SOME PRACTICAL RESULTS OBTAINED BY ELECTRIFICATION ON THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY

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This is a most valuable contribution, being a real railway story by a real railway man. The success of the Milwaukee electrification is told by the man who was in charge of this most wonderful railway undertaking. The operating facts told are too many to abstract, but we can say with confidence that all steam road men contemplating electrification will learn much that is useful and instructive from Mr. Goodnow's article.—Editor.

The Chicago, Milwaukee & St. Paul Railway has now in electric operation 226 miles of main line track and will, within a few months, have a total of 440 miles electrically operated. The electrified portion of the road crosses the Belt Mountains, reaching an elevation of 5768 feet; the Rocky Mountains at a height of 6350 feet; and the Bitter Root Mountains at 4200 feet. The use of electric engines on this portion of the road has entirely displaced steam locomotives and has eliminated one division point, namely, that of Three Forks. The electric locomotives run through between Deer Lodge and Harlowton on both freight and passenger trains, with the crews on freight trains changing at Three Forks. On the 2 per cent grade over the Rocky Mountains the electric locomotives haul 10 or 11 steel cars at speeds varying from 20 to 30 miles per hour, and on this important grade, with one helping engine, 2500-ton freight trains are handled. It is expected to increase this tonnage to 3000 tons as soon as the entire apparatus in contemplation has been installed.

From the outset the operation of electric locomotives has been a success and it is not too much to say that they have practically eliminated the mountain grades. Where formerly it was necessary to employ a large number of helper engines to handle the passenger and freight trains over the mountain grades, one or two helpers only are required to handle the greatly increased freight traffic of the present year and no helpers are used on passenger trains.

The movement of trains is so uniform and there are so few failures with the electric locomotives that only one set of train dispatchers is now employed to handle the trains on the 226 miles under electrical operation while two sets of three dispatchers each are employed under steam operation. The tonnage on maximum grades has been increased from 1700 to 2500 tons per train, and will soon be further increased to 3000 tons, and this tonnage is handled at a speed of between 15 and 16 miles per hour on maximum grades while steam engines could only average 8 or 9 miles per hour.

Regenerative braking is a feature that has proved most successful and most economical. The heavy transcontinental passenger trains are moved down maximum grades at a uniform speed by this braking, and the maximum tonnage of freight trains are handled in the same manner without the use of the air brakes, unless the train is to be stopped. It is a fair statement to say that the use of electric locomotives, so far as easy and uniform operation is concerned, has practically eliminated the grades of the Continental Divide.

It is yet too early to speak of economies, but the elimination of water and coal stations, of cinder pits and of round house forces at intermediate division points, and the quick inspection and ready turning back into service of electric locomotives, can but mean economy. The saving in brake shoes and wheels, the delay to trains for the purpose of cooling brakes shoes and wheels is also an economy that has been found to be far reaching in the handling of both passenger and freight trains. Since the electric locomotives have practically doubled the speed of freight trains on maximum grades it was found that a large saving results from this alone.

The winter of 1914-1915 will be memorable in the annals of Montana. There were long periods in the Rocky Mountain district when the thermometer stood as low as 40 degrees below zero, and it was almost impossible to move trains by steam locomotives, but the electric locomotives were always ready for service and always were able to work to the maximum. In some instances, where steam locomotives had failed (it should be understood that during December and January 1915 there was only partial electric operation) and heavy freight trains were standing on the

