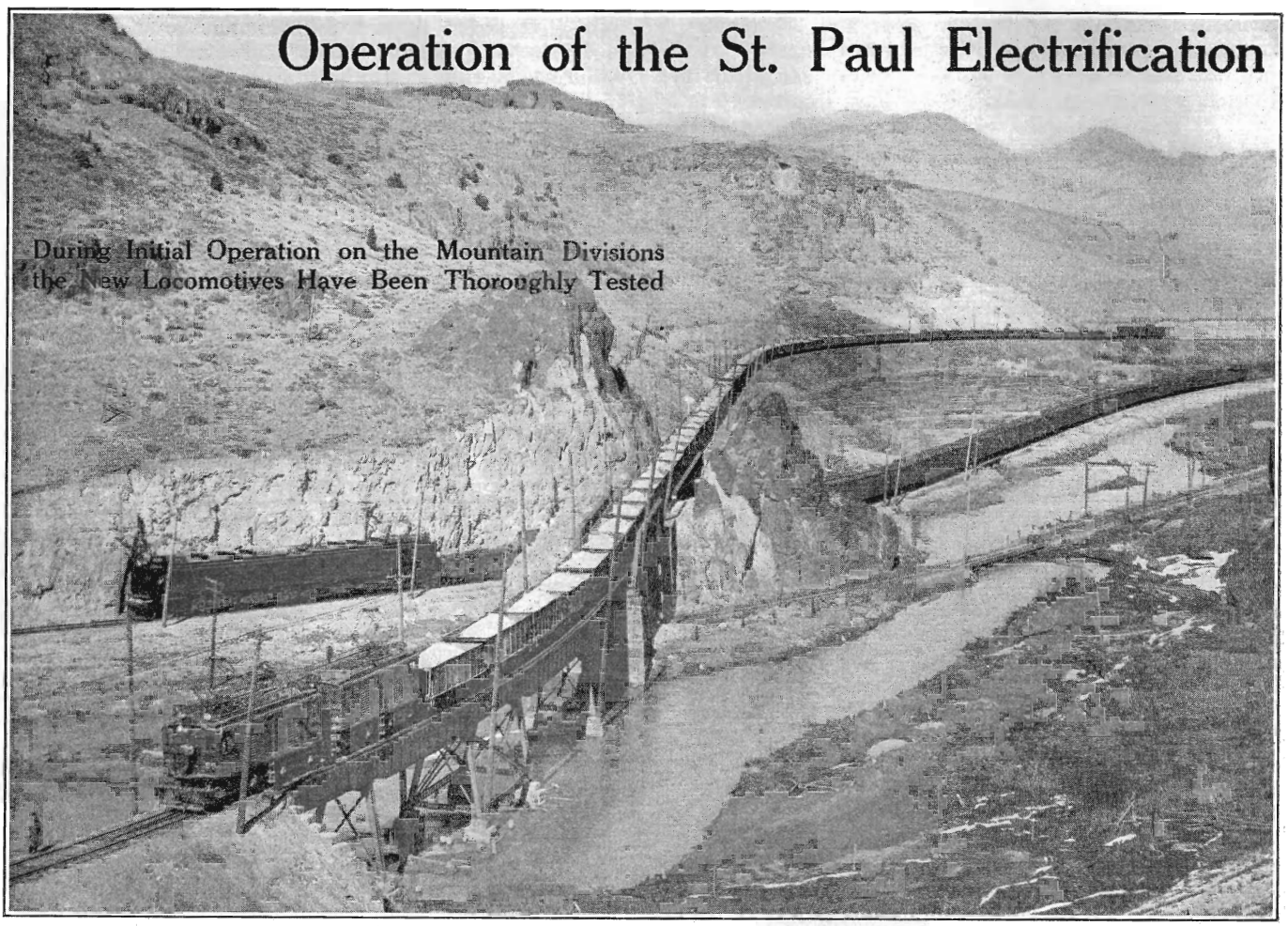
# Operation of the St. Paul Electrification




*Ore Train on the Butte, Anaconda & Pacific and Freight Train on the Chicago, Milwaukee & St. Paul*

WHILE a number of steam roads have electrified terminals or tunnels for the purpose of eliminating smoke, taking care of surburban traffic or other local conditions, the Chicago, Milwaukee & St. Paul electrification* was the first project of the kind where electric locomotives were installed to operate over several engine divisions.

