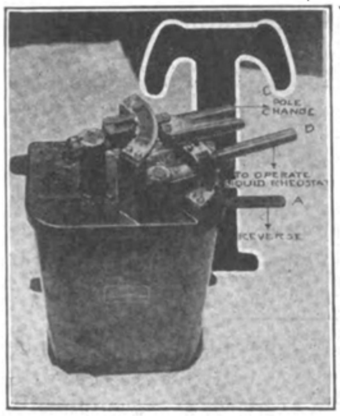
PRESENT STATUS OF RAILWAY ELECTRIFICATION

(The electrification of the railways of the nation is a problem that involves factors of such gigantic magnitude as to almost stagger the imagination. Yet the possible economic returns in conservation of coal and fuel oil combined with vast superiorities from almost every other conceivable viewpoint force thoughtful men to view with unusual interest the returns of records from present electrified lines throughout the nation. Here is authentic information on this subject which should prove of intense interest to our readers and of much timely import.—The Editor.)



The Master Controller on the Norfolk & Western Lines

TWO great railway electrifications have been followed with unusual interest during the past year by engineers generally. The Chicago, Milwaukee and Puget Sound Railway with its beautiful crossing of the high Rockies under electric propulsion has received frequent comment in the columns of the Journal of Electricity. In the issue for March 1, 1917, there appeared an article on the Norfolk & Western Railway electrification by A. H. Babcock, consulting engineer for the Southern Pacific Company, that has received nation-wide attention.

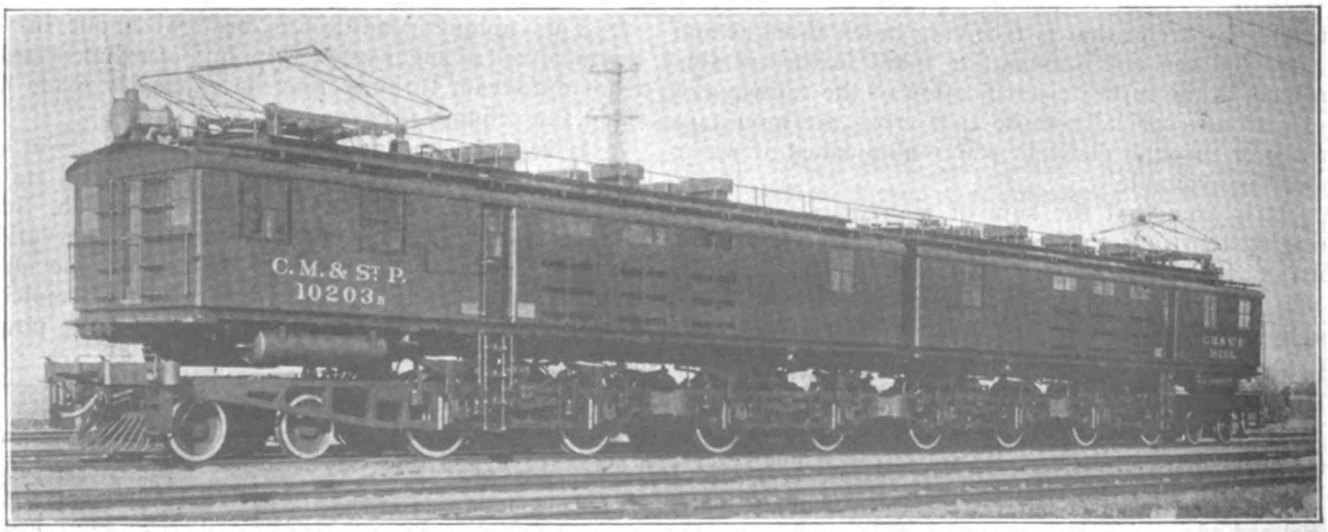
Since these various articles have appeared in the columns of the Journal of Electricity considerable investigation and inquiry have been made as to the actual costs of operation and maintenance of these two great systems of electrification. The executives of these organizations have been communicated with and the results of the inquiry have proven most illuminating. The information secured by the Mercantile National Bank of San Francisco, a correspondent of The National City Bank of New York, is interesting and timely. A few months back this banking institution gave out a statement from the superintendent of motive power of the Pennsylvania Railroad Company, showing that within the last five years that company has practically doubled the coal efficiency of its locomotives, at an increase of about 30 per cent in capital cost. Pursuing the same line of inquiry, to the substitution of hydro-electric power for steam power, a statement was given out from Vice-President Goodnow, of the Chicago, Milwaukee & St. Paul Railway Company, upon the results of electrical propulsion over its Rocky Mountain division, in October, November and December, 1916, as compared with steam propulsion in the corresponding months of 1915.

