

Progress on C. M. & St. P. Electrification

The First Division Electrification of 113 Miles Is Nearing Completion and Construction Work on Three Other Engine Divisions Is Actively Under Way, Making a Total of 440 Miles of Main Line Equipped with Forty-Two 280-Ton Locomotives

REPORTS from Montana show that the work of equipping the first division of the Chicago, Milwaukee & St. Paul Railway's electrified zone is nearing completion, and it is estimated that by the middle of November the first electric train will be tried out between Three Forks, Mont., and Deer Lodge, Mont., a distance of 113 miles. At present construction crews are working from Harlowton, Mont., which is nearly 100 miles east of Three Forks, as far to the west as Drummond, Mont., the latter station being some 30 miles west of Deer Lodge, the western terminus of the electric division that is about to be placed in service.

The electrification, which includes 440 route miles and 650 miles of single track for the four divisions that extend across the Rocky Mountains is thus practically finished for a distance of more than 200 miles, the trackage that is being made ready for immediate train operation including extensive yards and sidings at Three Forks, Deer Lodge and Piedmont, as well as passing tracks at other points. The 100,000-volt transmission line that is being erected by the railway company to parallel the electrified tracks has been installed for an equal distance, and tie-in lines from the 100,000-volt system of the Montana Power Company are ready for service.

Overhead trolley construction and feeder lines are practically completed from Eustis, Mont., to Janney, Mont., making a total of more than 70 miles of overhead work, the former town being east of Three Forks and the latter near the city of Butte at the middle of the Three Forks-Deer Lodge division. The remain-

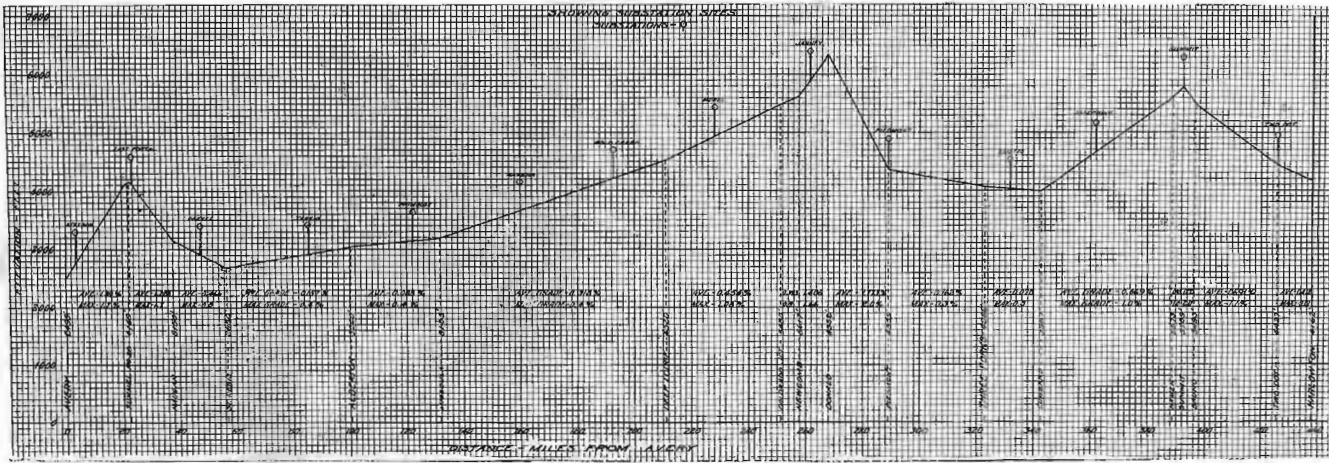
der of the overhead work westward from Janney is stated to be more than 50 per cent complete so that, in general, approximately 75 per cent of the overhead construction is in place. Three track-bonding crews are at work east of Three Forks, the bonding having been completed from Deer Lodge east to Canyon, a few miles east of Three Forks. The transmission line, which is of the wooden-pole suspension-insulator type with double cross-arms, has been completed from a point within 17 miles of Deer Lodge eastward to a point approximately 30 miles beyond Three Forks.

From the foregoing it is evident that the electrified division that extends between Three Forks and Deer Lodge is completely equipped, with the exception of the overhead construction between Butte and Deer Lodge. In addition, a considerable amount of work has been done east of Three Forks on the adjoining division, and in view of the magnitude of the undertaking, which is in charge of C. A. Goodnow, assistant to the president Chicago, Milwaukee & St. Paul Railway, the progress has been remarkable.