## The Electrified Divisions

The four steam engine divisions which were selected for electrification aggregate 440 miles in length. Steam engines were first abandoned on the Three Forks-Deer Lodge Division, 115 miles long, and crossing the Main Continental Divide, thus giving the electrical equipment its initial tryout under the severest service conditions of the entire system. The first electric locomotives were placed in regular service on December 9, 1915, and during the month of April, 1916, service was extended to Harlowton, Mont., making a total of 220 miles of electrically operated road. By the first of November, 1916, it is expected that steam engines will be superseded over the entire distance of 440 miles from Harlowton, Mont., to Avery, Idaho. The length of track between Harlowton and Avery is approximately equal to that from New York to Buffalo or from Boston to Washington.

In crossing the three mountain ranges included in the electric zone, there are several grades of one per cent or more, the most difficult of which is the 21 mile two per cent grade between Piedmont and Donald, and the longest is the 49 mile one per cent grade on the west slope of the Belt mountains.

The curvature is necessarily heavy, the maximum being 10 degrees. There are also numerous tunnels in the electric zone, 36 in all, of which the longest is the St. Paul Pass tunnel, over a mile and a half in length, through the ridge of the Bitter Root Mountains.

The passenger service consists of two all-steel transcontinental trains in each direction, the "Olympian" and the "Columbian," and a local passenger train in each direction daily between Deer Lodge and Harlowton.

Freight traffic through the electric zone comprises from four to six trains daily in each direction. Westbound, the tonnage is made up of manufactured products and merchandise for Pacific Coast points and foreign shipment. Eastbound tonnage includes grain, lumber, products of the mines and some live stock.

As a larger part of the traffic is through freight, trains are made up of an assortment of foreign cars, including box and flat cars, coal and ore hoppers, stock cars, refrigerators, etc., varying in weight from 11 to 25 tons empty and as high as 70 tons loaded. These cars being owned by many different railway systems are equipped with air brakes adjusted for different conditions of operation, and in accordance with different standards as to braking power and type of equipment, thus making the problem of holding the long trains on the heavy down grades by air brakes a most difficult one.

