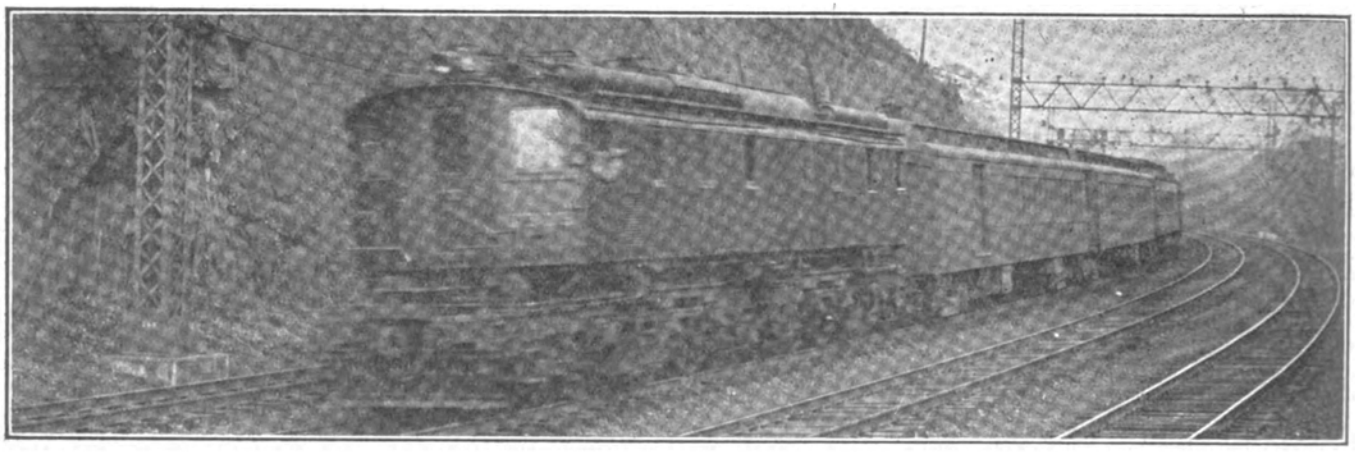


Electricity to Supersede Steam as Railroad Power

Experimental Stage Past—New System Should Go Far Toward Relieving Traffic Congestion —Advantages Over Steam

By **WILLIAM H. EASTON**

THE use of electricity for operating railroads is no longer an experiment. Practically all of the engineering problems arising in the application of this force to transportation have been solved, and several thousand miles of electrified railroads, representing traffic conditions of almost every kind, are now in successful operation.

Nor is the utility of railroad electrification still, broadly speaking, a matter of controversy. There always will be, of course, discussion as to whether this or that line should be electrically operated; but nothing is more certain than that the coming generation will see steam power abandoned on a considerable part of our railroad mileage and electricity installed in its place.

The electrification of a railroad is, however, an undertaking of great magnitude and involves, approximately, the doubling of the capitalization of the road. Hence it is evident that there must be reasons of the most compelling character behind every decision to electrify, and the question at once arises, "What are the factors that can cause our railroads even to consider so vast an expenditure?"

Advantages Not Fully Understood

It is a curious fact that the most important advantages gained by railroad electrification are not thoroughly appreciated, not only by the general public, but even by many otherwise well-informed financiers. The reason is that the electrified railroads familiar to the great majority of Americans do not clearly exemplify these advantages.

For example, the four greatest railroads entering New York City—the Pennsylvania, New Haven, New York Central and Long Island—were originally electrified because they had to pass through long tunnels. The Pennsylvania at Philadelphia was electrified in order to reduce the congestion in Broad street station. The B. & O. at Baltimore, the Boston & Maine at Hoosac, and the Grand Trunk at Sault Ste. Marie, are all examples of tunnel electrification, while the famous electrification of the Chicago, Milwaukee & St. Paul over the Continental Divide and the Cascade Mountains was mainly due to the fact that water power was available there for train operation, whereas fuel could only be hauled to that part of the country at great expense.

Of course, there were additional reasons for the electrification of these roads (the New Haven, New York Central and Long Island in New York and the Pennsylvania in Philadelphia are able to greatly facilitate the handling of their heavy suburban passenger traffic by the use of electric power; the electric locomotives of the C., M. & St. P. are by no means as badly affected by cold weather and blizzards as were the former steam locomotives, and many other equally conspicuous advantages are gained by these and the other roads), but, nevertheless, each of these roads was electrified to solve purely local problems, having no direct bearing on national transportation as a whole. Hence the prevailing opinion that railroad electrification is an expensive luxury, to be resorted to only under stress of particular circumstances.

A Different Story

But down in the far corner of West Virginia there is an electrified road, the Elkhorn Division of the Norfolk & Western, which tells quite a different story. The main business of this railroad is to haul coal, and probably few of the readers of this article have ever traveled over it, but here is tangible evidence that electricity will in time become a vital factor in American railroad transportation.

