

a road 78 miles long, with 2,211,000 train miles per year, meant a total in one year's operation of \$174,890.

When steam was used 60 locomotives were required, since 20 per cent. of this number were continually undergoing repairs, or otherwise out of service, and 11 per cent. of the number were required for switch service, so that only 43 out of 60 locomotives were required for the revenue bearing service. Only 28 electric locomotives would be required on the line, six being of the 60-ton passenger type and 22 of the 90-ton freight type. The electric locomotive is much less liable to get out of order than the steam locomotive. The decrease in the cost of operation would give an additional dividend of about 7 per cent. over and above the 4 per cent. interest charged on the capital invested when electrifying the road. Here is a comparison of detailed cost per revenue train mile:—

	Steam. Cents.	Electric. Cents.
Repairs to locomotives	8.32	1.67
Wages, engineers and firemen	8.75	
Wages, roundhousemen	1.62	
Wages, motormen and helpers		5.38
Roundhouse expenses	0.31	
Roundhouse and shop, repairs and re- newals	1.07	1.25
Shop expenses	0.20	
Shop machinery and tools, repairs and renewals	0.91	
Fuel	9.77	
Fuel-station operation	0.28	
Water supply	0.31	
Fuel and water station, repairs and re- newals	0.26	
Power delivered at locomotive		17.62
Oil, waste, grease, and supplies	0.99	0.23
Interest	1.41	9.76
Insurance and risks	0.53	0.63
Depreciation	2.12	1.40
Total	36.85	28.94

The dominating factor in this comparison is, of course, the price of power. Coal costs this railroad company only \$1 per ton. The cost of generation per kilowatt hour is .46130 cent, and for distribution .2550 cent, or a total, delivered at the locomotive, of .71630 cent per kilowatt hour. The farther a railroad is from the coal supply the more costly will its electricity be; but, of course, that will make no difference to the gain arising from the supersession of steam, because the coal has to be hauled to the place of consumption whatever the ultimate motive power.

The figures given would not apply minutely, of course, to Canadian conditions. But Canadian railways, speaking broadly, have advantages with regard to electrification over those of most other countries. We have unequalled water powers available, not only in the country contiguous to Niagara, but over the greater part of the territory likely to be traversed by railroads. Indeed, with improvements in long distance transmission it may presently be a simple matter to transmit power from the Winnipeg River more than half-way to the Rocky Mountains, and to utilize some of the mountain torrents for power, to be sent eastward to the limit of transmission from the eastern supplies of energy.

The electrification of steam railroads is predominantly a question of finance. The electrician and the engineer will increase the efficiency and economy of existing methods. But it is just on this certainty of improvement that the apparent hesitancy of railroad chiefs is founded. Besides the scrapping of enormous quantities of steam plant and its accessories there is the unknown factor of electrical improvement likely to involve the scrapping of enormous quantities of electrical plant, which Mr. Moyes, of Toronto, who has had great experience in operating electrical systems, describes as "Obsolescence." Street railway men are finding that in calculations made in the infancy of their enterprises they did not allow sufficiently for changes in equipment;

for charges likely to arise from electrolysis and a dozen other things which, absent from the childhood of an industry, may become as permanently costly with maturity, say, as shaving is to a man.

It is possible to buy secondhand electric cars in good running condition at very low prices, simply because they have been put out of business by larger and more economically managed conveyances. Of course, there will not be an indefinite enlargement of cars; but it is impossible to set a bound to the changes, more or less expensive and revolutionary, which may, within the next decade, upset the best-based calculations.

Take one aspect of the chances of obsolescence. Messrs. Stillwell & Putnam have recently presented to the American Institute a paper on "The Substitution of the Electric Motor for the Steam Locomotive," in which the standpoint is taken that the single-phase system is the only one worthy of consideration for railway electrification, and the suggestion is made that in ten years from now the 1,200 volt or 1,500 volt continuous current systems, which have been suggested as substitutes for larger potential alternating current systems in heavy electric traction, will be virtually extinct. The implied prophecy has produced an article by H. M. Hobart in the Engineering Supplement of the London Times, which predicts that within ten years continuous current systems, as applied to railway electrification, will employ line pressures up to 3,000 volts, the single-phase "delusion" having meanwhile been exposed and the system discredited, at the expense of the capitalists who will have been induced to utilize it.

The single-phase apparatus will require for 300 passengers travelling at a speed of 25 miles per hour, with one stop per mile, a train weighing 550,000 pounds, against a train of half the weight, if it is equipped for continuous current operation; and the average consumption under single-phase conditions will be twice as heavy, and the brake equipment, maintenance, and the wear and tear on the roadbed much greater than where the continuous current prevails. But Mr. Hobart, champion of the continuous current though he is, considers it possible that an efficient and satisfactory single-phase motor may in the near future put in its appearance.

It is just because nobody knows what the electrician will accomplish next that on the steam railroad, at least, he is regarded as an object of veneration, amounting almost to suspicion. Whatever happens, there is no subject of more absorbing interest to the engineer and business man, who watch the development of industrial methods, than the possibility of eliminating smoke and cinders from land travel.

THE PRICE OF EXPANSION.

There is to engineers a consolatory element in the deplorable railway situation in the West. For years the demand for equipment has exceeded the expectation of the extreme optimists of a decade ago. But the position to-day only reveals the inadequacy of contractors' facilities to supply equipment. The position is an incitement to patience—and to production.

To patience, because the railroads have done their best. If they laid out a bigger programme than they could immediately carry out, they have only done what most of us do at some time or other. The more unfortunate system is the Canadian Northern. If the C.N.R. were an old company, operating through well-settled country, there would, of course, be no excuse for it. But the wonder is, not that the C.N.R. has been unequal to the unprecedented conditions, but that it is there at all. It is true, of course, that the governing powers in the Canadian Northern are more skilled in laying track than they are in accommodating traffic. Looked at from to-day's viewpoint, the acquisition of the Regina to Prince Albert line was an unfortunate