

roundhouses have disappeared along with their staffs, and one electrician replaces the whole old force. An electric locomotive has made 9,052 miles in one month. Although schedules have been reduced the electricians have made up more than two and one-half times as many minutes as steam engines—time which had been lost on other divisions; 29 per cent. of electric passenger trains made up time in this manner. On a mileage basis alone the operating costs of the electricians are less than one-half the steam engine costs. Freight traffic increased 40 per cent. shortly after electrification—double-tracking would have been necessary to handle such increased business under steam operation. An average increase of 22 per cent. in freight tonnage per train has taken place. One electric handles about three and one-half times as many ton-miles as a steam engine; the reduction in time in handling a ton-mile is 30 per cent.; faster and heavier trains have accomplished these results, the number of trains has not been increased. About 11½ per cent. of the energy used by the railway is returned to the line in the process of regenerative braking and this returned energy helps to haul other trains. While this is a very important item and reduces the power bills, it is only regarded by the management as of secondary importance in comparison with the more safe and easy operation of trains on the grades and the elimination of former delays for changing brake shoes and repairs to brake rigging, when operating with steam locomotives.

The electricians maintain their schedules much better than steam engines. In three months the electricians only waited for the right-of-way 254 minutes, while the steam engines in a similar period waited 1,910 minutes, or seven and one-half times as long. Extra cars on trains only delayed electricians one-ninth of the time steam trains were delayed for a similar reason. Cold weather delayed steam trains 445 minutes in the three months under discussion, but the electricians were not delayed a minute; the latter are more efficient in cold weather. Many of the delayed steam trains were double-headers—never more than one electric is hitched to a passenger train. An entire suspension of freight service, due to steam engines losing their steaming capacity and freezing up was not an uncommon experience. Electrical energy for the operation of these trains costs considerably less than coal. This latter statement is one of the most interesting in connection with the operation of the C. M. & St. P. Railway and it is especially interesting because it was made more than one year ago.

The foregoing experiences of men who are actually operating large railway electrification projects, show what the electric locomotive is doing every day. As the vice-president of the last-mentioned railway said, "Electrification has made us forget that there is a continental divide."

The limitations of the steam locomotive are due to the fact that it is a mobile steam power plant of very limited capacity, compelled to carry its own supply of coal and water, and unable to take advantage of many of the economical refinements of the large modern stationary steam plant. On the other hand, the electric locomotive has no such limitations. It merely acts as a connecting link between efficient gigantic stationary steam or water power plants and the train to which it is connected. The "Electrical World" summed up the situation a short time ago when it said: "Why continue to haul millions of tons of coal, for and by uneconomical steam locomotives, all over the country, and thus add more loads to the already over-burdened railways, when the power which they need so badly can be much more economically and efficiently transmitted to electric locomotives over a wire the size of one's little finger?"

The continual increasing cost of coal and fuel oil will force railway managers to look more and more carefully into railway electrification. Estimates of a few years ago now need revision. Money may be hard to get, but if, at times, fuel cannot be obtained at all, some substitute must be obtained if normal life is to be continued in northern latitudes.

A representative of the National City Bank of New York, writing of the period after the war, referred to the stagnation which may ensue in all the great industries now engaged in war work as soon as peace is declared; the multitude of people thus thrown out of work in addition to the men of the returning armies would create unbearable conditions unless suitable employment will have been arranged for them in advance. He referred to the economic advantages of railway electrification and was of opinion that this work might solve the whole question if soon taken up with vigor.

The Minister of Public Works, Hon. F. B. Carvell, M.P., addressing the Ottawa branch of our organization a couple of weeks ago, spoke of the necessity of conserving the energy of our water powers—instead of letting them run to waste—so that this great store of energy might be employed in assisting to build up our own and rebuild other countries when peace comes. How nicely these two ideas, water power development and railway electrification, work together if properly carried out.

With the view of securing something really worthy of presentation to this important meeting, I recently wrote an eminent engineer, a man of international fame, and recognized as an authority on railway electrification, requesting him to tell me his own views upon this subject. A specialist's opinion, in my opinion, is always very valuable. Here is a short extract from his interesting reply: "Generalization is always dangerous, especially in connection with electrification of railways, where so many factors such as the physical location, character of loads, the power situation, etc., come in to affect the decision if applied locally." From his sober statement it may be seen that my correspondent is an engineer, not a politician. He proceeded as follows: "... with present equipment-prices, the cost is absolutely prohibitive." This opinion, let me point out, is in connection with the proposal to "electrify everything." Do not let it dampen our enthusiasm. Listen to this also and kindly keep it in mind; it is another extract from the address of E. W. Rice, above referred to. He said: "I think we can demonstrate that there is no other way known to us by which the railroad problem facing the country can be as quickly and as cheaply solved as by electrification."

While the present fuel shortage questions have made us look to railway electrification for relief, I feel such a project on a large scale can only follow or go hand in hand with power plant development and co-operative operation of power plants. The location of a number of plants at different points—large water power plants and auxiliary steam plants—so situated and inter-connected that a failure at one plant or the connections to it will not jeopardize the others or completely cut off and isolate an important railway district is, in my opinion, an essential feature in connection with any large railway electrification project.

The 99-year contract of the Chicago, Milwaukee & St. Paul Railway is worthy of more than a moment's attention and consideration in this discussion. That railway has a contract with a power company which has a series of plants stretching across the country parallel to the railway. The railway owns its sub-stations and