The facts in the case of the Norfolk & Western are as follows: This road runs through the rich Pocahontas coal regions of West Virginia and its service is essential to the welfare of the district. For many years it kept pace with the constantly increasing demands on its facilities, but about twenty years ago the management saw that in time the road's full capacity would be reached and that it would be physically unable to haul additional coal.

The difficulty was due to a section about 30 miles long between Vivian and Bluefield, where there is a very steep grade against traffic, and a long tunnel. Elsewhere the long coal trains moved freely enough, but on this section three of the largest Mallet steam locomotives on each train were unable to move the traffic more rapidly than 7 miles an hour. In consequence congestion occurred at this point and set a limit on the capacity of the entire system. It was, therefore, absolutely essential, not only for the sake of the railroad, but also of the producers and consumers of the coal, to increase the traffic capacity of this section.

This could be done in one of three ways. In the first place, the number of tracks could be increased. This, however, involved the cutting of the road bed out of solid rock and the construction of an additional tunnel several miles long, so that the expense was prohibitive. Secondly, more powerful locomotives could be used to haul longer trains at higher speeds over the existing tracks. But this solution likewise seemed impracticable, for the simple reason that steam locomotives of maximum capacity were already in use.

Electricity Solves the Trouble

But electricity provided the way out. The electric locomotive does not carry its water and fuel along with it, and hence can be built with far more power than a steam locomotive of the same weight and clearance dimensions. By using electricity, therefore, the Norfolk & Western was able to apply more power to its trains. As a matter of fact this road is now running its tonnage trains over the heaviest grades at a speed of 14 miles an hour. The net result has been to more than double the capacity of the division and to give the railroad ample relief for many years to come.

Five years ago the Norfolk & Western electrification was also regarded as an example of the solution of a local problem—

the "relieving of a congested mountain section" was the way it was usually classified. But today, alas, we find that traffic congestion is no longer a local condition, but has become general, especially on some of our most important roads.

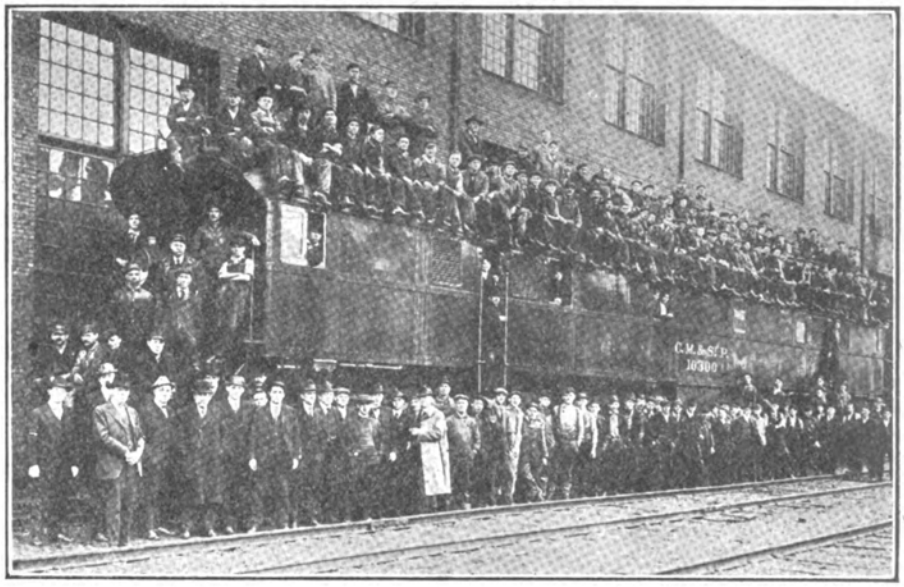
In the old days congestion did not cause the railroads any special concern, because it could be averted by merely using larger locomotives or adding more trains. But, as the Norfolk & Western discovered, there is a limit to this process, and this limit is now being reached or approached at too many points for the good of the nation.

The present situation is, of course, largely due to several unusual causes, but certainly one cause is congestion along the rails and in terminals. And while we may straighten out our difficulties temporarily, it must be remembered that there has been no railroad expansion worthy of the name for nearly ten years, whereas the nation's demands for transportation have been constantly growing at an ever-increasing rate. Consequently, congestion is bound to become more and more serious. At many points it can be economically relieved only by electrification:

The electric locomotive is today merely a substitute for the steam locomotive and, in general, operates under conditions imposed by the limitations of steam. When these limitations are swept away and electric operation is logically developed, a traffic movement will be possible that will be far more efficient and economical than anything we can picture today.

Advantages Over Steam

For example, many readers of this article will doubtless recall the time when the New York elevated railways were operated by steam locomotives. Imagine these trains operated by electric locomotives, gaining an increase of capacity through higher speeds, but still using the same light cars, delayed by schedules arranged for the steam locomotive's need of coal and water, and controlled by signal and safety systems based on the speed and headway of the steam trains. Now compare this picture with the fully developed electrically-operated subway system, with its long trains of great steel cars, high speeds, and 90-second intervals between expresses. In the first picture we have a condition quite similar to our electrified railroads of today; in the other, a realization of some of the full possibilities of electric transportation.