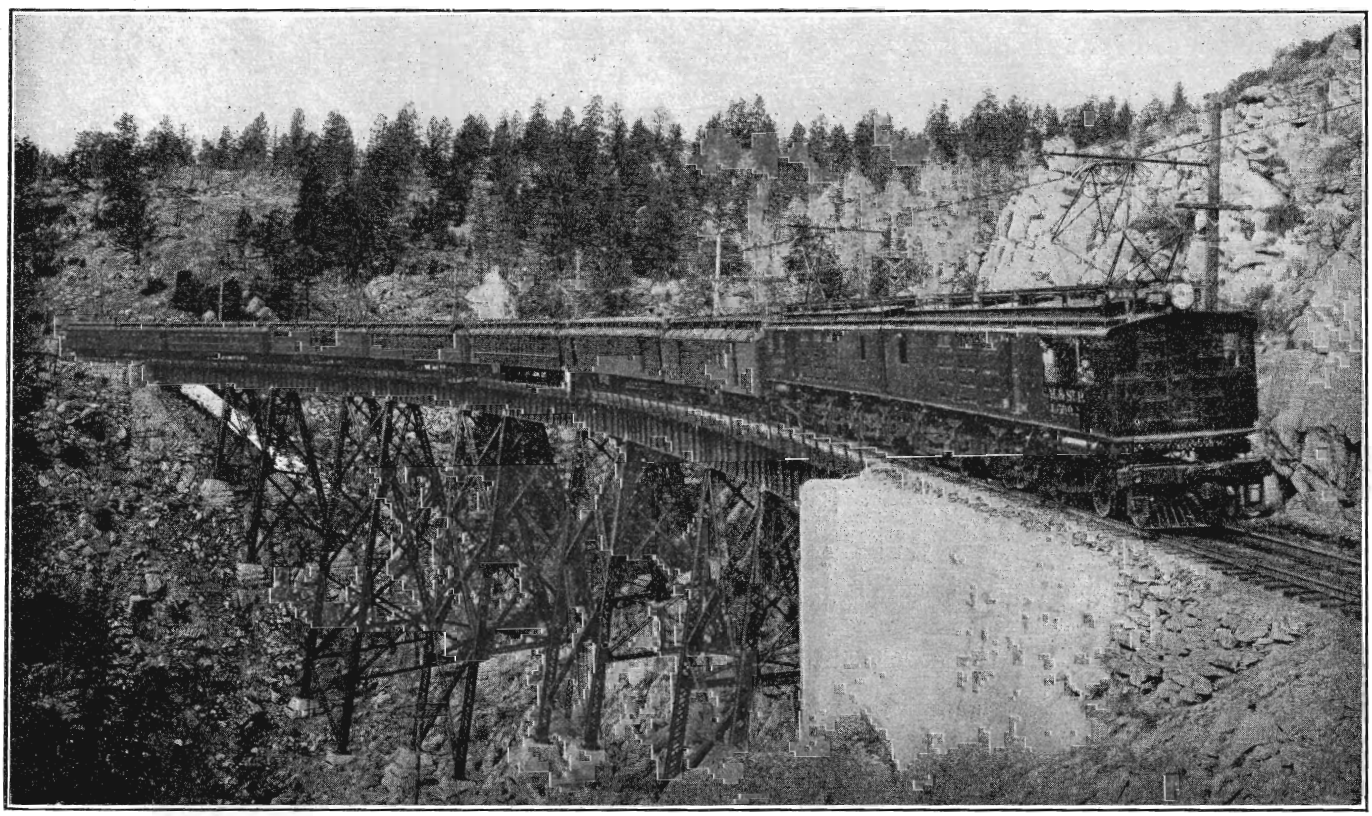
## Electrical Operation

Electrification promises a material reduction in running time. It has been found, for example, that on the 21-mile two per cent grade from Piedmont to Donald, the electric locomotive can reduce the running time of passenger trains from an hour and five minutes to approximately 40 minutes. On the run from Deer Lodge to Butte, which, under the steam

*An extensive study of the St. Paul electrification was published in the *Railway Age Gazette* of October 15, 1915, page 683. An article on its operation appeared in the *Railway Age Gazette* of April 28, 1916, page 957.

locomotive schedule, required an hour and 20 minutes, a saving of approximately 30 minutes can be made.

In the freight service, it has been found that on the first division, where the steam locomotives have required 10 to 12 hours to make 115 miles, electric locomotives can meet a schedule of from seven to eight hours for the same distance. The heavy grades and frequent curves at certain points offer serious obstacles to steam locomotive operation even in the summer time, but with winter temperatures as low as 40 deg. F. and heavy snowfalls in the Bitter Root mountains, serious delays have occurred, owing to engine failures or to inability to make steam. The capabilities of the electric locomotives are in no way impaired by cold weather or by inability to obtain fuel or water in case of snow blockades. During a series of record-breaking temperatures in December, 1915, Mallet engines were frozen up at different points on the system and the new electric equipment was rapidly pressed into service to replace them. On several occasions electric locomotives hauled in disabled steam engines and trains which would otherwise have tied up the line.



**Train No. 16 Descending Two Per Cent Grade on Eastern Slope of the Rockies**

During initial operation on the Rocky Mountain division, the capacity of the new locomotives has been thoroughly tested. Trains of 3,000 tons have been hauled east and 2,800 tons west, using a helper on the heavy grades. From the operating data obtained on the first division, it is evident that much heavier trains can be hauled with the electric locomotives than with steam engines, and all passing tracks are being lengthened to take advantage of longer trains. On some of the runs where the grades are less than one per cent trains of as many as 130 cars and as heavy as 4,000 tons have been hauled with a single locomotive.

