengers carried from July 1st, 1908, to June 30th, 1909, however, amounted to 1,265,455; in regard to which, it may be said, that a considerable portion of the revenue obtained by the operation of this division is apparently due to the five-cent fares collected between the west end of the Toronto Railway Company's system and the summering and picnic points located a short distance beyond the outskirts of the city.

Owing to several agreements which are in force between various local authorities and the Toronto and York Radial Railway Company, it is not possible to give a clear and concise table of the rates for passenger traffic in force on this division, but, briefly stated, the single fare is from five to fifteen cents and the return fare from ten to thirty cents. Special excursion rates are obtainable, however, by parties guaranteeing one hundred or more fares or desiring private cars.

The following time-table is at present in force on this division:

LEAVE SUNNYSIDE

Daily—5.15, 5.30, 6.00, 6.15, 6.30, 7.00 a.m., and every 20 minutes. Last car 11.45 p.m.

Sunday—7.15, 8.00 a.m., and every 20 minutes. Last car 11.00 p.m.

LEAVE LONG BRANCH

Daily—6.00, 6.30 a.m., and every 20 minutes. Last car 12.10 p.m.

Sunday—8.30 a.m., and every 20 minutes. Last car 11.30 p.m.

RIFLE RANGES AND PORT CREDIT.

LEAVE SUNNYSIDE

Daily—5.15, 6.00 a.m., and every hour. Last car 10 p.m.

Sunday—7.15, 8.00 a.m., and every hour. Last car 10.00 p.m.

LEAVE PORT CREDIT

Daily—6.00 a.m. and every hour. Last car 11.00 p.m.

Sunday—8.00 a.m., and every hour. Last car 11.00 p.m.

(Above in effect May 15th).

SATURDAY AFTERNOONS, SUNDAYS AND HOLIDAYS.

Special service will be operated leaving Sunnyside for Humber and Long Branch every 15 minutes.

For Rifle Ranges and Port Credit every 30 minutes.

Late Car leaves Sunnyside for Rifle Ranges and Port Credit Wednesday and Saturday at 11.00 p.m.

Bond Lake.

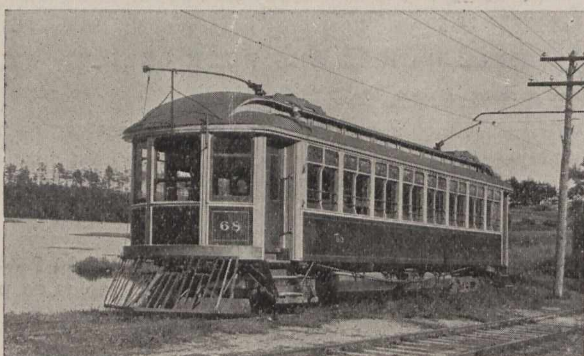
Scarboro Division.

When the consolidation in the form of the Toronto and York Radial Company was effected in 1904, this division was operating with 5.2 miles of track. During May of the following year, an extension of 5.99 miles of track was commenced and, in May of 1907, operation started with 11.19 miles of track constructed with fifty-six and sixty-pound rails on 2 miles of private right-of-way and 9.9 miles of highway.

This division, similar to the Mimico one, is operated by the 550-volt, single-trolley system, with power obtained also from the Toronto Railway Company. No provision has been made to date for freight traffic and transportation of passengers is provided for by eleven light interurban cars, the outlying district served being to the east of the city and somewhat similar to that in the west, and traversed by the Mimico division, the stations, distances and fares being given in the following table:

Scarboro Division.

Miles.	Stations.	Fares. Single.	Return.	Excursn.
....	Kingston Road and Queen Street	0.05	....	For 100 or more passengers guaranteed or for private cars.
1.68	East Toronto	0.05	....	
2.51	Hunt Club	0.05	0.10	
4.68	Halfway House	0.10	0.15	
....	Scarboro P.O.	0.15	0.25	
10.00	Highland Creek	....	....	
....	West Hill	0.20	0.30	



Standard Passenger Car.

The number of passengers carried by this division from July 1st, 1908, to June 30th, 1909, amounted to 809,570, the majority consisting of short-haul passengers on the Toronto end.

This division gives employment to 28 persons and has the following time-table at present in force:

EAST TORONTO (GERRARD AND MAIN).

LEAVE WOODBINE

Daily—6.15 a.m. and every 30 minutes. Last car 12.10 midnight.

