Electric Operation on the B., A. & P.*

During Seven Years of Heavy Freight and Passenger Service the Butte, Anaconda & Pacific Railway Electrification Has Increased in Capacity and Effectiveness—Locomotive Maintenance Costs Are Low

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THE Butte, Anaconda & Pacific Railway was built in 1892, principally for transfer service between the ore mines in Butte and the Washoe Smelter at Anaconda. Between the two cities the tracks are about 26 miles long. The railway was electrified in 1912 and 1913, the present total electrified mileage of single track being 120, which includes the main line, yards and sidings.

WHAT THE ELECTRIFICATION ACCOMPLISHED

To illustrate how the 2,400-volt direct-current system was able to meet the unusual conditions on this railway a few concrete examples will be given:

On the Smelter Hill line, 7 miles long with a 1.1 per cent grade, twenty-five ore cars, averaging 70 tons each, were hauled, as compared with sixteen cars hauled by a steam engine. With the electric locomotive the round trip is made in an hour, thus rendering it possible, unless there are unusual delays, to make eight round trips per day, or to deliver 200 cars in ten hours, as compared with six round trips and ninety-six cars per day with steam. Thus there is an increase of more than 108 per cent in this particular service, using the same crew and working the same hours.

In our main-line freight service between East Anaconda and Rooker, 20.1 miles, the standard westbound train formerly handled consisted of fifty cars, aggregating 3,500 tons in weight, and the average running time, with no stops, was about an hour and a half. This corresponds to 13.4 m.p.h. At first the electric locomotive took only the standard train, making the trip without stops in an hour, or at 20 m.p.h. The ruling gradient on the westward trip is 0.3 per cent and with a fifty-five car train the steam engine made approximately 7 m.p.h. The electric locomotive with a similar train made 16 m.p.h. on the same grade. The weight of train on this run has been gradually increased up to sixty-five loaded ore cars, averaging about 71 tons each, a trailing load of 4,620 tons. Adding 160 tons for the locomotives and 20 tons for the caboose gives a gross train weight of approximately 4,800 tons.

A comparison of June, 1913, under steam operation with June, 1914, under electrical operation shows that with a slight increase in the total tons of ore handled the average tonnage per train was increased from 1,761 to 2,378, or 35 per cent. The decrease in average time per trip was 27½ per cent. There was also a decrease of 75 per cent in the time lost through delays from all causes.

The trackage in and about the mines runs on many different levels, thus necessitating heavy grades and curves. It is safe to say that in approximately 25 miles of electrified track enough tangent track could not be picked out to equal 5 miles. Thus the overhead system has been built up to meet unusual conditions.

The original overhead installation was somewhat experimental in so far as the support structure was concerned. Subsequent to the first year of operation under electric power we found it possible to make a considerable reduction in the cost of overhead construction due to a more general use of brackets in place of the two-pole spans. On curve construction, up to and including four tracks with four degrees of curvature, we trim the pull-off points to a substantial backbone. Five tracks or more are trimmed in the usual manner, except that the backbone is done away with and a pole is substituted at each pull-off point. This change in construction was found necessary to reduce maintenance cost.

Three linemen are employed to maintain the overhead lines and feeders, with headquarters at Anaconda. One box car with a wood tower is kept for heavy line work and construction jobs. A Federal 1½-ton truck, equipped with car wheels and a Trenton tower, provides a convenient car for all general line work. The Trenton tower, as well as the movable table on top, is well insulated, so that it is possible to work on the contact wire under all weather conditions.

The average cost of maintenance of overhead system per mile per year for the past four years is $137.57. Table I shows the several items of cost for 1918.

TABLE I—COST OF OVERHEAD MAINTENANCE, B., A. & P. RAILWAY, 1918.

Poles and fixtures, labor	$3,261.52
Poles and fixtures, material	687.46
Feeders, labor	554.10
Feeders, material	87.77
Trolley, labor	3,889.79
Trolley, material	1,168.86
Bonding, labor	1,410.96
Bonding, material	1,980.23
Total of above	13,040.69
Motor car	1,119.65
Work train	2,290.04
Total maintenance expense	$16,451.08
Number of miles operated	120.27
Cost per mile per year	$136.78

The greatest wear, of course, comes at rigid points, such as pull-offs and rigid hangers. We use the roller pantographs, one to each locomotive, with a 2,400-volt bus line when two locomotives are connected in series. This bus line insures continuous current supply to both locomotives while passing under wood section insulators or in the event of arcing at rigid points. Currents up to 400 amp. per engine are collected, and we believe that better operating conditions are obtainable from the use of two pantographs.