The four through passenger trains, "Olympian" and "Columbian," are taken across the two mountain ranges by a single passenger locomotive. These trains at present consist of eight full vestibuled steel coaches, weighing approximately 650 tons. Instead of changing locomotives at Three Forks, as has been the practice under steam operation, the same locomotive is run through the 220 miles from Deer Lodge to Harlowton, changing crews midway. Passenger trains will travel over the entire electrified division in approximately 15 hours, including all stops, and the tourist thus will have an opportunity of traversing by daylight some of the most beautiful scenic regions in the United States and without suffering the annoyance of cinders and smoke incident to the use of steam locomotives. The local passenger train operating in the electric zone between Deer Lodge and Harlowton is handled by a half unit weighing about 150 tons with equipment similar to the main line locomotives.

### The Electrical Equipment

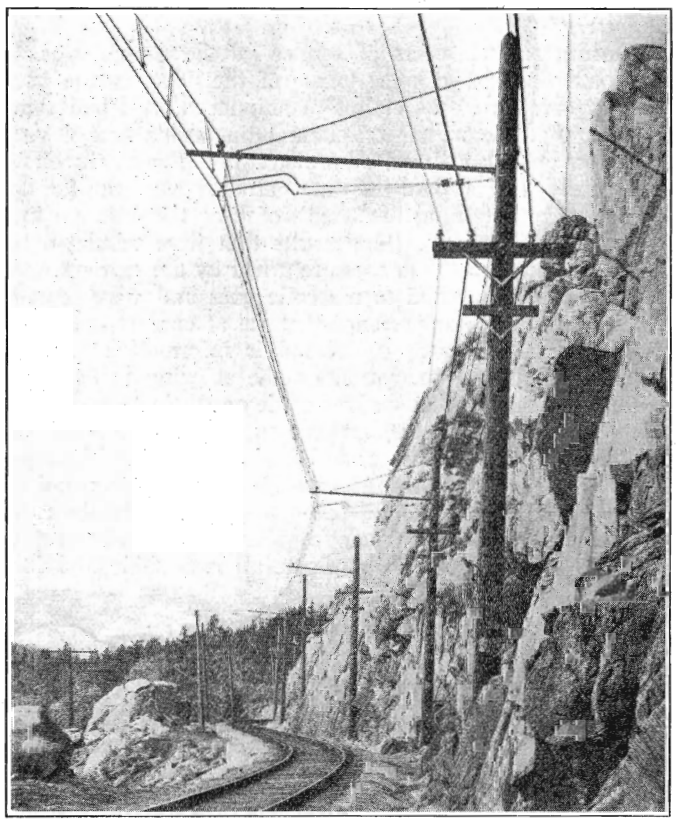
The main line electric locomotives are constructed in two units permanently coupled together, the halves being duplicates and each capable of independent operation. The enormous tractive effort of these electrical giants will be appreciated when it is stated that the wood burning locomotive of 50 years ago weighed 20 tons and had a tractive effort of only 5,000 lb. The modern Mallet steam locomotive weighing 278 tons with tender, which has been released, has a tractive force of 76,200 lb., while the electric locomotive, weighing 282 tons, has a running tractive force of 85,000 lb. and a starting tractive force of 136,000 lb.

There are 42 of these main line locomotives (30 freight and 12 passenger) and two switching locomotives. The locomotives are the first to be used for railroad service with direct current motors operating at a potential as high as 3,000 volts and the first to use direct current regeneration. The passenger locomotives are equipped with a gear ratio permitting the operation of 800 ton trailing trains at speeds of approximately 60 miles per hour on tangent level track. The average passenger train weighs from 650 to 700 tons and is hauled over the two per cent grade without a helper. The freight locomotives are designed to haul a 2,500 ton trailing train at approximately 16 miles per hour on all grades up to and including one per cent. On two per cent grades the

trailing load was limited to 1,250 tons, although this figure has been exceeded in actual operation.

The switching locomotives are of the swivel truck type, weighing 70 tons each, and equipped with four geared motors. A single pantograph of construction similar to that used on the main line locomotives is mounted on the cab and in other ways the locomotives represent the standard construction commonly used with the steeple cab type of switcher. Many of the switching locomotive parts are interchangeable with those used on the main line locomotives; for example, the air compressors, small switches, headlights and cab heaters.