LEAVE GERRARD AND MAIN

Daily—6.00 a.m. and every 30 minutes. Last car 12.00 midnight.

Sunday—Cars operate to Walter Street and Kingston Rd.

BIRCH CLIFF (STOP 21).

LEAVE WOODBINE

Daily—6.00 a.m. and every 30 minutes. Last car 11.30 p.m.

Later car to Hunt Club only at 12 midnight.

Sunday—8.00 a.m. and every 30 minutes. Last car 10.30 p.m.

Last Car to Walter Street only at 11.00 p.m.

LEAVE BIRCH CLIFF

Daily—6.15 a.m. and every 30 minutes. Last car 11.45 p.m.

Sunday—8.15 a.m. and every 30 minutes. Last car 10.45 p.m.

WEST HILL.

LEAVE WOODBINE

Daily—6.00 a.m. and every hour. Last car 11.00 p.m.

Sunday—8.00, 9.00, 10.00 a.m. and every 30 minutes. Last car 10.00 p.m.

LEAVE WEST HILL

Daily—5.45 a.m. and every hour. Last car 10.45 p.m.

Sunday—8.45, 9.45, 10.45 and every 30 minutes. Last car 9.45 p.m.

Wednesday and Saturday—Late car leaves Woodbine for West Hill 12.00 p.m.

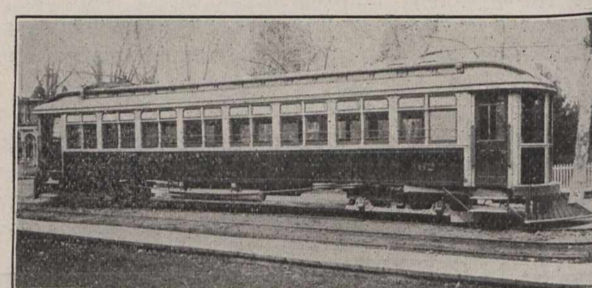
Special WEDNESDAY and SATURDAY AFTERNOON, SUNDAY and HOLIDAY Service from:

Woodbine to **Birch Cliff** every 15 minutes.

Woodbine to **West Hill** every 30 minutes.

Schomberg and Aurora Railway.

The Schomberg and Aurora Railway is a small, standard gauge steam road operated between Schomberg Junction on the Metropolitan Division of the Toronto and York Radial Railway and Schomberg, situated fifteen miles away to the north-west. 56-pound rails were used in the construction of the track and the traffic is provided for by means of one steam locomotive and two passenger cars. There are no special features pertaining to this road, and it is more than

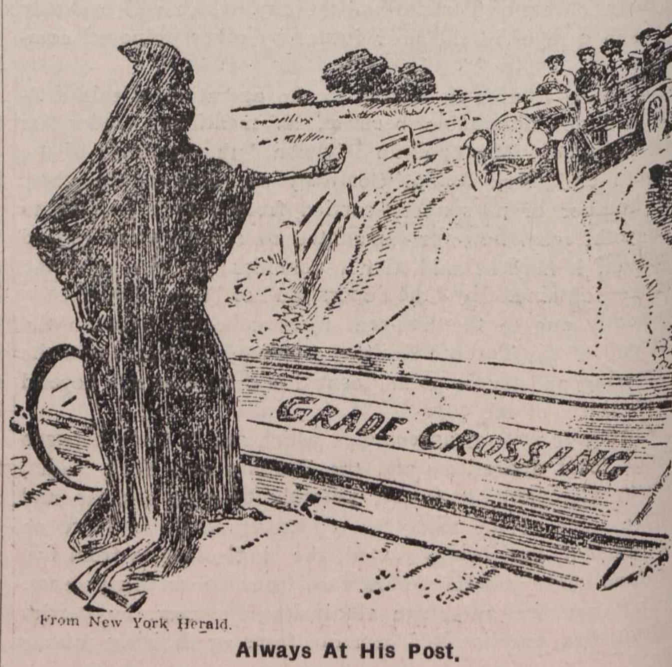


Model Passenger Coach.

probable that before many years elapse it will be electrified and become, to all intents and purposes, a portion of the Metropolitan Division of the Toronto and York Radial Railway.

The thanks of the writer are due to the following officials for the information kindly provided by them:

R. J. Fleming, Manager,
Toronto Railway Company.
W. H. Moore, Manager.
C. L. Wilson, Asst. Manager.
F. S. Livingstone, Tr. Manager,
Toronto & York Radial Railway.