The statement does not go into comparative costs in dollars and cents, which would be a very complicated calculation, but that a conclusion has been reached favorable to electricity, at least under similar conditions, is evident from the fact that the company is now installing electrical equipment on its Cascades division.

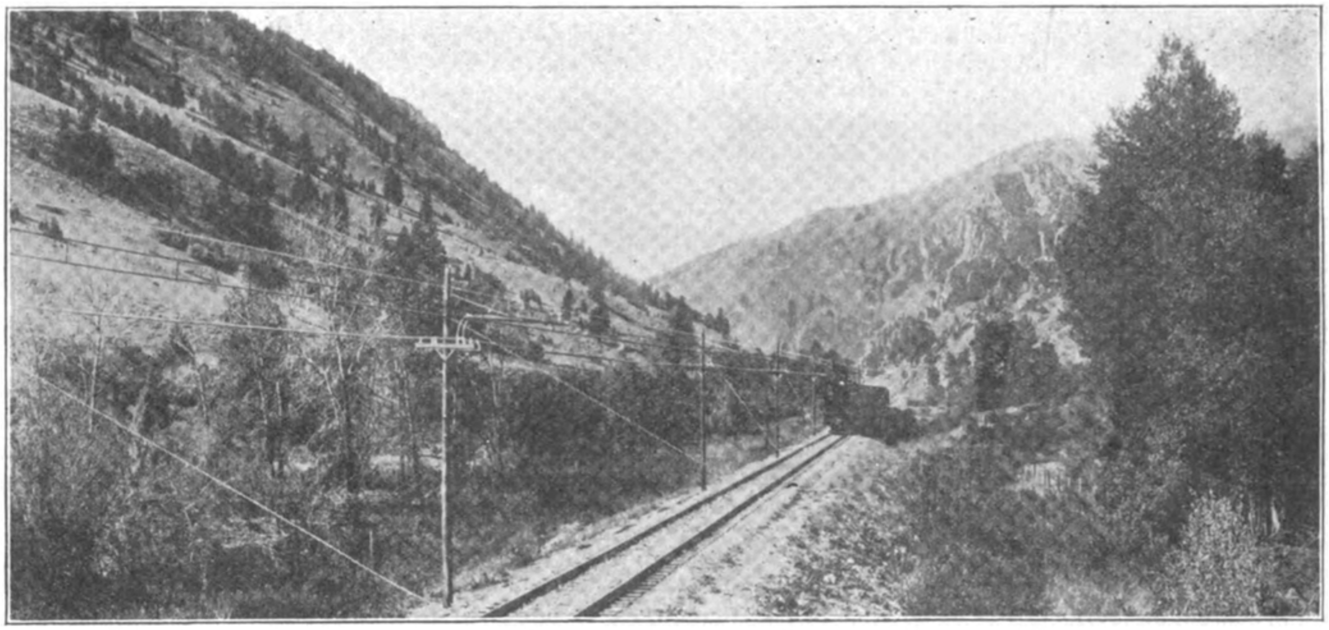
The facts given by Mr. Goodnow show that electricity is decidedly superior to steam in operating efficiency, especially in cold weather, and if the use of electric power increases the capacity of a road, enabling more trains to be operated over the same tracks, of course that fact is a very important element in the total cost of supplying transportation. The superintendent of the Rocky Mountain division has expressed the opinion that to have handled the traffic in the winter of 1916 without electricity, double tracking would have been necessary.

In this connection it may be added that an important consideration in the decision of the Pennsylvania Railroad Company to electrify its suburban service between Philadelphia and Paoli was the fact that it could thereby avoid a costly enlargement of its Philadelphia terminal.

An interesting feature of electrical propulsion is the fact that 11.3 per cent of the power consumed during the months under review was generated by the trains themselves on the down grades, but Mr. Goodnow says that this regeneration is reckoned as of minor importance compared with the ease and safety



Electric Locomotives on the Chicago, Milwaukee & Puget Sound Railway



The "Olympian" entering a Montana Canyon. This train is electrically operated and equipped throughout

of handling the trains on grades, and the lessened wear and tear on equipment. Other authorities say that the most valuable feature of this power generation is the "dynamic breaking," or the holding of the train at a uniform speed on down grades without the use of air brakes. Longer and heavier trains and greater speed are possible than with the use of air brakes.

The summary of the record of steam and electric operation in the periods under comparison is given below:

ber, 1916; item No. 7 for passenger service and item No. 20 gives the same information for through-freight service. The figures do not include coal used for switching or work trains, which figures I have not conveniently available. Item No. 5 of this table also gives the kilowatt hours used for passenger service, and item No. 18 gives the same information for through-freight service.