Utmost precautions were taken by the railway company in making plans for this electrification to insure a reliable source of power. The Montana Power Company, with whom the contract was closed for electric power, operates a network of transmission lines covering a large part of Montana, which are fed from a main plant at Great Falls, and a number of other widely separated water power plants of adequate capacity at all seasons of the year. A notable feature of this



**Overhead Catenary Trolley Construction on a Curve on a Two Per Cent Grade**

pioneer electrification is, therefore, the conservation of fuel consequent upon the utilization of water powers. The Montana Power Company's transmission lines tap into the railway system at seven different points where the power is most needed. The railway company's transmission line extends the entire length of the system on wood poles. With this completely inter-connected transmission system, each substation may be fed from either direction and also at the tie-in points from a third source of power.

Electric locomotion has been adopted by the Chicago, Milwaukee & St. Paul with the expectation of effecting a sufficient reduction in the cost of operation to return an attractive percentage on the investment required, as well as to benefit by all the operating advantages of electric locomotives. According to statements made by the railroad officers, about $12,000,000.00 will be expended, and with the work more than half completed there is every reason to believe that the cost of construction will come inside the estimates.

### Results of Electric Operation

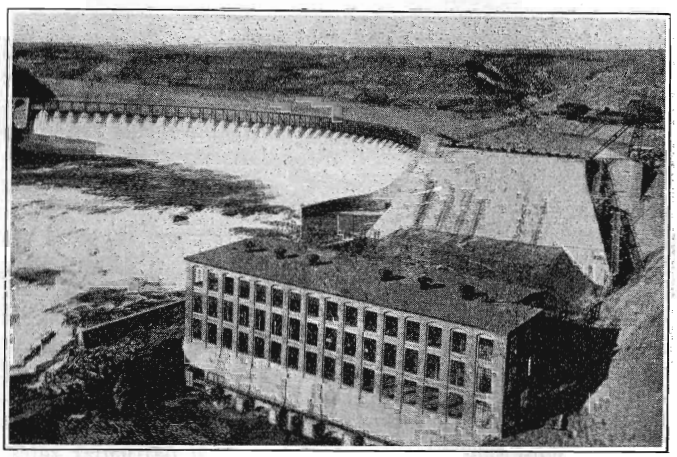
The results expected from electrical operation are as follows:

Marked reduction in cost of electricity as compared with cost of coal.

Reduction in maintenance cost of locomotives.

Elimination of delays due to coaling, taking water, oil, etc.

Elimination of delays due to natural causes, such as freezing of locomotives, loss of steam in cold weather, bucking snow drifts.



**Great Falls Dam and Power House at Volta, Mont.**

Elimination of non-revenue trains hauling coal and water for steam locomotives.

Increased tonnage per train.

Increased train speeds on grades.

Greater reliability and certainty of maintaining schedules.

Reduction in train crew hours per ton mile.

Reduction in damage to rolling stock due to rough handling by steam engines.

Greatly increased safety of operation on grades due to regenerative braking.

Saving in power and reduction in wheel and track wear by use of regenerative braking.

Improvement of tunnel conditions due to smoke and gas, absence of smoke and cinders which obscure scenic attractions, uniform speed and absence of grinding brake shoes on grades, all of which accrue to the benefit of the traveler on the transcontinental passenger trains.

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Harder Alloys of Copper.—An alloy of copper, having a degree of hardness not usually obtained, is secured by incorporating with the copper not more than 1 per cent of any one of the alkaline earth metals, calcium, barium, strontium and magnesium, according to a recent patent. The patentees assert that these alloys make sound castings, harder than pure commercial copper and of high electrical conductivity.—*Iron Age.*

Measurement of Bolts.—Bolts are generally measured from beneath the head to the first thread at the end. There is usually a point about 1/16 inch beyond the first thread. Cap-screws with square and hexagonal heads are provided with a thread cut three-quarters of the length for screws one inch and less in diameter, when the screw is less than four inches long. For longer screws the tread is usually cut one-half the length. Fillister-head screws are threaded two-thirds of the length. Screws are classified as set-screws only when the head is not more than 1/16 inch larger in diameter than the body of the screw. When the head is larger they are classified as cap-screws.