# Railway Electrification.

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Still smarting from the sufferings of two successive winters' fuel shortages, caused by inadequate transportation facilities, we are foregathered to see what can and should be done to prevent, if possible, recurrences of such serious and trying experiences. No argument is required to support the contention that eliminating the need for coal at a considerable distance from the mine is a greater measure of relief, and of true conservation, than increasing mine production and thereby incidentally adding more load to the already overburdened railways. Reducing coal consumption automatically relieves or releases men and apparatus all along the route from the mine to the consumer; it also relieves the route itself from some of its congestion. So eminent an authority as E. W. Rice, President of the American Institute of Electrical Engineers, addressing that body in New York recently, made the following statement:—

"It is really terrifying to realize that 25% of the total amount of coal which we are digging from the earth is burned to operate our steam railways—and burned under such inefficient conditions that an average of at least 6 lb. of coal is required per horsepower hour of work performed. The same amount of coal, burned in a modern central power station, would produce an equivalent of three times that amount of power in the motors of an electric locomotive, even including all the losses of generation and transmission from the power station to the locomotive."

Mr. Rice went on to say that 150,000,000 tons of coal, nearly 25%., of all the coal mined in the U.S., were consumed in steam locomotives last year. Here, in Canada, steam locomotives also did their bit and consumed about 9,000,000 tons; 30% of the 30,000,000 tons of coal imported into and mined in this country. Our 9,000.000 tons cover, I believe, wood and oil onsumed on steam locomotives; some 49.000,000 gall. of oil are covered by the Canadian record. But in the U.S. figures, 40,000,000 barrels of oil (15% of the total output) are not included.

The conservation of—the elimination of the necessity for mining—those great quantities of fuel would be secured if all the railways were operated electrically, and if the electrical energy were generated from water power. Modern steam central stations would save from 50 to 66% of the coal now used in steam locomotives if the latter were discarded and electric locomotives used instead. With such possibilities for fuel conservation in sight may we not soon expect to learn that the fuel controllers in both countries have asked the railways, and that the railways managers have asked their engineers: "How many of these millions of tons of coal can you save? When will the good work begin?"

It is said that our fuel shortages were due to a combination of bad weather and inadequate transportation. As we cannot control the weather, our attention and efforts must be directed to the transportation portion of the difficulty. Railway electrification will reduce coal consumption and haulage; it will also greatly improve traffic conditions. Electrification, therefore, seems to be the solution of the problem. Under these circumstances it may not be out of place to recite in general terms what electrification has actually accomplished on some notable railways. Railroading in the mountains is the most strenuous kind of railway work. The examples which I have chosen cover mountain sections. The Butte, Anaconda and Pacific Ry., by electrification, increased its ton mileage 35%., and at the same time decreased the number of trains, and its incidental expenses, 25%. The time per trip was decreased 27%. It is said the savings in the first year's operation, after electrification, amounted to 20% of the total cost of electrification. It buys power from water power plants.

On the Norfolk & Western Ry., power is obtained from its own steam station. Twelve electric locomotives have replaced 33 Mallets of the most modern and powerful type. The tonnage has been increased 50%. Electrification obviated the necessity for double tracking. The salvage value of the released steam locomotives was 45% of the cost of electrification. Electric locomotives make eight times as many miles per train minute delay as the steam ones. Their terminal lay overs average 45 minutes and they are double crewed every 24 hours. Pusher locomotive crews have been reduced from 8 steam to 4 electric. Pusher locomotives have been reduced from 7 steam to 2 electric. Steam locomotives used to "fall down" in cold weather—the electrics always "stand up," and are really more efficient in cold weather. At the New York Railroad Club meeting last year the N. & W. electrical engineer stated that "coal wharves, spark pits, water tanks and pumps, as well as roundhouses and turntables, have all disappeared from the electric zone. The track capacity has been doubled. The operating costs have been reduced. From an engineering, an operating and a financial viewpoint the electrification has been a success." Speaking of the value of the regenerative electric braking of the system, he went on to say: "The use of the air brake is practically eliminated; it is only used to stop trains. It is regrettable we are unable to put a dollars and cents value on this great asset; to appreciate it properly, one must have had experience with the difficulties of handling 90-car trains with air." Another official. referring to the same subject. made the following statement:— the 2.4% grade, without ever touching the summit 12 to 20 times every day. down the 2.4% grate, without ever touching the air. We never broke a train in two or slid a wheel. It is done so nicely we wouldn't spill a drop of water out of a glass in the caboose."

The 440 route miles of the Chicago, Milwaukee & St. Paul Ry. which have been electrified will soon by augmented by 450 miles more. Nearly 900 route miles and about 33% in addition for passing tracks, vards, industrial tracks and sidings will soon represent the extent of this great railway electrification. Among the advantages secured by this railway on its electric sections are the following: The cruising radius of each electric locomotive is twice that of the steam locomotive. Subdivisional points, where freight crews and steam locomotives were formerly changed, have been abolished; the passenger crews' runs are now 220 miles, instead of 110. For railway purposes, these stations do not now exist; seven or eight miles of track have been taken up; through freights do not leave the main line track at all; shops and locomotive houses 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 electrics have made up more than two and a half times as many minutes as steam locomotives—time which had been lost on other divisions; 29% of electric passenger trains made up time in this manner. On a mileage basis alone, the operating costs of the electrics are less than one-half the steam locomotive costs. Freight traffic increased 40% shortly after electrification—double tracking would have been necessary to handle such increased business under steam operation. An average increase of 22% in freight tonnage per train has taken place. One electric handles about three and a half times as many tone-miles as a steam locomotive; the reduction in times in handling a ton-mile is 30%; faster and heavier trains have accomplished these results, the number of trains has not been increased. About 11½% 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 electrics maintain their schedules much better than steam locomotives. In three months the electrics only waited for the right of way 254 minutes, while the steam locomotives in a similar period waited 1,910 minutes, or seven and a half times as long. Extra cars on trains only delayed electrics 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 electrics were not delayed a minute; the latter are more efficient in cold wather. 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 locomotives 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. Ry. and it is especially interesting because it was made more than a 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. A technical paper summed up the situation a short time ago when it