From New York Herald.

Always At His Post.

SOME SUGGESTIONS AS TO THE SELECTION OR DEVELOPMENT OF A BASIS FOR A CORRECT SYSTEM OF RAILWAY SIGNALING.*

By L. R. Clausen.

The first question that may be asked is, "What is a railway signal in the ordinary meaning of the term?" It may be answered as follows: "A device used to convey certain information to a train crew to govern them in controlling the physical movement of their train." Before starting on the discussion in relation to the development of the system, or the selection of a basis for a system of signaling, certain assumptions may be made.

(1) Signals are used to a sufficient extent on practically all roads to make it necessary to have some system of signaling.

(2) In designing a system of signaling, the first question naturally is, "For what purposes do you want to use the signals?"

(3) We know from past experience that signals are required for the following purposes:

(a) Blocking or spacing of trains.

(b) Interlocking or protection of fouling points.

(c) To show the position of switches, drawbridges, etc.

(d) A variety of other purposes, such as stop signs, slow boards, etc.

The next logical step, it seems to the writer, is to make a preliminary study of the indications required, and the colors and combinations available to give them. (Definition of "Indication": The word "Indication," as used in this discussion, refers to the name or description of the signal aspect, or rather the meaning of the aspect to the engine-

*A paper read before the American Railway Engineering and Maintenance of Way Association.

(Continued on Page 380).

SPECIFICATIONS.

(Continued from Page 349).

work of any kind in connection therewith. One half the cut-off will be paid for.

40. **Rings and Shoes, How Paid For.**—Rings shall not be paid for, but shoes will be paid for at the specified rate per shoe.

SHEET PILING.

41. **Points.**—Sheet piles shall be cut at the end, so as to form a point at one side and not in the middle, and when driven, this point shall be kept next to the pile previously driven to insure contact.

42. **Broken Joints.**—Where there are two or more rows of sheet piles, they shall be driven with broken joints.

43. **How Paid For.**—Sheet piling will be paid for at the specified price per thousand feet board measure left in the work.

Masonry.

44. **Classes of Masonry.**—All stone used in the different classes of masonry must be sound hard stone free from drys and cracks, subject to the engineer's or the inspector's approval and the classes of masonry will be of the following description.

45. **First-Class Masonry.**—First-class masonry work will consist of rock faced ashlar work, laid in regular horizontal course, having parallel beds and vertical joints of not less than ten or more than thirty inches in thickness, decreasing in thickness regularly from the bottom to the top of the wall.

46. **Stretchers.**—Stretchers shall not be less than two and one-half (2½) feet nor more than six (6) feet in length, and not less than one and one-half (1½) feet in width, nor less in width than one and one-fourth (1¼) times their depth.

47. **Headers.**—Headers must not be less than three and one-half (3½) feet nor more than four and one-half (4½) feet in length where the thickness of the wall will admit of same, and not less than one and one-half (1½) feet in width, nor less in width than they are in depth of course. The beds and sides of the stones shall be cut before being placed on the work, so as to form the joints not exceeding one-half (½) inch in width. Every stone must be laid on its natural bed, and all stones must have their beds well dressed parallel and true to the proper line, and made always as large as the stone will admit of. The vertical joints of the face must not be less than eight (8) inches in from the face, and as much more as the stone will admit of, all corners and batter lines to be run to neat line and the projections of the rock faces must not exceed four (4) inches beyond the face or draft lines of the masonry. The masonry shall consist of headers and stretches alternating so that at least one-fourth of it shall consist of headers extending entirely through the wall, and every header shall be immediately over a stretcher of the underlying course; the stones of each course shall be so arranged as to form a proper bond with the stones of the underlying course, and a bond of less than one foot will in no case be allowed. The whole of the masonry must be laid in good cement mortar and each course shall be thoroughly grouted before the next course is laid, and no hammering will be allowed on the wall after the course is set; if any inequalities occur they must be carefully pointed off.

48. **Backing.**—The backing shall be of good size, well-shaped stones, laid so as to break joints and thoroughly bond the work in all directions, and leave no space between them over six (6) inches wide, which spaces shall be filled with small stones and spawls well grouted.

49. **Foundation Courses.**—All foundation courses must be laid with well selected, large flat stones, not less than twelve (12) inches in thickness, nor of less superficial surface than fifteen (15) square feet.

