As regards cost of maintenance, Mr. Fisher submits the following figures: The cost of maintenance of a cast-iron line is generally small, due to leaks in lead joints at 12-ft. intervals, and infrequent, but sometimes serious, breaks in the metal. The cost of maintenance of a properly constructed cast-iron line for the first 25 years, we believe, will be fully equal to that of a lock-bar steel line constructed as herein described, after which the maintenance of a steel line, due to recoating, will much exceed that of the cast iron.

The portion of Conduit 3 in question is 37½ per cent of the total length of Conduit 2, and the average condition relative to cost of recoating similar. The cost of recoating this portion may therefore be taken at 37½ per cent of the total cost.

COST OF RECOATING

The amount expended in recoating the total length of Conduit 2, as per table prepared by Mr. Skinner, was for 13 years:

From 1903 to 1915 inclusive	$122,851.91
Or an average of, per year	9,450.15
37½ % of which is	3,496.55

The total cost of $122,851.91 may be subdivided as follows:

For the first 5 years it was	$21,762.62
An average of, per year	4,352.53
37½ % of which is, per year	1,632.20
For the next 8 years it was	101,089.18
An average of, per year	12,636.12
37½ % of which is, per year	4,738.54

It has been assumed that no recoating would be required for the first 25 years and that an average of $1,632.20 per year would be expended the next five years.

Steel is $44,235 less than cast iron:		
$44,235 at 4% for (25 + 5) 30 years		$143,471.80
Less cost of recoating for 5 years (average per year $1,632.20)		8,840.52
Net sum remaining for future maintenance after 1946		$134,631.28
$134,631.28 at 4% for 8 years amounts to		184,252.33
Recoating for the next succeeding 8-year period, based upon the repairs of Conduit 2 for the last 8 years, would cost $4,738.54 per year or, accumulating at 4%, it would amount to		43,662.00
Deducting this from the above, we will have left in the year 1954		$140,590.33

Which at 4% interest will yield in perpetuity an annual maintenance fund of $5,623.61, while at all times after 1954 the principal sum of $140,590.33 will still be available.

The foregoing $5,623.61, at the rate of $3.08 per lineal foot, will recoat 1826 ft. of conduit per year, or 3.58 per cent of this section, which is about 25 per cent more than the average rate of recoating of Conduit 2 for the last 8 years. It will therefore be seen that if the conduit is constructed of steel, the present saving of $44,235 will keep it in repair for the next 38 years, while at the same time a fund of over $140,000 will have been created for future use.

In view of the foregoing statements and of the conditions on this portion of the line, Mr. Fisher is of the opinion that the adoption of the steel conduit, with the saving of $44,235 at this time, will not entail unwarranted expense upon a future generation. He therefore recommends that the contract be awarded to the lowest bidder for steel pipe.

SINGLE ELECTRIC UNIT HANDLES SEVEN AND EIGHT COACHES ON 2-PER CENT GRADES

Advantages of St. Paul Electrification Show

Six Months of Electric Operation Demonstrate That Greater Tonnages Can Be Handled at Higher Speeds

ELECTRIC operation of the Rocky Mountain division of the Chicago, Milwaukee & St. Paul Railway has now undergone a six months' trial, and certain advantages appear to have been demonstrated. One of these is a material reduction in running time. On one 21-mile 2-per cent grade alone the time for passenger trains has been reduced from 1 hr. 5 min. to approximately 40 min. In the freight service it has been found that where steam locomotives have required from 10 to 12 hr. to make 115 miles, electric locomotives can meet a schedule of from 7 to 8 hr. for the same distance.

The capacity of the new locomotives has been thoroughly tested. Trains of 3000 tons have been hauled east and 2800 tons west, a helper being used on the heavy grades. On some of the runs, where the grades are less than 1 per cent, trains of as many as 130 cars and as heavy as 4000 tons have been hauled by a single locomotive. It has been shown that much heavier trains can be hauled with the electric locomotives than by steam, and furthermore the capabilities of the electric equipment are not impaired by bad weather. During a series of record-breaking temperatures last December, Mallet engines were frozen up at several points and were rescued, with their trains, by electric locomotives.

Through passenger trains of 650 tons are hauled 220 miles by a single electric locomotive. Steam operation required a change of engines midway. Local passenger trains are handled by a half unit.

REGENERATING BRAKING

The regenerative braking has proved an easy solution to a difficult problem on the long mountain grades. Electric freight trains usually descend the maximum grades at 17 miles per hour, but half that speed can be maintained if desired. In case there are no other trains between the substations, to absorb the power generated by a descending train, the power passes through the substation machinery and is readily absorbed by the extensive system of the power company.

There are forty-four electric locomotives on the division—twelve passenger, thirty freight and two switching. They operate on the 3000-volt direct-current system, being the first to use so high a direct-current potential. (See the Engineering Record of Nov. 28, 1914, page 581, and that of Oct. 23, 1915, page 518.)

The foregoing information and illustrations are taken from an advance copy of a bulletin, "An Epoch in Railway Electrification," about to be issued by the General Electric Company, builder of the St. Paul locomotives.

BUTTE, ANACONDA & PACIFIC ORE TRAIN ON UPPER LEVEL; ST. PAUL FREIGHT ON LOWER