I might state, however, in this connection that the question of relative cost of fuel is only one of a good many items which affect the question of relative

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY CO.
Electrification Department

Data on Operation Under Steam in 1915, and Under Electricity in 1916

	Rocky Mountain Division	October		November		December		Total	
	Passenger	Steam	Electr.	Steam	Electr.	Steam	Electr.	Steam	Electr.
1	Train or Train Engine Miles	39,426	40,169	41,276	40,549	38,628	38,519	119,330	119,237
2	Helper Engine Miles	4,738	......	7,966	......	12,048	......	24,752	......
3	Number Engines	13	7	13	7	13	7	13	7
4	Train Miles per Engine	3,040	5,730	3,180	5,800	2,970	5,510	9,190	17,040
5	1,000 K.W.H. at Power Co.'s Meters	......	1,217	......	1109.5	......	1,152	......	3478.5
6	K.W.H. per Train Mile	......	30.3	......	27.4	......	29.9	......	29.1
7	Coal, Total Tons	3,380	......	4,150	......	3,739	......	11,260	......
8	Coal, Pounds per Train Mile	171	......	201	......	193	......	188	......
	Freight								
9	1,000 Ton Miles	98,512	125,522	93,228	130,848	91,122	107,717	282,862	364,087
10	Train Miles	60,666	65,400	58,014	63,299	58,257	57,311	176,937	186,010
11	Helper Engine Miles	16,605	7,022	20,422	7,544	19,336	5,591	56,363	20,157
12	Number Engines	42	15	41	15	44	15	43	15
13	1,000 Ton Miles per Engine	2,405	8,370	2,270	8,720	2,070	7,170	6,745	24,260
14°	Number Subdivision Trains	535	585	523	583	526	543	1,584	1,711
15•	Ton Miles per Train Mile	1,625	1,920	1,605	2,070	1,563	1,880	1,600	1,960
16	Total Time, Hours	6,094	5,022	5,946	5,084	5,785	4,429	17,825	14.535
17	Minutes per 1,000 Ton Miles	3.70	2.40	3.83	2.38	3.81	2.47	3.78	2.39
18	1,000 K.W.H. at Power Co.'s Meters	......	4,696	......	5,119	......	4,528	......	14,343
19	K.W.H. per 1,000 Ton Miles	......	37.4	......	39.1	......	42.0	......	39.4
20	Total Tons Coal	12,150	......	13,670	......	13,230	......	39,050	......
21	Pounds Coal per 1,000 Ton Miles	247	......	294	......	291	......	276	......

°"Subdivision Train"—One train over one Subdivision: Divide by 2 for trains over entire Division.

•"Ton-Miles per Engine-Mile" equals tons per train with one electric engine and short helper service, or with one steam engine and longer helper service. In this connection consider Item 17.

Total Regeneration over entire Division, month of November, equals 11.3% of consumption at motors.

Passenger on 2% grade, January 21-27, 1917—Regeneration = 42.8% of consumption at motors.

Passenger on 1.66% grade, January 21-27, 1917—Renegeration = 23.1% of consumption at motors.

Statement by Vice-President Goodnow

Chicago, August 31st, 1917.

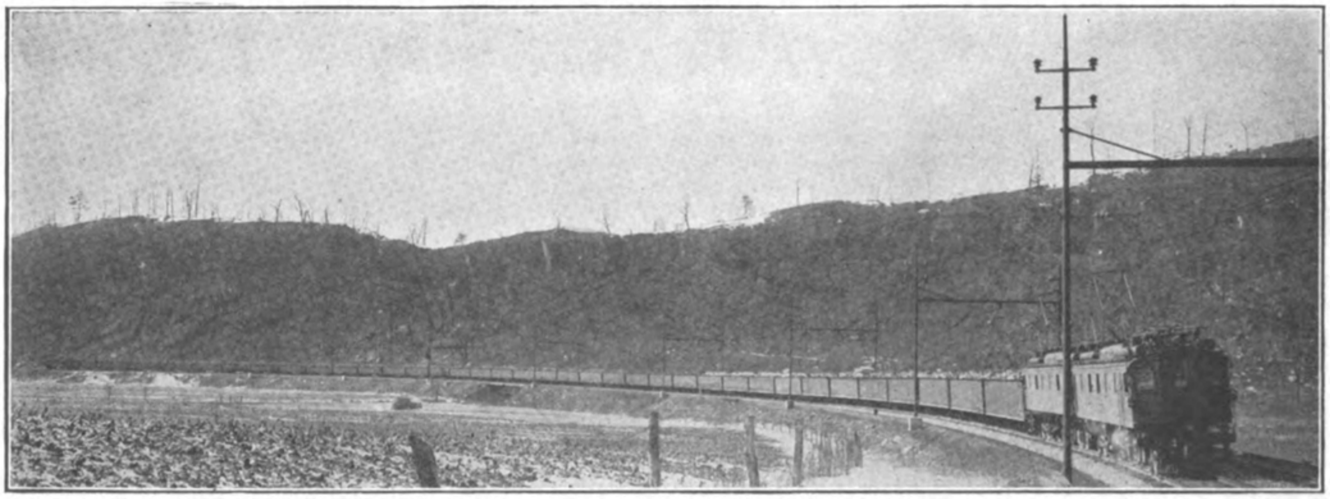
The National City Bank,
New York City, N. Y.