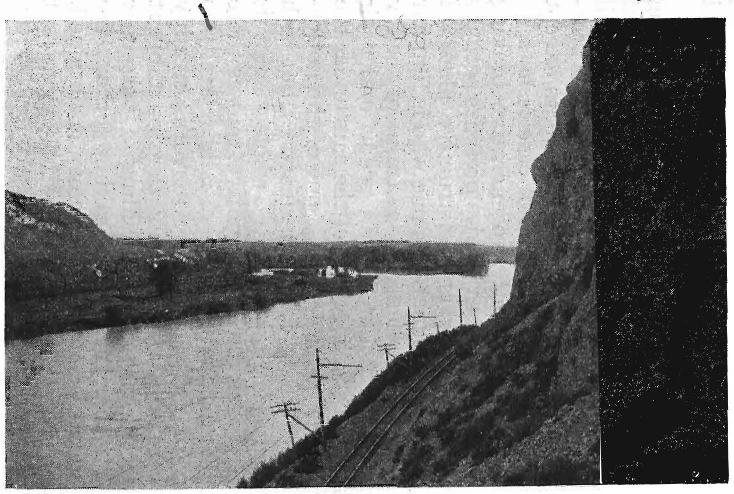

Fig. 1. The Missouri River at its Source in Montana

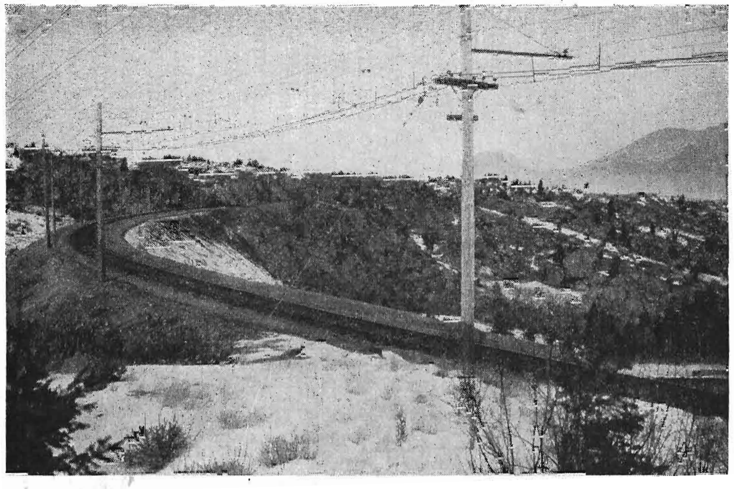

Fig. 2. Electrified Line in Rocky Mountains East of Three Forks, Montana

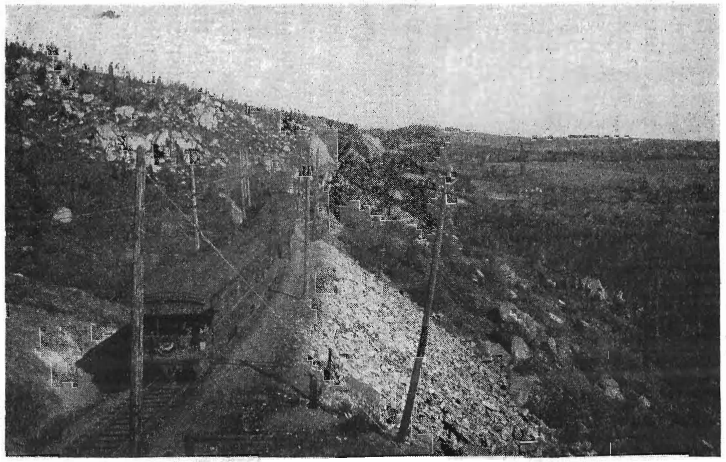

Fig. 3 "The Columbian" on the Summit of the Rocky Mountains

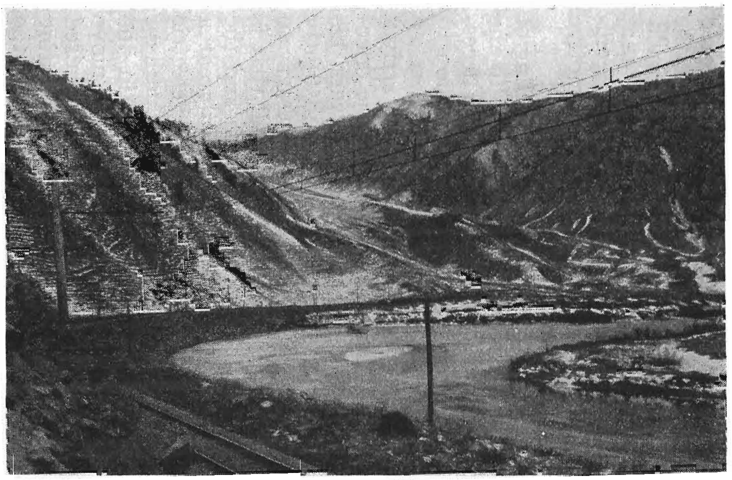

Fig. 4. Jefferson River Canyon, Montana

main track the electric locomotives cleared the track without difficulty and pulled the delayed cars and engines into terminals, demonstrating in a practical manner that while the steam engine is at its lowest efficiency in cold weather the electric locomotive is at its highest point of efficiency.