The accompanying illustrations show the general appearance of the new type of trolley construction that has been installed. It will be noted that wood-pole construction is used throughout both for cross span and bracket construction. The twin No. 0000 trolley wires are suspended individually and separately from the same steel catenary and the hangers of one trolley wire are located at points opposite the mid-span on the other trolley wire. In the switching yards, however, only one trolley wire is used, because the train movements at these points will take place at low speed, mak-



CHICAGO, MILWAUKEE & ST. PAUL ELECTRIFICATION—282-TON, 3000-VOLT DIRECT-CURRENT LOCOMOTIVE IN EXPERIMENTAL OPERATION ON TEST TRACK



CHICAGO, MILWAUKEE & ST. PAUL ELECTRIFICATION—PROFILE OF ELECTRIC ZONE AND SUBSTATION LOCATIONS

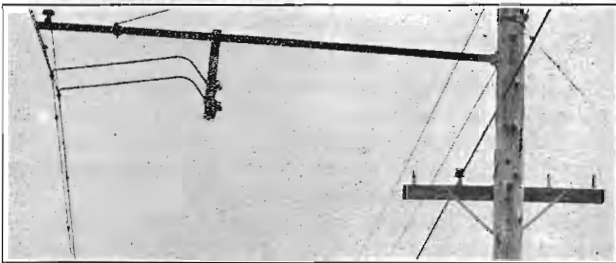
ing the collection of the large drafts of current an easy matter.

SUBSTATIONS AND EQUIPMENT

Seven substations designed to supply power to the eastern half of the 440 miles of route have been completed and electrical equipment is being rapidly installed. Complete shipments of transformers, motor-generator sets, switchboards and other accessories have

erection of the remaining seven substations located between Deer Lodge, Mont., and Avery, Idaho, at the western end of the electrified zone.

Each of the motor-generator sets in the substations consists of a 60-cycle, three-phase, 2300-volt, synchronous motor direct-connected to two 1500-volt direct current generators. The generators are connected permanently in series to supply 3000 volts to the trolley. Each set is also provided with an exciter at each end, one providing excitation for the revolving field of the motor and the other supplying the separately excited fields of the d.c. machines.