Pantograph rollers give an average life of 20,000 to 40,000 miles. Each roller is mounted on a pair of Hyatt roller bearings, which wear out as many as three roller tubes. These bearings are greased twice each week with semi-hard grease. The contact pressure is main-

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TABLE II—MAINTENANCE AND OPERATING DATA, BUTTE, ANACONDA & PACIFIC RAILWAY, 1914-1919.
(Road Electrified 1912-1913)

	1914	1915	1916	1917	1918	1919
Number of electric locomotives	17	18	21	24	28	28
Average locomotive weight, tons	80					
Miles single track basis	90	90	114	114	120	122
Cost of repairs	$27,811	$35,253	$49,811	$55,846	$54,167	$35,264
Freight revenue miles	321,946	317,595	505,162	412,509	413,519	226,851
Passenger revenue miles	65,428	87,625	100,290	94,659	80,020	90,805
Switch revenue miles	136,892	161,871	404,356	367,690	324,322	197,838
Mixed and special revenue miles			616	456		
Total revenue miles	524,266	567,091	1,011,424	875,314	817,861	515,474
Non-revenue miles		5,507	2,477	10,796	2,957	1,142
Total locomotive miles	524,266	572,598	1,013,901	886,110	820,808	516,616
Maintenance per locomotive-mile in cents (not including depreciation)	5.3	6.16	4.91	6.3	6.4	6 8

tained at approximately 30 lb. and is adjusted by means of a hand spring-balance. All adjustments of this kind are made on a special track, wired but not energized.

Three electrical workers are employed at the machine shop to make such repairs as are necessary on electric locomotives, shop lights and power, coach heating and lighting, as well as to assist in the maintenance of block signals and dispatchers' telephones.

The equipment which must be maintained comprises twenty-eight electric locomotives, weighing 82 tons each, and equipped with four GE-229 motors with type M control. There are also two steam engines which have been retained for service on the Georgetown branch and on a sand-pit job not electrified.

The cost of the maintenance work on the locomotives, together with the data which are necessary in order to permit comparisons to be made, are given in Table II.

For comparison with the data in Table II, it is interesting to note that during 1909 the maintenance cost for steam locomotive operation per locomotive-mile, not including depreciation, was 16.1 cent. Wages and material have increased greatly in cost since 1909, so that the real saving is not shown by the data in Table II.

Taking up some of the details of maintenance work, attention may first be directed to tire wear. On account of the character of the track on this road, it is necessary to turn the tires every year. Tire wear is most noticeable at the flange. Our principal haul is "infested" with curves of 8, 10 and 20 deg. In all there is a total curvature of 13,342 deg. between the mines at Butte and the Washoe Smelter at Anaconda.

The average time for each locomtive in the shop per year is ten days, while the shortest is four days. During this time a general overhauling is given to the mechanical and electrical equipment. The time for electrical inspection and repairs varies with the class of service. In general, the electrical work is completed in less than two days. Poor rheostat connections and tight contactor pins give the only causes for electrical work in the cab. Regarding rheostats, ours have stood the test beyond any expectations. The first year or two of electrical operation developed a weakness which was soon overcome by replacing the jumpers between the rheostat boxes.

Our electric locomotives are inspected approximately every forty days. Engines working at Butte or on Butte Hill have no care except oiling and renewal of brake shoes. The maximum number of days which a locomotive has been away from the shop is seventy, during which it was working two ten-hour shifts per day. Monthly inspections, as we call our forty-day periods, are made over a cinder pit, summer and winter. Two electrical men inspect a double unit in twenty minutes to an hour, making all necessary repairs and adjustments. One machinist inspects the mechanical parts in the same time.

Seven machinists, two machinist apprentices, four helpers, two drill press men, one wiper, one oiler, one boilermaker and his helper, three blacksmiths and three helpers, who work on steel cars principally; a pipefitter and helper and a carpenter form the machine-shop crew.

One of the first questions asked by all visitors is: "How do your commutators wear?" In reply, it can be said that to date we have not turned a single commutator on account of wear. We have turned a few due to injuries received when inspection plates were allowed to fall on the commutators. The wear is now just appreciable. The color could not be improved, and there is no evidence of burning or flashovers. We are using an electro-graphitic brush, which gives very good mileage and very little breakage.

TABLE III—OPERATING DATA, B., A. & P. RY.

	April, 1917	April, 1918
Number of cars handled during month	31,282	25,980
Average cars per day	1,042.7	866 0
Total tonnage for month	1,337,911	1,137,498
Average tons per day	44,597	37,917
Number of main-line trains east per month	190	154
Total tonnage east per month	275,327	240,217
Average tons per train east per month	1,449	1,560
Number of main-line trains west per month	190	155
Tonnage of trains west per month	787,634	716,925
Average tons per train west for month	4,198	4,625
Average tons per train east and west	2,797	3,098

Like all electric roads, we have had some armature trouble. However, this amounts to so little that we keep but one man as an armature winder and his time is spent principally on equipment other than armatures. Recently we went one year and eleven months without an armature failure.

In order to give an idea of the amount of traffic handled the figures for April, 1917, and April, 1918. may be taken as representing average conditions. These are given in Table III.

Accountants Needed by I. C. C.

THE Interstate Commerce Commission is in need of a large number of examiners of accounts of common carriers, at salaries ranging from $1,800 to $3,000 a year, with the addition of the bonus of $20 a month granted by Congress. The United States Civil Service Commission is receiving applications for these positions.

The commission states that the positions afford an unusual opportunity to qualified persons; that under recent legislation returning the railroads to private control the duties of the Interstate Commerce Commission are greatly increased, and that those who enter the service as examiners of accounts will receive invaluable training in their chosen profession and at the same time will have a part in a public work of first importance. Applicants for these positions will not be given written tests in an examination room, but will be rated solely upon their education, training and experience.