There are many features in the handling of electric locomotives which will appeal to the operating man. For instance it is not necessary, unless there is work and inspection to be done, to house electric locomotives no matter what the weather may be. On arrival at terminals the engineer places the locomotive on a designated track, lowers his pantograph, and the locomotive instantly becomes dead. When it is again necessary to put the locomotive into operation all that is necessary is to raise the pantograph and the locomotive is ready for service. So great a contrast in the operation of steam and electric locomotives can only be appreciated perhaps by the man who has actually been in the field, and has had important trains to move and has had to wait while steam was raised in a steam locomotive. As an interesting illustration of the above: At a time when the thermometer was 40 degrees below zero two freight trains, having three steam locomotives and 75 cars, were standing on the main track east of Three Forks, Montana, with the engines dead on account of the bitter cold, and passenger trains were due in both directions. The Superintendent was naturally anxious to clear the main line but had no steam engines available. An electric freight locomotive was standing on a sidetrack at Three Forks. The line was not then in electric operation east of Three Forks, but, for a distance of about nine miles the trolley was energized. The Superintendent inquired of an engineer if it would be possible to take the electric locomotive and clear the main track. The engineer was confident that he could do it, and in company with the Superintendent, he boarded the electric locomotive, raised the pantograph, and instantly the electric locomotive was ready for service. In five minutes from the time the inquiry was first made the electric locomotive, manned by the Superintendent and engineer, was moving out on the main track toward the stalled trains. Without experiencing the slightest difficulty the two trains were coupled up and the 75 cars and three steam engines were pulled into the sidings at Three Forks, the main track was cleared and there was no delay to the passenger trains. The above is but one instance of many of a similar character during the severe weather of December and January 1915, but it has had the effect naturally of endearing the electric locomotive to the operating men of the Rocky Mountain division.

It was thought that but half an electric locomotive should be used in handling way freights. It seemed quite out of the question to accomplish the handling and switching of a way freight train by means of a great locomotive 112 feet long, but the importance of pulling tonnage was so great that it was finally decided to try the full locomotive on these trains. The success was phenomenal. The handling of the electric locomotive in switching service was so much easier than with steam service that the engineers came to regard the full electric locomotive as the only proper machine to handle way freights. The reasons for this were two. First, that the electric engines without pulling out drawbars would handle any tonnage attached to them; and second, that in the switching movements, instead of being obliged to look out of the window, and then, when he got a motion to move in the opposite direction to have to handle heavy reversing gear, with an electric locomotive he could hang out of the window all the time and without changing his position could handle the tiny reversing lever and control.

The electric locomotives while handling much greater freight tonnage, as has been stated, "get" fewer drawbars, because the pull is uniform and easily controlled and it is practically impossible to pull out drawbars except through an extreme degree of carelessness.

The handling of the regenerative braking descending 2 per cent grades presents perhaps a most interesting and instructive phase of mountain railroading. To one who is familiar with the movement of a train of heavy tonnage down a mountain grade under air brake control, the rolling of the cars under the application of the brakes is one of the noticeable and perhaps dangerous features, but with regenerative braking the whole train is bunched against the locomotive, and as there are no brakes applied, there is absolutely no rolling of the cars. They move as steadily and evenly as though they were on tangent prairie track. In the handling of passenger trains with regenerative braking perhaps the best idea of comfort and safety is obtained. In the use of the air brakes on 2 per cent mountain grades it is necessary to let the train accelerate to a speed where it must be