50. **Bridge Seats and Tops.**—All bridge seats shall be bush hammered to receive bed plates. All tops of walls shall be finished with a coping course of such dimensions and projections as the plans of the engineer may require. Dressed and cut to a true surface on top and front edges, in conformity with diagram for same which will be furnished by the engineer.

51. **Second-Class Masonry** shall consist of broken or random ranged rock work of the best description. The face stones shall be dressed to their uniform thickness throughout before being laid, but not hammered, and shall be laid with horizontal beds and vertical joints on the face. No stones shall be less than eight (8) inches in thickness. There shall be at least one header to every three stretchers, and both header and stretcher shall not be less than three (3) feet in length, and fifteen (15) inches in width where the thickness of the work will permit.

Mortar joints shall not exceed three-quarters (¾) of an inch in thickness. All corners and quoins shall have hammered dressed beds and joints. All corner and batter lines to be run to a neat line. The vertical joints of the face must be in contact at least eight (8) inches, measured in from the face, and as much as the stone will admit of. The work need not be laid up in regular courses, but shall be well bonded. The stone shall be cleaned and dampened before setting, and shall be laid in cement mortar. Bridge seats and tops of wall are to be coped in the same manner as specified for the first-class masonry. Stones in foundation courses shall not be less than twelve (12) inches in thickness and contain not less than twelve (12) square feet of surface.

52. **Third-Class Masonry** will consist of good substantial rubble work, laid in cement mortar; all stones to be perfectly sound, laid on their natural beds and sufficiently large to make good, well-bonded, strong work, and to be laid in the most substantial manner with as much neatness as this description of work admits of. The stones in the foundations must be not less than ten (10) inches in thickness, and shall contain not less than ten (10) square feet of surface, and each be firmly, solidly and carefully laid.

53. **Dry Masonry.**—Box culverts shall be of good rubble masonry, neatly laid up dry with square shaped stones of a size and quality approved by and satisfactory to the engineer.

When box culverts are ordered to be laid up in cement mortar, they will be classified as third-class masonry, and must conform to the specifications for the same. The covering stone for all box culverts shall be not less than ten (10) inches in thickness for two feet culverts, twelve (12) inches for three feet culverts, and fifteen (15) inches for four feet culverts, and must have a good solid, well-levelled bearing on the side wall of not less than fifteen (15) inches for two and three foot culverts or eighteen (18) inches for four (4) foot culverts. Side walls for masonry box culverts will be of a thickness directed by the engineer.

54. **Drain Pipes.**—When so ordered by the engineer sizes of twelve, eighteen and twenty-four (12, 18 and 24) inch diameter may be used and the quality must be the best double strength, vitrified pipe, subject to the approval of the engineer. Drain pipes must be well and carefully bedded and laid in accordance to the instructions of the engineer.

55. **Retaining Walls.**—Retaining walls will be classified as second or third-class masonry laid dry, as may be ordered in each particular case.

56. **Stone Paving.**—Paving for culverts and other water courses will be made by setting stone on edge from eight (8) to fifteen (15) inches in depth, laid either dry or grouted with strong cement mortar as may be directed by the engineer.

57. **Pointing.**—All masonry must be neatly pointed with cement mortar in proportions of one of sand to one of cement.

Foundations.

58. **Excavations.**—Foundations for masonry shall be excavated to such level depths as may be necessary to secure a solid bearing for the masonry of which the engineer shall be the judge.

59. **Classification of Material Excavated.**—The material excavated will be classified and paid for as provided for in these specifications, under the head of excavations and foundations. This does not include box culverts or timber bridge foundations.

60. **Artificial Foundations.**—When a safe and solid foundation for masonry cannot be found at a reasonable depth (to be judged by the engineer) there will be prepared by the contractor such artificial foundations as the engineer may direct.

61. **Excavated Material Deposited.**—All material taken from excavations for foundations, if of proper quality shall be deposited in the contiguous embankments, but any material unfit for such purpose shall be deposited outside the roadway or in such place as the engineer shall direct, and so that it shall not interfere with any drain or water course.

62. **Timber Foundations.**—Timber foundations when required shall be such as the engineer may by drawing or otherwise describe and will be paid for per thousand feet board measure, as timber in foundations. The price covering cost of material, manufacture and placing in the work according to plans and directions.

All timber for foundations must be sound, straight-grained pine or hemlock, free from sap and defects that would impair its strength or durability. It must be sawn straight and to full dimensions with full corners and square edges; all framing must be done in a thoroughly workman-like manner, and both material and workmanship shall be subject to the inspection and acceptance of the engineer.