Gentlemen:—

Referring to your letter of August 6th, I attach hereto a blueprint which shows you the approximate tons of coal used for October, November and December, 1916; item No. 7 for passenger service and item No. 20 gives the same information for through-freight service.

economies under steam vs. electric operation, as I believe the following will indicate to you:

In the first place, although the figures shown on the blueprint show up favorably for electrical operation, they can by no means be considered as final, inasmuch as the compaıative figures for steam operation represent the results of many years of effort and experience, while the figures for electricity are based



How Giant Haulage is Accomplished Electrically on the Norfolk & Western

on the use of apparatus and a system which is entirely new in many respects, and at the time the figures were prepared, on an operating experience of less than one year. The figures are given for the Rocky Mountain Division only, as they have not been compiled in a similar manner for our Missoula Division.

Harlowton is the eastern terminus of the Rocky Mountain Division, and is the station where electric operation begins. Deer Lodge is the western terminus of this division, while Three Forks, located about midway between the two above named points, was formerly a steam engine division point. Under steam operation, train engines were changed at Deer Lodge, Three Forks and Harlowton. Thus, a steam locomotive made about 113 continuous miles. At the end of that run it was put in the roundhouse or shop to have it cleaned, boilers washed, etc., and for any light repairs. This necessitated a large roundhouse and shop force at each of the three above mentioned points. Freight trains were tied up in the yards and there were the usual other costly and vexatious delays. All train and engine crews changed at each of the through subdivision points mentioned, except passenger train crews which ran from Deer Lodge through to Harlowton. Under steam, the cabooses and many of the engines were assigned which of course made it necessary to take the caboose from the train at each subdivision point.

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 entirely. All locomotives run the entire 226 miles from Deer Lodge through to Harlowton with only a light inspection at Three Forks of bearings and pantographs. The shop and roundhouse are entirely closed down, seven or eight miles of tracks have been removed and the comparatively large roundhouse 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.

The same change in operation as referred to above has been effected on the Missoula Division, Avery to Deer Lodge; in this case Alberton being the steam engine division point eliminated.

The blueprint being sent you also shows for the Rocky Mountain Division a comparison of locomotive performance for October, November and December, under steam operation in 1915, and electric operation in 1916. It should be understood that the figures given, while sufficiently correct for comparative purposes, as they are taken from the same report forms, are not to be considered as strictly accurate when considered individually, the forms being those from which the data could most conveniently be obtained.

Item No. 2 on the blueprint shows that helper engine miles increased under steam as the temperature decreased, this being due to the difficulty of "steaming" the locomotives during extremely cold weather and making it necessary to operate helper engines in connection with passenger trains, over long distances. This helper service for passenger trains, with its extra crew cost, switching delays, etc., has been eliminated under electricity.

By reference to item No. 3 on the print, showing the relative number of engines required for electric vs. steam operation, you will note that less than half as many electric locomotives are required compared with steam engines, for the same service.

Item No. 9 under freight data, "Thousands of Ton Miles" shows an average increase during the months of electric operation of 28.8 per cent over that of steam. For November the increase was 40 per cent. In this connection the superintendent of the division has stated that to handle the 1916 business, either electrification, or with steam,—double tracking, was necessary. The latter would of course have required extra motive power. Possibly the superintendent did not intend his statement should be taken literally, but in any event it is reasonable to assume that under the business conditions which existed during the period under consideration, and the resulting congestion, the steam figures would be, for steam, too favorable.

Item No. 11 indicates that under freight service and for the same ton miles, there would be over three times as many helper engine miles under steam as under electricity, the cause for this being due largely to the same conditions as applied under passenger service.