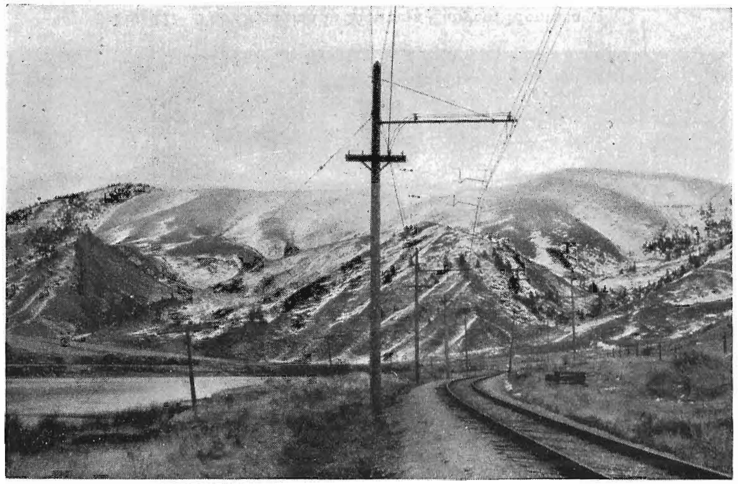

Fig. 5. In the Jefferson Canyon, Rocky Mountains

Fig. 6. Another View in the Jefferson Canyon

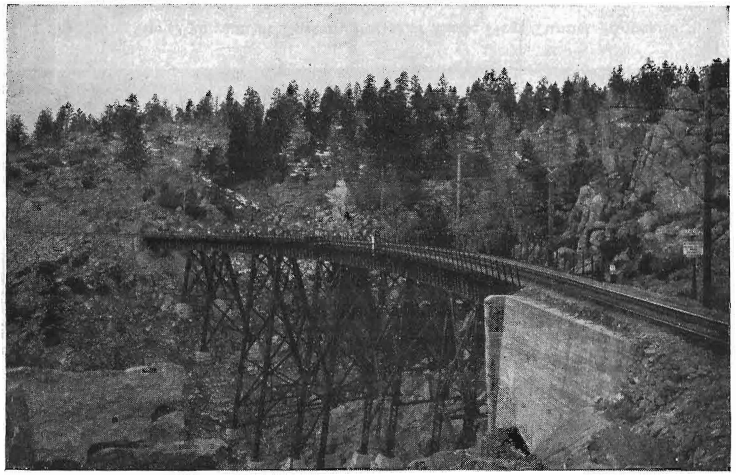

Fig. 7. East Side of the Continental Divide, Near Donald, Rocky Mountains, Montana

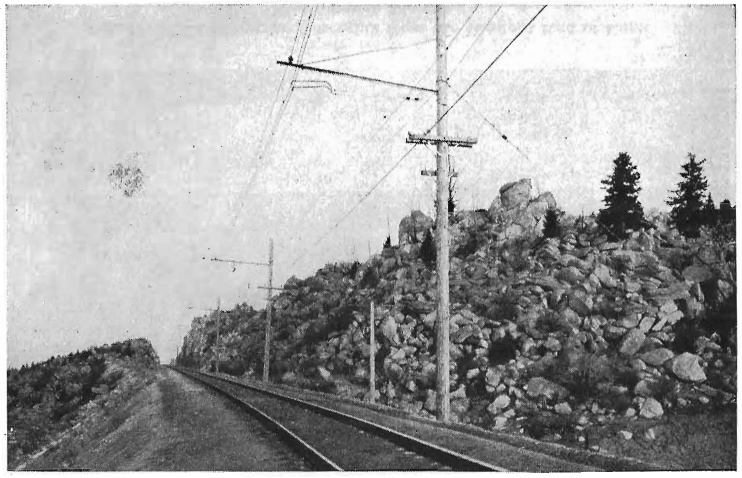

Fig. 8. The Rockies, between Butte and Janney, Montana.