63. **Cofferdams and Concrete in Foundations.**—Where cofferdams are in the opinion of the engineer necessary the prices provided for timber, piles, and iron in foundations will be allowed for the material and work of placing same, which is understood as covering all risks from high water and otherwise and draining, bailing and pumping, and all other material and labor connected with the cofferdam.

Detailed plans for such work, including caissons, should any be required, will be furnished by the engineer. Where concrete is used in foundations it shall be of the quality specified under specifications for concrete attached, all in accordance with the plans and special instructions furnished by the engineer.

64. **Excavations in Foundations.**—Excavations in foundations other than box culverts and timber bridges, will be classified as follows:

Earth excavated dry, per cubic yard.
Loose rock excavated dry, per cubic yard.
Solid rock excavated dry, per cubic yard.
Earth excavated in water, per cubic yard.
Loose rock excavated in water, per cubic yard.
Solid rock excavated in water, per cubic yard.

Timber Structures.

65. **To be Built to Plans.**—All structures must be built in strict accordance with the general or special plans.

66. **Timber.**—All timber must be of the best description of the kind required. It must be sawn square and to proper dimensions. It must be free from all loose, large, or unsound knots, sap, sun cracks, shakes, wanes, or other imperfections or defects which would impair its strength or durability.

The timber used for each portion of the structure must be cut from wood, as specified or approved by the engineer.

67. **Clearing Ground.**—Before commencing work on any wooden structure, the ground must be entirely cleared of logs, brush and trees for the whole of the width of the right of way, and during the progress of the work, all pile and timber ends, chips and brush, shall be cleared from around the structure and burnt, or otherwise disposed of as the engineer may direct.

68. **Framing.**—No shimming will be permitted. Great care must be taken in framing all timber structures, to insure a perfect fit at all joints. At the completion of the work they must be left in perfect line and surface.

70. **Erection of Bridges Ahead of Track.**—Bridges must be erected ahead of the track in all cases where not specially excepted, but the maximum distance beyond the end of track to which the contractor shall be required to haul material without extra payment, shall not exceed four miles.

SOME SUGGESTIONS AS TO THE SELECTION OR DEVELOPMENT OF A BASIS FOR A CORRECT SYSTEM OF RAILWAY SIGNALING.

(Continued from Page 376).

man. The word "Aspect," as used in this discussion, refers to the picture that the signal presents to the engineman.)

Such preliminary study has been made by most Signal Engineers, and that result is that forty or more indications have been found desirable by some. A brief trial in providing this number of indications, or even half the number with aspects, from the customary semaphore (or its practical modifications) will, the writer believes, convince anyone that without some system, nothing but a conglomeration of aspects, wholly impractical, can result.

This brings us to the selection of some kind of a basis in working out a system of proper indications for a practical signaling system. It is obvious that a number of different schemes can be used for subdividing and building up a list of requisite indications. For example:

(1) Signals may be classed as those relating to tracks, and those relating to trains; or

(2) Those restricting rights and those conveying information.

Many opinions can be advanced, and many have been advanced, on this question. The writer's personal opinion, however, from what study he has given the subject, is that the only proper basis for a signal system is the control of the physical movement of the train.

If this latter basis is used in selecting indications, except as explained below, but three indications are necessary. Generally speaking, and except as explained below, but three actions can be taken to fully control the physical movement of a train in motion:

(1) It can be stopped.

(2) It can be allowed to proceed.

(3) Its speed can be restricted for a greater or less distance.

From this it follows that but three signal indications are necessary:

(1) Stop.

(2) Proceed.

(3) Reduce Speed.

Some roads may require, for convenient operation, two reduce-speed indications. If so, a fourth indication would be required. Again, no reference has been made to diverting trains to other tracks, which, however, can safely be done on the reduce-speed indication. Some roads may require separate indications for this purpose, but they are not absolutely necessary and, therefore, a part of the signal system just outlined, which is complete without them. The basis above referred to, the writer believes to be the only correct one, as it strikes at the very result we are trying to accomplish, namely, the control of the physical movement of the train.

The system outlined is complete and sufficient for any railroad, provided, however, that there is no overlapping of signal functions or indications, and each signal reads to the next. Experience has shown us that it is practically impossible at the present time to so signal a railroad that each signal will always read to the next. For example, we have non-block interlocking stations in the middle of manual block sections, and many other conditions of overlapping indications we can all think of with a few moments' study. It is manifestly then a question of providing for Overlapping Indications. Overlapping indications constitute the obstacle to the success of the simple signal system outlined above.

