THE ELECTRIFICATION OF TRUNK LINES

WITH the general use of electricity, especially for urban and interurban transportation, the question is often heard, When will the complete electrification of the great trunk lines take place, and what are the leading objections aside from mere expense to such a change? In the United States, with some 358,000 miles of track for railways operating with steam locomotives, trunk-line electrification to-day amounts approximately to about 2500 miles, yet this is more than double the accomplishment in Europe.

One reason, perhaps is that railway engineers are not entirely informed as to the relative costs and economies of steam and electricity inasmuch as authoritative data is so limited with the result that unusual interest attaches to a series of papers in the May issue of the *General Electric Review* (Schenectady, N. Y.) where the results of the electrical operation of an extended section of the Chicago, Milwaukee & St. Paul Railway are discussed. From these preliminary data there is every reason to believe that figures for a longer period will be wholly favorable to electric train haulage. What is most convincing, however, is the decision of the directors to establish a new electrified zone over the Cascade Mountains from Othello, Washington, west to Seattle on the Pacific Coast, involving about 250 miles of main line and a cost of $6,250,000, exclusive of locomotives. This will give on the St. Paul some 690 miles of main line electrically operated, or a distance approximately equal to that from New York City to Cleveland, Ohio.

According to R. Beeuwkes, electrical engineer of the Chicago, Milwaukee & St. Paul Railway,

> The first electric locomotives were placed in operation on the Rocky Mountain Division of the Chicago, Milwaukee & St. Paul Railway on December 9th, 1915, between Deer Lodge and Three Forks. In April, 1916, electrical operation was extended to Harlowtown on the east, and early in 1917 the entire 440 miles was equipped for electrical operation.
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> The 440-mile electrified section is now divided into two operating divisions, of which only one—the Rocky Mountain Division—has been running long enough to get reasonably reliable data concerning operation. I may say, however, that on the Missoula Division we have been handling 3000-ton trains as a standard through the worst winter months, and the entire operation is working out very successfully. . . .
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> With the introduction of electricity we were able to double what I may call the cruising radius of our locomotives. As far as the railroad is concerned we have eliminated Three Forks—a station formerly used for changing steam locomotives—entirely. All locomotives run the entire 226 miles from Deer Lodge through to Harlowton with only a light inspection of bearings and pantographs at Three Forks. The shop and roundhouse are entirely closed down, seven or eight miles of tracks have been removed, and the comparatively large round-house force previously employed has been replaced by a single electrician. All locomotives and cabooses are pooled, the men being given suitable locker space to store their lanterns, flags, tools, etc. Through freight trains do not leave the main track and often are not switched at all. At Harlowton the engine is given a rough inspection and any light repairs made that are necessary. Detailed inspection and maintenance work is done at Deer Lodge.
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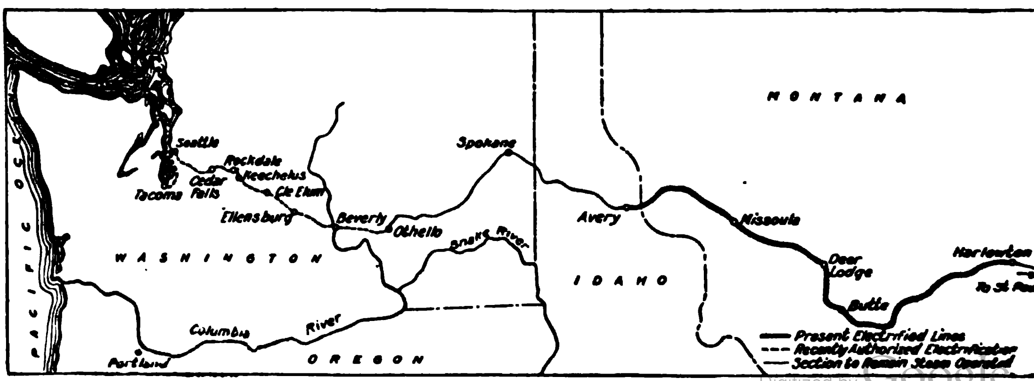
> The same change in operation has been effected on the Missoula Division, Avery to Deer Lodge; in this case Alberton being the steam engine division point which has been eliminated.



ELECTRICALLY OPERATED SECTIONS OF THE C. M. & ST. P. RY.

FREIGHT TRAIN HAULED BY ELECTRICITY ON MOUNTAIN GRADES

This important development on the St. Paul has been comparatively recent. The first systematic test runs were made on December 9, 1915. A special train of three cars and an electric locomotive was operated over the mountain from Butte, Montana, to Piedmont at various speeds up to seventy miles an hour and trains of various tonnage were handled. On the same day, states K. R. Hare, associate editor of the *Railway Age Gazette,* "two electric locomotives took a train of forty-eight loaded cars, 3000 tons, from Butte up the two per cent grade to the summit of the Rocky Mountains at a speed of fifteen miles an hour and then continued down the descending grade on the opposite side. This was the inauguration of electric operation. It was not until January, 1916, however, that steam freight locomotives were entirely removed from the electrified division.