CHICAGO, MILWAUKEE & ST. PAUL ELECTRIFICATION—DOUBLE PULL-OFF ON CURVE FOR TWIN TROLLEY WIRE

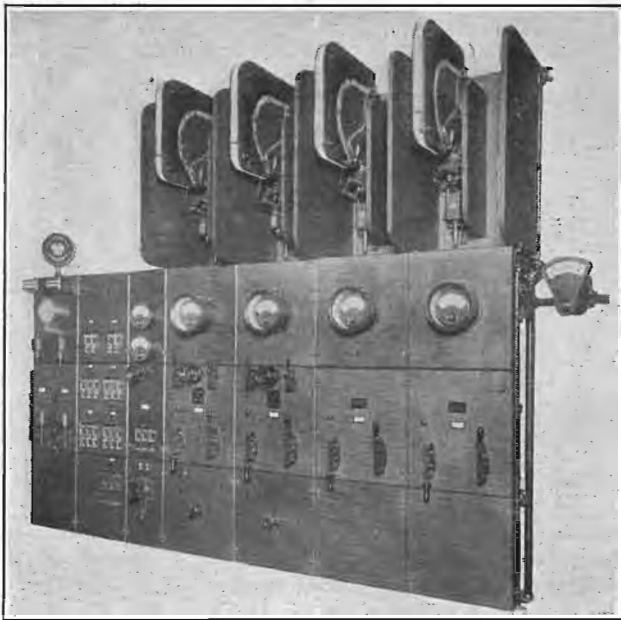
SUBSTATION EQUIPMENT, CHICAGO, MILWAUKEE & ST. PAUL RAILWAY

Station	Miles from Avery	Number Units	Size Motor-Generator Sets	Substation Capacity	Size Transfrs	Total Transfrs
Two Dot	425.6	2	2,000 kw.	4,000 kw.	2,500 kva.	5,000 kva.
Summit	392	2	2,000 kw.	4,000 kw.	2,500 kva.	5,000 kva.
Josephine	361.8	2	2,000 kw.	4,000 kw.	2,500 kva.	5,000 kva.
Eustis	331.8	2	2,000 kw.	4,000 kw.	2,500 kva.	5,000 kva.
Piedmont	289.1	3	1,500 kw.	4,500 kw.	1,900 kva.	5,700 kva.
Janney	261.7	3	1,500 kw.	4,500 kw.	1,900 kva.	5,700 kva.
Morel	228.3	2	2,000 kw.	4,000 kw.	2,500 kva.	5,000 kva.
Gold Creek	192.7	2	2,000 kw.	4,000 kw.	2,500 kva.	5,000 kva.
Ravens	160	2	2,000 kw.	4,000 kw.	2,500 kva.	5,000 kva.
Primrose	122.2	2	2,000 kw.	4,000 kw.	2,500 kva.	5,000 kva.
Tarkio	85.6	2	2,000 kw.	4,000 kw.	2,500 kva.	5,000 kva.
Drexel	47.5	2	2,000 kw.	4,000 kw.	2,500 kva.	5,000 kva.
East Portal	23.7	3	2,000 kw.	6,000 kw.	2,500 kva.	7,500 kva.
Stetson	3.6	3	1,500 kw.	4,500 kw.	1,900 kva.	5,700 kva.
		32		59,500 kw.		74,600 kva.

been made by the General Electric Company from Schenectady, N. Y., for the stations first erected, and the equipment of the four substations on the Three Forks-Deer Lodge division is practically ready for operation. Construction crews are proceeding with the



CHICAGO, MILWAUKEE & ST. PAUL ELECTRIFICATION—SUBSTATION AND OPERATORS' HOUSES AT TWO DOT, NEAR THE EASTERN END OF THE ELECTRIFIED DIVISION

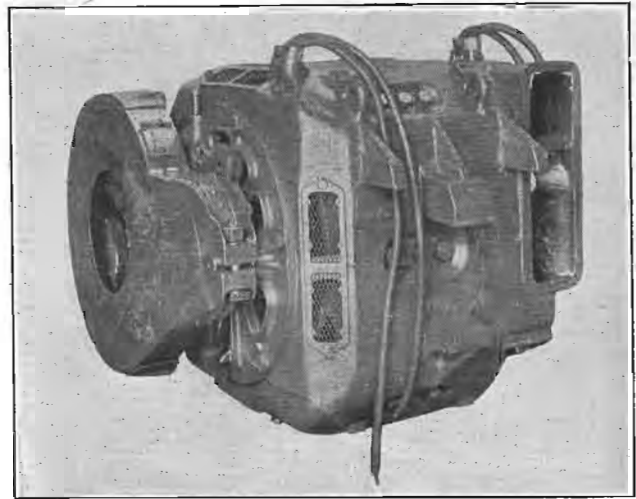


CHICAGO, MILWAUKEE & ST. PAUL ELECTRIFICATION—
HIGH-VOLTAGE, DIRECT-CURRENT SWITCHBOARD
FOR SUBSTATIONS

These sets are, in general, similar, except as regards voltage and capacity, to the five 1000-kw., 2400-volt units that have been in operation on the Butte, Anaconda & Pacific Railway for the past three years. However, there has been added one new feature which deserves mention. This consists of a longitudinal ventilation of the core and field coils similar to that employed in the well-known GE ventilated railway motor. The use of this method of cooling has effected a considerable reduction in the floor space required per kilowatt.

The d.c. generators are equipped with commutating poles and compensated pole-face windings to insure sparkless commutation under heavy overloads. The overload capacity is 150 per cent of the normal load for two hours, and 300 per cent of the normal load for periods of five minutes. This will provide ample margin for starting a train of maximum tonnage on the most difficult grades.