The overlapping indications met with in practice to-day, and which probably will be met with for years to come, make it necessary for us to make further distinctions in signal aspects, and therefore further indications. Right here is where extreme caution is required in further enlarging the signal system. The question is, "What further distinctions shall be made, and what further signal indications shall be used to provide against overlapping indications?" It is the writer's personal opinion that whatever distinctions are made they should be so made as not to interfere with the basis of the system referred to above. Here again we are confronted with the fact that if a different indication, or set of indications, is used for each particular purpose for which railway signals are used, entirely too many indications will be the result. A broader and more general classification should be made, something that will result in fewer indications. It should be remembered that the chances of an engineer making a mistake in interpreting signal aspects increase rapidly with the increased number of aspects, and possibly vary directly as the square of the number of aspects.

It is obvious that there are many ways of making distinctions in signal indications or aspects, and the question may be summed up as follows: Shall we make each signal for a special purpose distinct by special indication and aspect, and thereby have no overlapping indications, but a large number of indications, or shall we make a broader classification with a considerably smaller number of indications (and therefore aspects) and avoid overlapping indications, by combining the functions of the signals themselves? The writer believes that the latter is the proper course, in view of the excessive number of indications and aspects resulting from the former course. Assuming that the latter course is the proper one, the question is, "What broad classification shall we use?" A study of the conditions and the available number of safe aspects leads to the belief that the distinctions should be made according to the methods of operation of the signals themselves in ordinary road operation as follows:

Class 1. Signals operated by attendants.
Class 2. Signals operated automatically.
Class 3. Signals located to show conditions of track or to mark physical characteristics of the road, such as switchstands, stop signs, etc.

The writer advocates the broad basis described above, for the reason that no other classification or methods of distinctions which have come to his notice seem to be proper, and certainly our experience with them to date has shown that it is impossible for signal engineers to agree on the necessary or requisite indications under any of the classifications that have been suggested to date. The writer also advocates this classification for the reason that it seems to aim at the proper result, which is, the control of the physical movement of the train.

LOCOMOTIVE SHOP REPAIR JIGS.

Repairing locomotives is a very different proposition from almost any other work I know of, and requires different treatment, says a writer in the American Machinist. Micrometers are an unknown quantity in most of the work, yet the results are probably as good as can be expected, when the service is considered. Side rods must have play on the pins, both as to diameter and end movement, varying from 1-64 to 1-32 inch, because the different crank pins are almost never in line on account of frogs, switches and high and low spots in the track. But the main rod has to be as close as it will run cool, on account of pounding out the brass, to say nothing of the noise.

Rebolting a Frame.

When an engine comes in for general repairs and the frame bolts have to be driven out, it's a case of new bolts when the engine is put together again. These bolts have a taper body and drive into the reamed taper holes of the frame. The taper is usually 1-16 inch to the front.

This is usually a case of fitting each bolt to its place, as the holes are just cleaned up with the reamer in the air drill. This fitting has to be well done, as it is very important that they should not work loose.

To do this rapidly, the foreman in charge of this work at the East Buffalo shops of the Delaware, Lackawanna & Western Road has a portable outfit which he sets down near the track the engine is on. This outfit consists of a lathe, a centering machine, and a grinding wheel for sharpening tools, all tied together on base and driven by an independent motor.

A bright boy completes the outfit and the combination gives star performances when it comes to fitting up a locomotive frame with new bolts. The bolts are centred, and the ends all threaded to standard size before the frame has been reamed, and as soon as a few holes are ready the boy gets busy.

He sets a pair of inside calipers to both ends of the first hole to be sure and get the right taper set in the lathe, then he starts in, only measuring one end of the rest of the holes, and turns each bolt to fit its hole. There is no micrometer about it; he just sets his outside calipers by the inside calipers set to the hole, measures by "feel" in the old fashioned way, and does a good job in a lathe that had seen hard service long before it joined the bolt-turning outfit.

Detecting Cracks in Frames, Rods and Axles.

Every railroad shop has its hair-raising story of axles that have dropped in two on the turntable after a hard run and other cases, all depriving the yellow journals from a prominent display of scare headlines about another wreck, and the best or worse of it is they are true. In no place is the effect of constant vibration better shown than in railroad service, the most prominent defects occurring in frames, rods and axles, all of which are hard to detect unless they are very pronounced. The hammer test helps in many cases where the man is trained for the work, but even this is not infallible.

