The Armour Engineer

VOLUME VIII NOVEMBER, 1915 NUMBER I

THE TRANSMISSION AND CONTACT SYSTEMS USED ON THE ELECTRIFIED DIVISIONS OF THE C., M. & ST. P. RY. CO.

BY MARSTON CURTIS*

Mr. Curtis presents a very timely article which should be of interest to all of our readers. According to the engineers in charge the electrification of that stretch of the road which covers three mountain ranges and has many long distance grades of from 1½ to 2 per cent will double the capacity. The railway company expects the same result as if the line over the mountain divisions would have been double-tracked.—The Editors.

The C., M. & St. P. Ry. Co. will be operating their first electrified division on the main line to the Pacific Coast very soon after this article goes to press, and it seems that now is the proper time to give the undergraduates and alumni an idea of the transmission and contact systems used on this project.

The first division will consist of 112.2 miles of main line single track from Three Forks to Deer Lodge, Mont., and in this territory will cross the Continental Divide at an elevation of 6,322 feet above sea level, by winding in and out of the canyons of the Rocky Mountains. The second division to be electrified extends from Three Forks east to Harlowton, Mont., a distance of 114.2 miles, crossing the Big Belt Mountains, and will be in operation by the early part of 1916. Construction work has already been started on the third division, which really consists of two engine divisions, extending from Deer Lodge, Mont., west to Avery, Idaho, a distance of 211.2 miles, crossing the main range of the Bitter Root Mountains at an elevation of 4,133 feet above sea level.

In this electrified territory are located fourteen substations, seven of which are practically complete, and the balance of

*Class of 1913. Assistant Electrical Engineer, C. M. & St. P. Ry. Co., Butte, Montana.

which are in the process of construction. The stations vary in capacity from 3,000 K. W. to 4,000 K. W., depending upon the load conditions which will be imposed upon them resulting from the proximity to other stations, track grade, and curvature. Seven substations will have power taps to the various transmission lines of the Montana Power Co., who are supplying power to the railroad at a potential of 100,000 volts.

The Railway Company's transmission line, which connects all but two of the substations together, consists of a three-phase, 60-cycle, 100,000 volt alternating current line supported on wood poles. Seven standard types of construction have been used to take care of different alignment and anchorage conditions, and may be classified in two groups, namely, normal construction, including plane, tangent and curve structures, and special construction, to take care of heavy angles, anchorage and long span conditions.

Figures 1, 2 and 3 show the tangent, right and left-hand curve type of construction, respectively, and are used on spans up to 450 feet, or on those which give a weight on one pole equivalent to 450 feet each of three transmission wires, which are 2/0 hemp core, six strand medium hard drawn copper wire, and one ⅜-inch Siemens-Martin galvanized steel strand ground wire. The standard length of spans on tangent work is 300 feet. The tangent pole is also used on curves up to one degree or angles of three degrees with the additions of a ⅜-inch S. M. guy. The curve types of construction are used on curves over one degree and on angles up to ten degrees, the span length being such that this angle is not exceeded on curves.

On spans where there are more than 450 feet of wire on a tangent pole, the construction shown in Fig. 4 is used, which is similar to that in Fig. 1, except for the double arms and two side guys. Angles of from ten to thirty degrees are built on a two-pole structure, similar to that shown in Fig. 6, except for the length of the cross arms. Where the angles are between thirty and ninety degrees the type shown in Fig. 5 is used. These, as well as the tangent construction in Fig. 6, are anchorage structures and serve to dead end the transmission line. One of these two pole structures is built in the line at least every mile, so that any failure in the pole line will amount to but a