It is interesting to note in connection with these substations that the motor-generator sets are designed to



CHICAGO, MILWAUKEE & ST. PAUL ELECTRIFICATION—
430-HP., 1500-VOLT MOTOR USED ON
LOCOMOTIVE

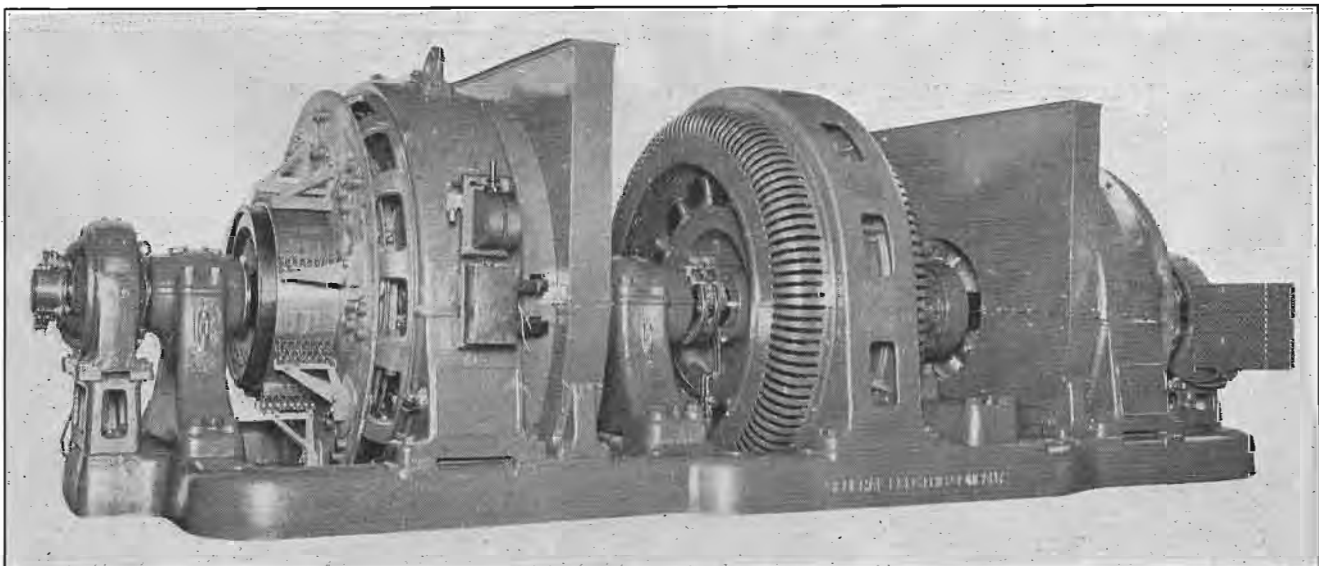
operate inverted in case the power that is regenerated by the locomotives on the down grades exceeds that required by other trains operating nearby. For this reason there is no necessity for water boxes or other energy-consuming devices, since the excess energy is returned direct to the 100,000-volt transmission system.

SWITCHBOARDS AND TRANSFORMERS

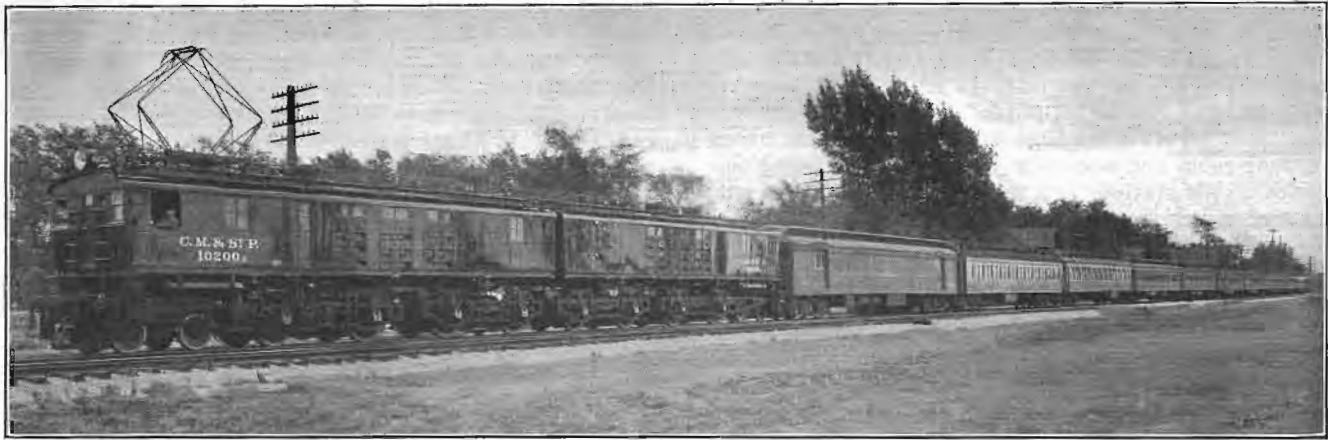
The main direct-current switchboard in each station is of special interest, since it represents the latest practice in high-voltage direct-current switch apparatus. A panel is provided for each set and two panels are provided for feeders in each direction.