THE WORLD'S HIGHEST POWERED ELECTRIC LOCOMOTIVE
A Baldwin-Westinghouse locomotive built for the Chicago, Milwaukee and St. Paul Railroad and in use on its Puget Sound Extension.

Much the same order of development will take place on our present steam lines and the ultimate result will be an undreamed-of freedom of traffic flow, without the innumerable delays that are today responsible for incalculable economic losses. In other words, electricity will revolutionize railroading, just as it has illumination, manufacturing, urban transportation, the dissemination of intelligence, and every other field of human activity into which it has been introduced.

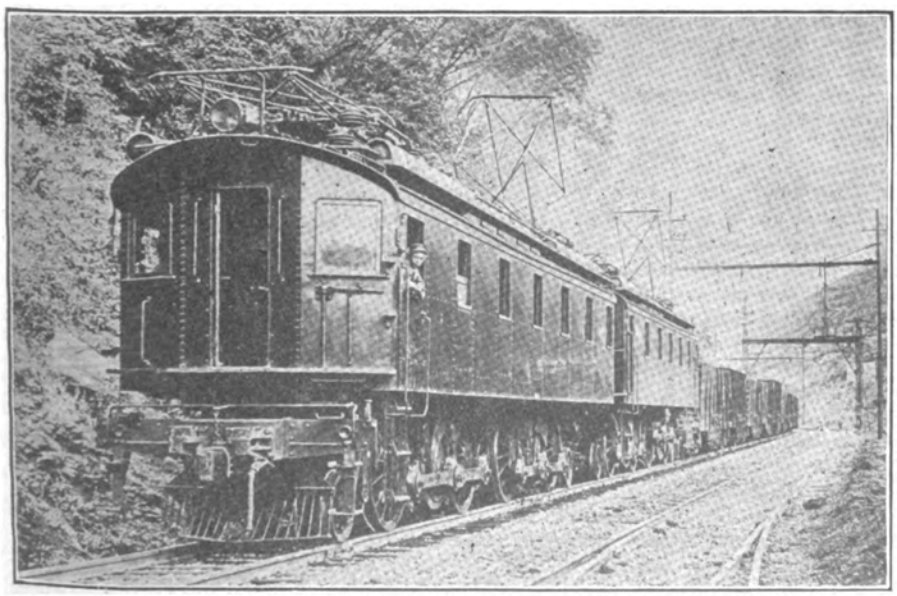
But, it may be objected, suppose the Norfolk & Western reaches the limit of its present capacity, as it is likely to do in time; what is then to be done? This brings out another interesting feature of electric operation and especially of the particular system used by the Norfolk & Western.

In the first place no limit to the capacity of an electric locomotive is as yet in sight. Electrics ranging from 4,000 to 7,000 horse-power are now in regular operation (as compared with 3,500 horse-power, which is about the upper limit for a steam locomotive); much larger ones can readily be built, and it is technically possible to make every car, or every other car, of an electrically-operated train a motor-car (similar to the "multiple-unit" trains of the New York subway), with everything controlled from a point at the head of the train. Consequently electricity can provide all the power that will ever be needed to propel a train.

Secondly, the amount of power that can be supplied through a trolley wire is likewise practically unlimited, when the alternating-current system, such as is employed by the Norfolk & Western, is used. Should the present current-carrying capacity of this road's overhead wires be reached, it is a simple matter to increase the voltage and thereby increase the power capacity of the wires in direct proportion.

The alternating-current system is in contrast with the direct-current system used by the Chicago, Milwaukee & St. Paul, in which the voltage is fixed and the power capacity of the present lines cannot be increased in so easy a manner. This system is entirely satisfactory for the present condition of this road (which will probably not reach its capacity limit for many years), but it is not considered flexible enough for roads of dense traffic. Moreover, it is not practicable to operate "multiple-unit" passenger trains on the St. Paul's system, and this is an important consideration for railroads serving large cities. Hence the Norfolk & Western may very well be regarded as the prototype of the future American railroad, from the standpoint of both railroad operation and electrical engineering.

(*Continued on page* 518.)



ELECTRIC OPERATION ON THE NORFOLK & WESTERN RAILROAD
Using the alternating-current system the amount of current supplied by a trolley wire is practically unlimited, supplying all the power ever needed to propel a train.

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ELECTRICITY TO SUPERSEDE STEAM

(*Continued from page* 453)

In addition to the ability of electricity to increase the traffic over a given road, it has a number of other advantages, including fuel conservation, more reliable operation, and the reduction of the amount of labor required to handle a ton-mile. While these are secondary to the principal advantage of freer traffic movement, they are nevertheless of great economic importance, and will add weight to the reasons for electrified railroads.

In conclusion, it is well to point out that probably the great part of our railroad *route mileage* will never be electrified because conditions will not warrant it, but it is probable that the great part of our *tonnage* will be hauled electrically before the close of this century.