Fig. 1
Fig. 2
Fig. 3
Fig. 4

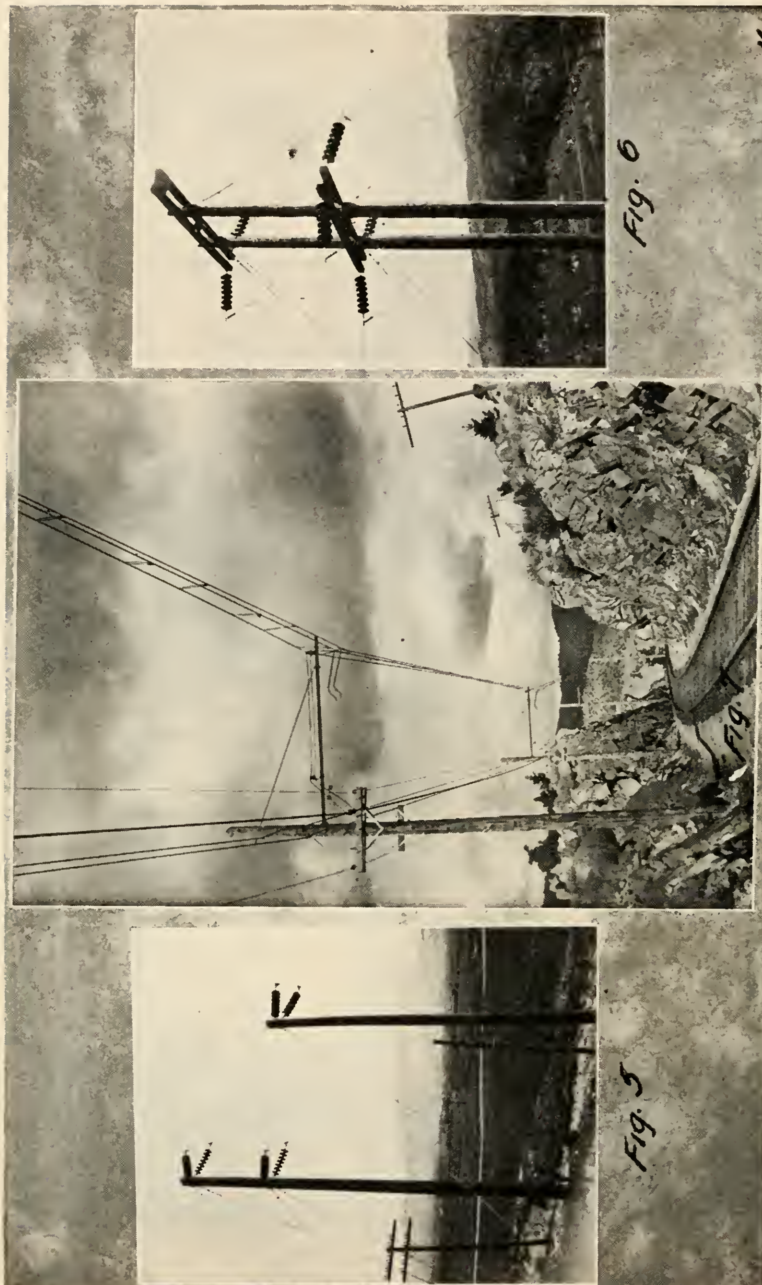
Fig. 6
Fig. 7
Fig. 5

comparatively small matter. Anchorages are also inserted in the line wherever there is a change in the tension of the wire, due to sections of extra long spans, such as over canyons, adjacent to standard spans.