The circuit breakers and switches are mounted on separate panels located above and a short distance back of the main panels, similar in general to those now operating in the Butte, Anaconda & Pacific substations. The control handles for operating the breakers and switches are located on the main panels and are connected to the circuit breaker panels through insulated wooden rods.

In addition to the special high-voltage d.c. panels, switchboards are also being furnished for the synchronous motors and auxiliary circuits. Oil switches and



CHICAGO, MILWAUKEE & ST. PAUL ELECTRIFICATION—VENTILATED 2000-KW. MOTOR-GENERATOR SET FOR 3000-VOLT
DIRECT CURRENT



CHICAGO, MILWAUKEE & ST. PAUL ELECTRIFICATION—LOCOMOTIVE COUPLED TO THE "OLYMPIAN," THE FAMOUS TRANSCONTINENTAL TRAIN BETWEEN CHICAGO AND TACOMA

other standard 100,000-volt equipment are also being installed for the high-tension circuits.

The transformers are an excellent example of the most recent design and construction. There is a total of thirty-two of these units which are to be used for stepping down the power supply from the 100,000-volt transmission line to the 2300 volts required for the synchronous motor-generator sets. All are of the three-phase core type with a ratio of voltages of 102,000:2300. For regulating purposes taps are provided for 97,200 volts and 94,200 volts. Taps are also brought out on the secondary windings to give 1150 volts for starting the motor-generator sets.

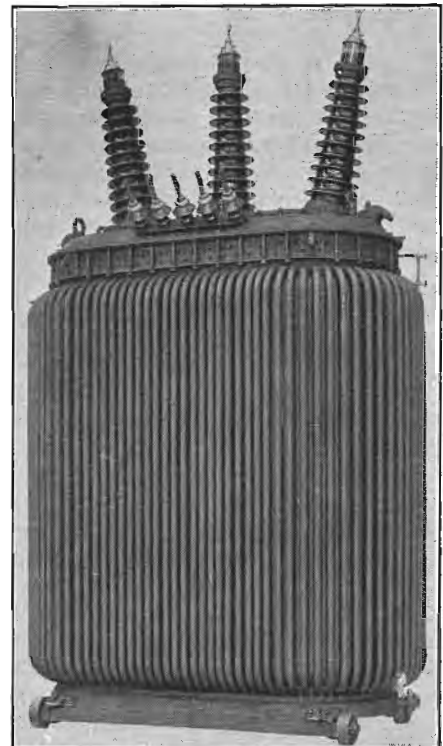
The transformers are oil cooled and the tanks are of the tubular type, the main body consisting of steel plate with tubes welded to the sides of the tank at top and bottom, giving absolutely oil-tight joints. An air dryer and breather is attached to the tank so that all interchange of air between the interior of the tank and the outside must take place through this channel. This drier is provided with chambers containing a

moisture extracting medium thereby preventing the entrance of moisture to the tank.

The bushings furnished with these transformers are weatherproof and as all joints are tight, they are suitable for outdoor as well as indoor operation. At the top of the high tension oil-filled leads is a glass cup which shows the height of oil in the leads. Accessories consisting of thermometer, oil gage and drain valve are also provided. Each transformer is mounted on flat wheels to facilitate movement for making repairs and a lifting device is furnished for removing the transformer core.

In addition to the main transformer equipment, each substation is furnished with a standard 10-kw., three-phase transformer stepping down from 2300 volts to 110 volts for lighting and auxiliary power circuits. For operating the railway signal circuits, a standard, 25-kw., single-phase transformer is being installed in each substation, this stepping up the voltage from 2300 to 4400.

A portable oil drying outfit will be used for remov-



CHICAGO, MILWAUKEE & ST. PAUL ELECTRIFICATION—BONDING CREWS AT WORK—RADIATOR TYPE, 100,000-VOLT TRANSFORMER

ing moisture from the transformer oil. This outfit consists of a motor-driven pump which forces the oil through a specifically-designed filter and an electric drying oven for drying the filter paper. A portable oil-testing set will also be supplied.