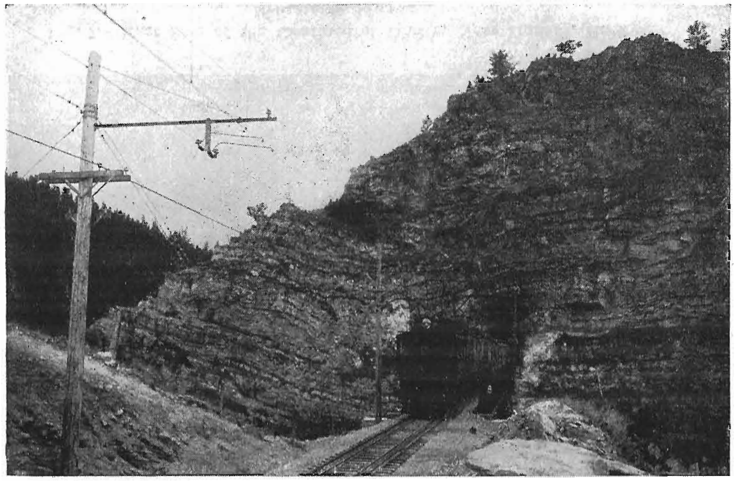

Fig. 9. The Olympian at Eastern Portal of Eagle Nest Tunnel, Montana

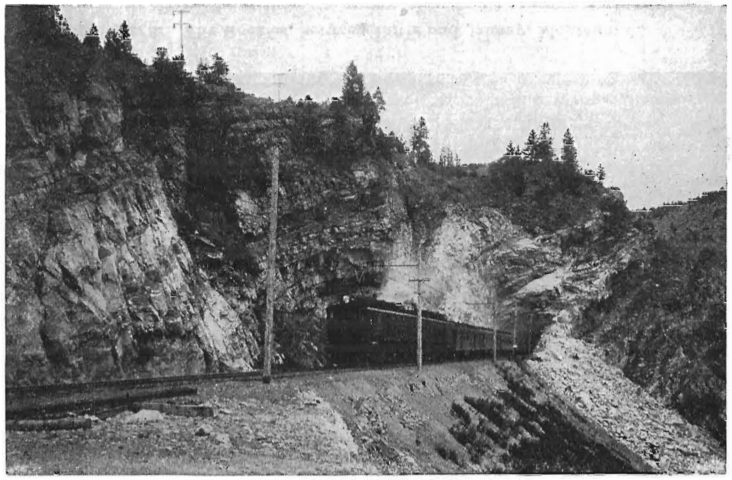

Fig. 10. The Olympian Emerging from the Western End of Eagle Nest Tunnel, Montana