Using the figures as they stand, we find from item No. 13, "Thousands of Ton Miles per Engine," that the electric engine handles about 3½ times as many ton miles per month as the steam engine, and from item No. 17, "Minutes per Thousand Ton Miles," that the electric engine cuts from the time to do a given business, 30 per cent, partly by faster running and partly by heavier trains.

Item No. 15, "Ton Miles per Train Mile," is about the same as tons per train, and 22 per cent greater for electricity than steam.

As to the effects of regeneration on the power consumption, it will be noted that for the month of November, the amount of regenerated power measured at the locomotives was 11.3 per cent of the total power consumed at the motors. I may say, however, that the power saving features of regeneration is not considered so important by us as the increased safety and ease with which trains are handled on the heavy mountain grades and the saving in wear and tear on brake shoes and equipment.

Truly yours,

C. A. GOODNOW, Vice-President.

Norfolk and Western Railway

The Norfolk & Western Railway has been operating for over a year with electric power over 29 miles of heavy grades upon its Pocohontas division, which includes the passage over the Allegheny Mountains. It has a heavy coal movement to handle. The company has made a statement about its experience with electric propulsion, from which we take the following:

"In the development of this business the company has taken advantage of all modern methods in steam traction, in respect to the use of maximum weight trains and the most powerful type of locomotives, and has thus reduced the movements over the division to a minimum. But it was found that track capacity was frequently reached in normal service and that growth of business could be cared for only by very expensive physical reconstruction. Careful study of the possibilities and economy of electric traction for these special conditions resulted in the conclusion that it would be practicable to increase the train speed greatly and that this, together with the elimination of delays occasioned by coaling and watering of steam locomotives, would enable a greatly increased tonnage to be handled at a reduction in operating cost which would return a substantial profit above interest and depreciation charges on the electric equipment, thus postponing the necessity for new trackage and other additions which would not directly reduce operating costs.

" . . . Twelve electric locomotives have been provided for the service, replacing thirty-four Mallet steam locomotives. Each electric locomotive consists of two units weighing 135 tons, giving a total weight of 270 tons for the complete locomotive.

"Electric operation has been in service too short a time to give data as to performance, but it may be said that the estimates of increased capacity to be obtained from this equipment have been fully met and that an unusually heavy tonnage has already been handled without congestion. The movement of the heavy tonnage trains by electricity has been effected with ease and smoothness; the trains accelerate promptly and without shock or jerk on the heavy grades, and it has been found that the full trains can be smoothly controlled by one head engine on the 2.5 per cent down grade by electric braking alone and at a uniform speed slightly above that of the regular running speed. The acceleration of one of these heavy trains is impressive as regards the amount of power required. Preliminary tests indicate that getting a train in motion up the grade requires as much as 11,000 electrical horsepower and that running at uniform speed up the grade requires 8,000 electrical horsepower to be delivered to the train. It is believed that no such amount of power has ever before been developed on a single train, either steam or electric, in regular service."

Railway Electrification After the War

The possibilities of railway electrification are especially interesting at this time, because they suggest a vast field open for construction work in this country and throughout the world, as soon as capital and labor can be had for it. There is naturally a feeling of uncertainty and apprehension as to industrial conditions after the war. The demand for war materials will fall off, the supply of labor on the market will be greatly increased, and it is a question whether all of this labor can be promptly placed in employment. It will be the most stupendous reorganization of industry ever known, and it is going to be a great social problem to accomplish this change without confusion, loss of confidence, and a period of stagnation. It is important that plans be laid on a large scale to take up the slack, and other countries are laying them. In this country, ready at hand, is the task of equipping the railroads, and other industries where practicable, to operate by electric power. The undertaking would involve an enormous amount of work and of many kinds. Hydro-electric plants would require in construction a great amount of labor, cement, steel, and heavy machinery. The demand for copper would take the place of the war demand for that metal, and keep the copper mines busy. The demand for electrical equipment of all kinds, including locomotives, would be very great, for the enlargement of the facilities for supplying electric power would cause electricity to be more generally adopted for all the industries. The amount of work in sight, if a general scheme of electrification was undertaken, would be sufficient to relieve the business community.

The danger will be in a pervasive feeling of uncertainty, causing men to wait with their own plans until they can discern the general trend, and waiting of itself slows down business. Large plans for the employment of labor which can be brought definitely forward at the critical time will serve to inspire confidence and support the whole situation.

The strength of the proposal is in the great amount of work of a semi-public character which it is possible to have done, and which would not only tide the country over the period of industrial uncertainty, but serve to put the country's industries upon a more economical basis permanently. Any reduction in the cost of power will strengthen the country's position in the competitive situation after the war. Every saving of this character will lessen the necessity for wage reductions after the war.