The master mechanic at these shops, B. H. Hawkins, has introduced a method that is at once simple and efficient whether it is original or not. When an engine comes in for repairs and is stripped, the frames, axles and rods are given a coat of a white water paint. This dries in about an hour and does not rub off readily.

Then, as the wheels are turned up in the lathe, or the frames and rods worked on in any way, or even without it, the oil and dirt that are in any crack in these parts work through this paint and show a dark streak so plainly that it cannot be mistaken. At the time of my visit a driving axle had just been discarded, owing to a slight crack just starting from the round corner of a keyway for the eccentric, and which would never have been discovered in any other way.

The same thing holds good in the other parts, and cracks are constantly discovered that might cause accidents later had they not been found. So a little white paint is probably a life saver when applied in this way.

Boring and Facing Driving Boxes.

Two Bullard vertical lathes or boring mills with a side tool carriage or head, are in use here doing all sorts of face-plate work. The way in which driving boxes are bored is interesting as showing the use to which the side head is put as well as the method of holding and boring.

The lower place or fixture is bolted to the face-plate, and the driving boxes fit in this and are easily centred and set. A mole in the centre of this plate forms a guide for the pilot on the boring bar, holding it steady in its work and insuring a straight cut as well as making high speed possible.

At the same time the side head comes in and faces off the hub lining so that no extra time is required for this work. It makes a neat way of handling work of this kind.

Babbitting Crossheads.

They have the simplest form of babbitting jigs I have seen, and they do the work in good shape. They depend on the faces XX of the crossheads being planed alike in all cases so far as the distance from one guide to the other is concerned, as well as being the same width on the outside. This allows the fixtures or jigs to be held on the crossheads by the simple clamps, shown at the side, and the babbitt fills the opening between the two, being retained at the bottom by an asbestos sheet or pad on which it rests. The crossheads are tinned beforehand, being heated by an oil torch for this purpose.

There are several sets of these jigs of different widths to allow for guides being planed down on the sides to true them up at different times. These cost very little to make and have been handling all the babbitting done here for some time.

THE CANADIAN GOVERNMENT'S RAILWAYS.

A Magnificent System.

The Intercolonial is frequently called the People's Railway, because it is the one great railway system in the Dominion which is not owned or controlled by a corporation or company, but from the beginning has been constructed owned and operated by the Government for the people of Canada.

The Canadian Government Railway system also includes the Prince Edward Island Railway. This Railway traverses the entire length of the Island Province from Tignish in the west to Souris in the east, with branches to Cape Traverse, Murray Harbor, Georgetown and Montague, in fact so well served is the island by the railway that no portion of it is more than fifteen miles distant from the main line or its branches.

(Continued on page 115.)

(Continued from Page 327).

CANADIAN NORTHERN RAILWAY.

In 1896, Mr. Wm. Mackenzie and Mr. D. D. Mann, two railway contractors, who had been partners for ten years, purchased the Lake Manitoba Railway and Canal Company's charter, and built 100 miles of railway under it. Some extensions were built, and in 1889 a line from Winnipeg to Lake Superior was begun. In 1902 the Manitoba lines of the Northern Pacific were leased, they being exceptionally valuable to the then rapidly growing railway on account of the terminal facilities in Winnipeg. In the same year the road from Winnipeg to Port Arthur was completed. In 1905 the line westerly to Edmonton was finished, passing through a magnificent agricultural territory hitherto without any railroad facilities. It is interesting to note that this line is located 290 miles north of the International Boundary, as noted earlier in this article. British engineers in 1874 were of the opinion that it was an utter impossibility to construct a transcontinental line of railway north of the International boundary line. In 1906 double entrance was gained to Prince Albert.

During the past year work on the line from Saskatoon to Calgary has been rushed ahead, about 200 miles of which are completed.

In British Columbia work on the Vancouver-Edmonton line has commenced, and will be pushed ahead as rapidly as men and supplies can be procured. This will be, without doubt, the best location through the Rocky Mountains, passing westerly from Edmonton through the Yellowhead Pass down the North Thomson River to Lytton, thence following the Fraser to Yale, and on to Vancouver, the best Pacific seaport on Canadian territory.