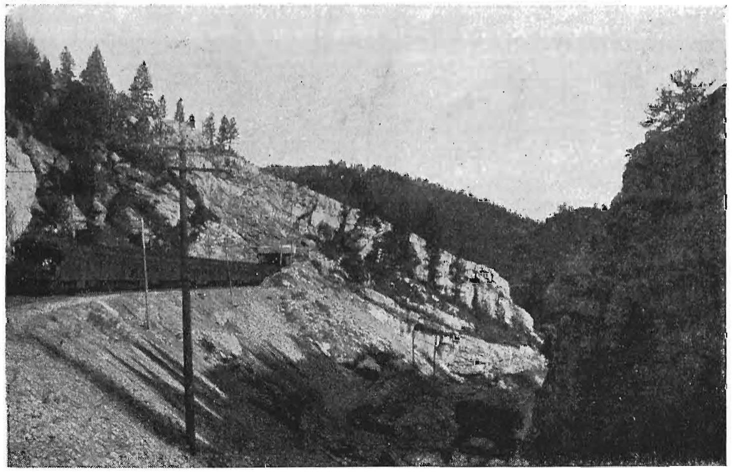

Fig. 11. The Olympian in Montana Canyon, Montana

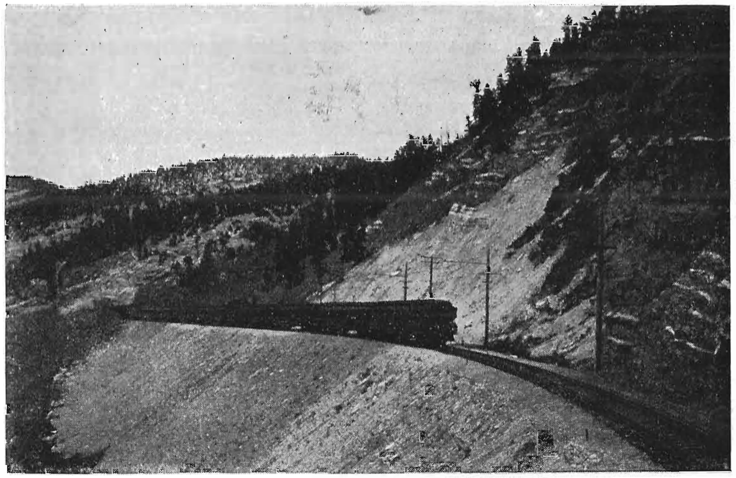

Fig. 12. The Olympian in Montana Canyon, Montana

checked and to apply the air brake to bring it down to the speed required. It is then again allowed to accelerate and then again checked; but with regenerative braking the speed is uniform and there is no grinding of brakes and no annoyance to passengers in consequence. In the practical operation of the transcontinental trains of the Milwaukee Company over the Rocky Mountain grades, eastbound, the train is brought to the summit at a speed of about 23 to 25 miles per hour and after pitching over the summit, as soon as the train reaches a speed of 30 miles per hour, regenerative braking is started and, without the slightest knowledge on the part of the passenger, the train is held uniformly at 30 miles per hour down the 22 miles of 2 per cent grade. There is no difficulty in obtaining a speed of 60 miles per hour on level grades with 10 all-steel cars, and woe to the competitor who attempts a speed trial with one of our transcontinental trains.

The Milwaukee railroad decided on two innovations for geared locomotives, first that the trolley potential should be 3000 volts and second that there should be a full guiding truck at both ends of the locomotive. A great deal of doubt was expressed by electrical engineers as to the feasibility of collecting current at so high a voltage, but, by the use of the sliding pantograph there has not been the slightest difficulty in this matter and absolutely no sparking, and eight months of continual use has demonstrated that there has been no appreciable wear on the trolley wire. The use of the guiding trucks aside from all questions of safety has resulted in a locomotive which at the highest speeds rides almost as smoothly as a Pullman car

Electrification has been such a tremendous success on the Milwaukee road that it is difficult to state the results without seeming exaggeration, but I think it quite within the fact to say that the Milwaukee road has forgotten that the Continental Divide exists.

THE MONTANA POWER COMPANY AND ITS PART IN THE ELECTRIFICATION OF RAILWAYS

BY JOHN D. RYAN

PRESIDENT MONTANA POWER COMPANY

Mr. Ryan's article will be of special importance to engineers interested in the absolute continuity of service, the achievements of the Montana Power Company in this direction being wonderful. The general layout and tying together of the system is described and many of the interesting features noted. Both the B., A. & P., and the C., M. & St. P. Railways are supplied with electric energy from the Montana Power System, and in some of the opening paragraphs the author notes the successful results obtained.—EDITOR.

The development of water powers and the transmission of electrical energy had reached a point in Montana about the year 1912 where electricity began to force itself upon the attention of railway managers as a substitute for steam in railway operation.

More than a dozen hydro-electric plants had been connected with a great system of high tension wires to supply the fast growing needs of the State for power and light. The necessity for continuous service in the operation of mines forced the consolidation of plants into one system, out of which could be drawn the energy needed when the source of direct supply might for any reason fail temporarily.

The one vital need for railway operation is continuity of power, and the experience of the Butte mines and ore reduction plants at Anaconda and Great Falls had proved that, given the plant capacity, located at several points on different rivers, draining different water sheds and connected with ample transmission lines traversing different sections of the territory covered, as safe and certain a supply of power can be assured as by isolated steam plants, or any other possible means. The record of continuous operation with power from the Montana system, is, I believe, unparalled and unequaled.

The Butte, Anaconda & Pacific Railway Company took the first step by electrifying its main line and principal branches, about 70 miles in all. The work was completed in the autumn of 1913. The cost was within the original estimate; the operation has been an unqualified success and the economy at least 50 per cent in excess of the promises of the engineers at the time the work was undertaken. The tonnage handled over the lines has increased over 50 per cent in three years; no difficulty has been found in moving the increase, and in the opinion of the railway