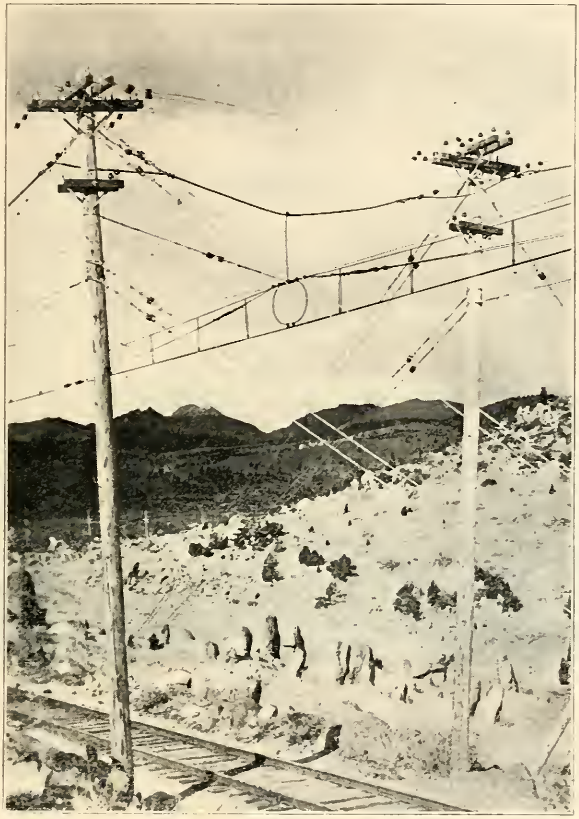

Fig. 8.

The feeder systems, which also serve as a tie on the 3,000 volt direct current side of all substations, is carried on the four-pin cross arm on the trolley pole. Fig. 7 also shows a feed tap to the two 4/0 copper contact wires, such taps occurring every thousand feet. The size of the feeder varies from one 500,000 circular mil bare copper cable to two 700,000 c. m.

cables, depending upon load conditions. Fig. 8 shows a feeder, signal and power-limiting wire crossing (the latter wires were not strung when the photograph was taken), and also a feed tap and a trolley and messenger anchorage.

The trolley and feeder systems are provided with "air breaks" in the former and cut-out knife switches in the latter, at the end of all yards and passing tracks, substations, and at each end of all long tunnels. This provides a means of killing a section of feeder and trolley in case of an accident, and at

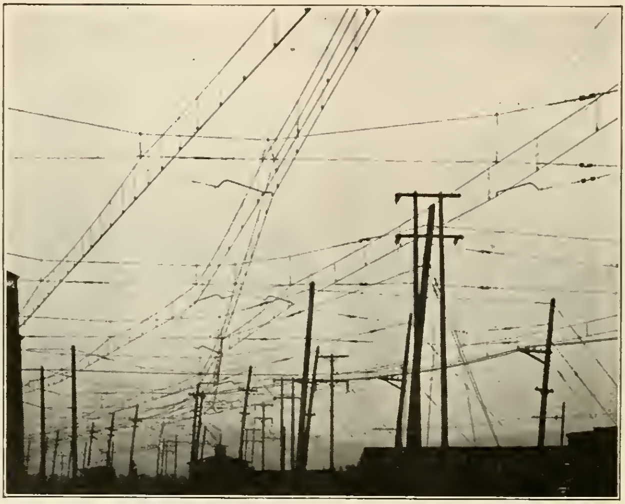

Fig. 9.

the same time allow the remainder of the system to be in operation.

The contact system consists of two 4/0 grooved copper wires on the main line, and one wire on passing track and guard tracks, Figs. 7, 8 and 9, suspended from one messenger of ½ inch high strength steel strand by catenary hangers placed every fifteen feet on the contact wire. The hangers are so placed on the main line that those on one wire stagger those on the other, which results in having a hanger every seven and a half feet on the messenger. The object of the double contact wire is to eliminate sparking at the pantograph due to "hard spots" in the line, and also to provide sufficient current carrying capacity for the locomotives.

The return current system consists of the track rail return through bonds, and the supplementary negative consisting of a 4/0 stranded copper conductor shown near the top of the pole in Fig. 7. All main line rails are bonded, while passing and yard tracks have only one rail bonded, all bonds being of 250,000 c. m. pin type. Two bonds per joint are used on the main line over the heavy mountain grades, while one is used elsewhere. The rail is tapped to the supplementary negative every 4,000 feet, and the latter is used mainly as a protection to section men and as a lightning protection to the wires on the trolley poles.