While 3,500 miles of track have been secured in the West, the elements of a transcontinental have been secured in the East. The Canadian Northern Ontario has been built for 300 miles from Toronto to the Moose Mountain iron mines, which via Key Harbor, a new port on Georgian Bay, will give Cleveland and Pittsburg an additional unlimited supply of first-class iron ore five hundred miles nearer than that which comes through Duluth.

About one hundred miles of the line from Toronto to Ottawa will be in operation by next spring, and construction work on the balance commenced.

The Canadian Northern Quebec gives Ottawa a new connection with Montreal and Quebec. With the governance of the Quebec and Lake St. John Railway have come first-rate terminal facilities on the St. Lawrence, and access to the greatest pulp-wood forests in America. In Nova Scotia, 431 miles of line have opened up the ocean shore between Halifax and Yarmouth; and have tapped great coal deposits in Cape Breton Island. This year two magnificent steamers, the "Royal Edward" and "Royal George," were placed in commission, plying between Bristol and Montreal. The first train in this system ran on December 19th, 1896. In the first year the gross earnings were $60,000. The staff totalled about twenty. West of Port Arthur alone the earnings are now on a basis of $10,000,000 per annum, and 10,700 people are on the regular pay-roll.

The growth of this wonderful system of railways has been phenomenal, due in a great measure to the far-sightedness and indefatigable energy of the promoters, Mr. Wm. Mackenzie and Mr. D. D. Mann.

NATIONAL TRANSCONTINENTAL RAILWAY.

Under an agreement with the Dominion Government, dated July 29th, 1903, and under a modifying agreement, dated February 18th, 1904, ratified by the Act of that year, the Grand Trunk Pacific Railway Company have undertaken the construction of a line of railway wholly upon Canadian territory, between the city of Moncton, in the Province of New Brunswick, and the navigable waters of the Pacific Ocean, at or near Port Simpson, or some other port in British Columbia. Prince Rupert, situated 550 miles north of Vancouver, has been decided on as the western terminus. The railway is composed of two divisions, namely, the eastern division, between Moncton and Quebec, thence westerly through the northern part of the Provinces of Quebec and Ontario, and in the Province of Manitoba to the city of Winnipeg, 1,800 miles, and the western division, between Winnipeg and the Pacific Ocean, 1,760 miles. The eastern division is being constructed by the Government under four commissioners, appointed by Governor-in-Council, under the name of "The Commissioners of the Transcontinental Railway," and on completion is to be leased to, and maintained and operated by the company who undertake to construct at their own cost and to maintain and operate the western division. The lease of the eastern division is to be for a period of 50 years, at a rental of 3 per cent. per annum upon the cost of its construction; the first seven years to be free of rent. Both divisions are to be equipped by the company.

By way of assistance to the company in the construction of the western division it is provided that the Government shall guarantee payment of the principal and interest of an issue of bonds to be made by the company for an amount sufficient to produce a sum equal to 75 per cent. of the cost of its construction, such amount not to exceed $13,000 per mile, in respect to the prairie section, from Winnipeg to the eastern limit of the Rocky Mountains.

A subsidiary company was incorporated by Act of Parliament in 1906, under the name of the Grand Trunk Pacific Branch Lines Company, having as its object the construction of various branch lines, or feeders to the main line, as above described. Charters have been obtained for branch lines to Brandon, Regina, Prince Albert, and Calgary, and to Dawson City, in the Yukon Territory. Work has been pushed rapidly and a freight and passenger service has been inaugurated between Winnipeg and Edmonton. The construction of the railway easterly from Prince Rupert has been under way since the first part of 1908.

Yellowhead Pass has been selected as the route through the Rocky Mountains, and better gradients have been obtained than were possible through the Kicking Horse, Peace River or Pine River Passes. On the eastern or Government section, the work is proceeding rapidly, and the Moncton-Quebec portion is nearing completion.

The cost of the eastern section has greatly exceeded the estimates, due principally to the increased cost of labor and materials.

From Quebec to Winnipeg the line traverses an almost unsettled country which, however, is rich in timber and minerals, and a great portion of it suitable for agriculture.

Notwithstanding all that has been done in the past, as Sir Wilfrid Laurier has stated on more than one occasion on his recent tour through Western Canada, this vast territory, comprising the Dominion of Canada, must have more railways; without railways we cannot develop. Settlers from the British Isles and United States are pouring into the country, and facilities must be provided to enable them to convey their crops to European markets.

There is undoubtedly immense areas of fertile land suitable for agriculture hundreds of miles north of the present railways, which will be rapidly taken up when transportation facilities are afforded.