THE ELECTRIFICATION OF THE PUGET SOUND LINES OF THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY

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The author gives a brief account of the scope of the work to be undertaken on this the most important of steam road electrifications. He gives a description of the power supply available, the cost of power to the railway company, the type of substation and rolling stock equipment, and the overhead construction to be adopted. It is of special interest to note that the trolley potential is to be 3000 volts, which is the highest direct-current potential yet adopted in this country for railway work.—Editor.

Plans for the electrification of the first engine division of the Chicago, Milwaukee & St. Paul Railway have now been completed and contracts have been let with the General Electric Company for electric locomotives, substation apparatus and line material, and with the Montana Power Company for the construction of transmission and trolley lines. The initial electrification of 113 miles of main line between Three Forks and Deer Lodge is the first step toward the electrification of four engine divisions extending from Harlowton, Montana, to Avery, Idaho, a total distance of approximately 440 miles with approximately 650 miles of track, including yards and sidings. While this comprises the extent of track to be equipped in the near future, it is understood that plans are being made to extend the electrification from Harlowton to the Coast, a distance of 850 miles, should the operating results of the initial installation prove as satisfactory as anticipated.

The plans of the Chicago, Milwaukee & St. Paul Railway are of especial interest, as this is the first attempt to install and operate electric locomotives on tracks extending over several engine divisions, under which conditions it is claimed the full advantage of electrification can be secured. The various terminal and tunnel installations made in the past have been more or less necessary by reason of local conditions, but the electrification of the Chicago, Milwaukee & St. Paul is undertaken purely on economic grounds with the expectation that superior operating results with electric locomotives will effect a sufficient reduction in the present cost of steam operation to return an attractive percentage on the large investment required. If the savings anticipated are realized in the electric operation of the Chicago, Milwaukee & St. Paul Railway, this initial installation will constitute one of the most important mile-stones in electric railway progress, and it should foreshadow large future developments in heavy steam road electrification. The success of electric operation on such a large scale will at least settle the engineering and economic questions involved in making such an installation, and will limit the future problems of electrification to the ways and means of raising the required capital to effect the change in motive power.

The first step taken towards electrification by the Chicago, Milwaukee & St. Paul Railway was to enter into a contract with the Montana Power Company for an adequate supply of power over the 440 miles of main line considered for immediate electrification. The precautions taken both by the Railway Company and Power Company to safeguard the continuity of power supply should guarantee a reliable source of power, subject to few interruptions of a momentary nature only.

The Montana Power Company covers a great part of Montana and part of Idaho with its network of transmission lines which are fed from a number of sources of which the principal are tabulated below:

Madison River	11,000 kw.
Canyon Ferry	7,500 kw.
Hauser Lake	14,000 kw.
Big Hole	3,000 kw.
Butte, steam turbine	5,000 kw.
Rainbow Falls	21,000 kw.
Small powers aggregating	7,390 kw.
Total power developed	68,890 kw.

Further developments part of which are under construction are as follows:

Great Falls	85,000 kw.
Holter	30,000 kw.
Thompson Falls	30,000 kw.
Snake River	20,000 kw.
Missoula River	10,000 kw.
Total power undeveloped	175,000 kw.

Total power capacity developed and undeveloped, 244,000 kw.

tives having the above characteristics. The freight and passenger locomotives are similar in all respects except that the passenger locomotives will be provided with a gear ratio permitting the operation of 800 tons trailing passenger trains at approximately 60 m.p.h., and will furthermore be equipped with an oil-fired steam-heating outfit for the trailing cars. The interchangeability of all electrical and mechanical parts of the freight and passenger electric locomotives is considered to be of very great importance from the standpoint of operation and maintenance.

The cab consists of two similar sections extending practically the full length of the locomotive. Each section is approximately 52 feet long and the cab roof is about 14 feet above the rail exclusive of housings for the ventilation. The trolley bases are about five feet about the roof owing to the unusual height of the trolley wire which will be located at a maximum elevation of 25 feet above the rail. The outer end of each cab will contain a compartment for the engineer while the remainder is occupied by the electric control equipment, train heater, air-brake apparatus, etc.

Motors

The eight motors for the complete locomotive will be Type GE-253-A. This motor has a normal one-hour rating of 430 h.p. with a continuous rating of 375 h.p. The eight motors will thus give the locomotive a one-hour rating of 3440 h.p. and a continuous rating of 3000 h.p. which makes it more powerful than any steam locomotive ever built. The tractive effort available for starting trains will approximate 120,000 lb. at 30 per cent coefficient of adhesion.

Each motor will be twin-geared to its driving axle in the same manner as on the Butte, Anaconda & Pacific, the Detroit River Tunnel and the Baltimore and Ohio locomotives, a pinion being mounted on each end of the armature shaft. The motor is of the commutating-pole type and has openings for forced ventilation from a motor-driven blower located in the cab.

The freight locomotives are designed to haul a 2500-ton trailing load on all gradients up to one per cent at a speed of approximately 16 m.p.h., and this same train load, unbroken, will be carried over the 1.66 and two per cent ruling grades on the west and east slope of the Rocky Mountain Divide with the help of a second similar freight locomotive acting as a pusher. Track provision is being made at Donald, the summit of the grade, to enable the pusher locomotive to run around the train and be coupled to the head end to permit electric braking on down grade. In this case the entire train will be under compression and held back by the two locomotives at this head end, the entire electric braking of the two locomotives being under the control of the motorman in the operating cab of the leading locomotive. It is considered that electric braking will prove very valuable in this mountain railroading, as in addition to providing the greatest safety in operation, it also returns a considerable amount of energy to the substations and transmission system which can be utilized by other trains demanding power. In this connection, the electric locomotives will have electric braking capacity sufficient to hold back the entire train on downgrades, leaving the air-brake equipment, with which they are also equipped, to be used only in emergency and when stopping the train. There is therefore provided a duplicate braking system on down grades which should result in safety of operation, and should eliminate breakdowns, wheel and track wear and overheating, as well as leading to a reduction in maintenance and an improvement in track conditions.

With the completion of the remaining engine divisions it is proposed to take advantage of the possibilities afforded by the introduction of the electric locomotive by combining the present four steam-engine divisions into two locomotive divisions of approximately 220 miles length; changing crews, however, at the present division points. As the electric locomotive needs inspection only after a run of approximately 2000 miles, requires no stops for taking on coal or water, or layover due to dumping ashes, cleaning boilers or petty roundhouse repairs, it is expected that the greater flexibility of the locomotive so provided will result in considerable change in the method of handling trains now limited by the restrictions of the steam engine.

The electrification of the Chicago, Milwaukee & St. Paul Railway is under the direction of Mr. C. A. Goodnow, Assistant to the President in charge of construction, and the field work is under the charge of Mr. R. Beeuwkes, Electrical Engineer of the railway.