"At about that time it was found that the electric locomotive could handle considerably more tonnage than the builders guaranteed, and it was also demonstrated by the various tests run during that period that the system of regenerative braking was entirely successful."

Gradually electrical service was extended until the entire 440 miles section from Harlowton to Avery was put into operation on February 24, when electric trains began running through the one mile and further St. Paul Pass at the summit of Bitter Root range.

One important consideration of the electrification of railways is that notwithstanding the increasing cost of coal and labor, electricity is to-day cheaper and its supply is more reliable and available over much wider area than ever before. Accordingly, states A. H. Armstrong of the Engineering Department of the General Electric Company:

The operation of the heaviest freight and passenger trains by electric locomotives has been demonstrated as entirely feasible. The record of reliability, the low cost of maintenance of the electric locomotives, and the flexibility of this new type of motive power to meet the varied condition of haulage service leaves no room to doubt that electricity is destined to play a most important part in the future development of our railroads. Not only can present steam service be easily duplicated as regards the weight and speed of trains hauled, but it has been demonstrated that the electric locomotive is free from many of the restrictions placed upon train operation by the steam engine, and that it makes possible train weights, speeds, economies, and improvements in operation thus far unattainable by the steam-engine operator.

The last link in the 440-mile electrification of the Chicago, Milwaukee & St. Paul Railway between Alberton and Avery over the Bitter Root Mountains has just been completed and placed in regular operation. To those having knowledge of the facts regarding the operation of the electric locomotives on this road, it is plainly evident that the quality of service rendered is far superior to that previously attained or possible with steam engines. . . . The motors and the locomotives, the sub-stations, and the trolley construction were all amplified in magnitude from similar types in successful commercial operation and the result has been that the change from steam to electricity was made with no interruption in service and under climatic conditions that were extremely abnormal. . . .

It is a conservative statement to make that the substitution of the electric locomotive for the steam engine will result in doubling the daily tonnage capacity of a mountain grade division with no addition to the previous track facilities and will, in addition, release a large amount of rolling stock by reason of the considerable reduction in running time effected.

ZONES OF SILENCE

AMONG the curious phenomena connected with the war is that of the striking irregularities in the transmission of the sound attendant on violent explosion. Thus, it is well authenticated that the heavy firing on the western front of battle is sometimes audible in England, though inaudible in Western Belgium. This is explained by the fact that the interference of sound waves causes what are known as zones of silence, since just as the crest and the hollow of two waves of water may neutralize each other, the crest and hollow of two sound waves may produce silence. On the other hand, if the crests of two waves coincide, whether in water or in air (and hence in the case of sound transmitted by air), the effect is intensified.

Many explosions, volcanic or other, thus present the phenomenon of two zones of audition separated by a zone of silence. It has been discovered that the zone of direct or immediate audition is always asymmetrical. That is, it does not form a symmetrical circle around the focus of explosion, but tends to be propagated in certain directions in preference to others. In some it goes exceedingly far, in others it attains only a short distance. Mr. Henry de Varigny, editor of the scientific section of the *Bibliothèque Universelle* (Lausanne), gives a *résumé* of some interesting recent examples.

On January 19 an explosion took place in East London which was heard at a great distance. Mr. Ch. Davison took occasion to investigate the question of zones of audition and silence by extended inquiries in the localities where it was heard and intervening places.

The zone of direct audition was found to take the shape of the letter L, having its angle in Godalming, Surrey, southwest of London. The horizontal portion ran east-west between Godalming and Canterbury. The vertical part ended near Northampton. The minimum distance from the focus was nineteen kilometres, the maximum distance 104 kilometres. The zone of indirect audition, situated beyond the zone of silence had its center a little west of King's Lynn. Its long axis extended a distance of 210 kilometres, from Lowestoft to Nottingham; its width was about eighty-eight kilometres. It constituted, therefore, a band running from southeast to northeast, situated north-north-east of the focus of explosion. . . . Evidently the meteorologic conditions prevailing at the moment governed the form and direction of the zones, as well as distance and direction. . . . The zone of silence between the two zones of audition varied in width from twenty-five kilograms to eighty-six, and its exterior limit was about ninety-six kilograms from the focus.

From the zone of direct audition, comprising some 3500 square miles, Mr. Davison had 250 reports; from the indirect zone, covering 5708 square miles, 233; while from the zone of silence, of about 4500 square miles, only one ear-witness living near the sea, sent in a report. It is noteworthy that the witnesses were almost as numerous on the peripheries of the zones as in their central portions. This indicates that the audibility does not grow progressively weaker until it reaches zero in the silent zone. . . . The greatest distance at which the explosion was heard was about 193 km.

Mr. de Varigny quotes also from an article in the *Quarterly Journal* of the Royal Meteorological Society on the audibility in England, between September, 1914, and September, 1916, of the cannonading in Flanders and along the Somme. This was very variable, according to localities, days, and seasons. The sound was heard very clearly at distances of 160, 200, and 250 kilometers, but seems to have attained even 480 kilometers in the case of the battle of the Dogger; the naval cannonade was heard at Great Malvern and Pontrelan January 24, 1915. The Jutland battle (May 31, 1916) is said to have been heard at the same distance in Norfolk.