For housing the families of the substation operators, four-room and five-room bungalows are being constructed at the stations and these will be furnished with light and power from the low-voltage auxiliary circuits.

LOCOMOTIVES

Work on the construction of the forty-two 282-ton locomotives for this electrification is progressing rapidly at the Erie Works of the General Electric Company and in the Schenectady plant of the American Locomotive Company. The first complete locomotive was placed on the test tracks early in September and shipment was made as scheduled on Sept. 25.

This locomotive has been taken in charge by the railway company at Chicago and it is now being towed over the lines of the Chicago, Milwaukee & St. Paul for purposes of exhibition at Chicago, Minneapolis, St. Paul, Spokane, Seattle and Tacoma, Wash. At each of these cities the time and place at which the locomotive is to be on exhibit is announced in the local newspapers. The engine is in the charge of two men familiar with its construction so that any questions which may be asked by the public will be correctly answered. Aside from the exhibition of the locomotive, moving pictures of it are to be exhibited at all points along the lines of the Chicago, Milwaukee & St. Paul Railway. An illustration on page 797 shows the locomotive coupled to the crack train of the St. Paul system, the "Olympian."

A complete set of tests on the Schenectady testing tracks indicate that the locomotive will easily exceed the expectations of the designers which were outlined in the *ELECTRIC RAILWAY JOURNAL* for June 5, 1915. The actual weights of the complete unit equipped for freight service are as follows:

Total weight	564,000 lb.
Weight on drivers	448,000 lb.
Weight per driving axle	56,000 lb.
Weight per guiding axle	29,000 lb.

Twelve of the locomotives on order are geared for passenger service and the remaining thirty are geared for freight service. Both freight and passenger types are equipped for regenerative braking, this apparatus being under control of the engineer. All of the passenger locomotives and several of the freight locomotives will be equipped with oil-fired steam boilers for heating the passenger trains, this equipment, of course, including ample storage tanks for oil and water.

Recent Conferences on the Safety Code

The American Electric Railway Association committee to confer with the bureau of standards on the proposed "National Electrical Safety Code of Rules," met in Rochester, N. Y., on Sept. 28, 29 and 30 in pursuance of its study of the code. At this meeting there were present representatives of similar committees appointed by the Central Electric Railway Association, the New York Electric Railway Association, and the Pennsylvania Street Railway Association. Those present were: C. L. Cadle, electrical engineer New York State Railways, Rochester, N. Y., and W. J. Harvie, Allen & Peck, Inc., Syracuse, N. Y., representing the American Electric Railway Association; Adolph Schlesinger, superintendent of distribution Terre Haute, Indianapolis & Eastern Traction Company, Indianapolis, Ind., and G. H. Kelsay, superintendent of power Union Traction

Company of Indiana, Anderson, Ind., representing the Central Electric Railway Association; James P. Barnes, general manager Buffalo, Lockport & Rochester Railway, Rochester, N. Y., representing the New York Electric Railway Association, and Gordon Campbell, president York (Pa.) Railways, representing the Pennsylvania Street Railway Association.

It was not possible to complete the work at this session and the meeting was adjourned to Oct. 5 at New York, at the rooms of the American Institute of Electrical Engineers, and the same procedure was followed in Rochester. In New York the American Association was represented by Messrs. Harvie and Cadle and by Prof. A. S. Richey, Worcester (Mass.) Polytechnic Institute. The other associations were represented as before excepting that Mr. Kelsay was absent. This meeting produced very beneficial results in co-ordinating details of electric railway practice.

On Oct. 6, by invitation of the bureau of standards, the committee and representatives of the bureau met and discussed in detail the suggestions which had been developed by the American Association's committee, with the co-operation of the state committees above referred to, and it was found possible to eliminate a considerable number of points of difference, thereby enabling the bureau and the committee to come much closer to agreement in perfecting the proposed code. It was not possible during the day to consider completely all of the suggestions made, and the committee expects to co-operate in further conference with the bureau and with the other associations.

Report on Taxation Matters

Owing to typographical errors the totals in the last two columns of Table III in the report of the committee on taxation matters of the American Electric Railway Association, abstracted in the *ELECTRIC RAILWAY JOURNAL* of Oct. 9, page 734, were erroneous. The percentage of total federal taxes to electric railway operating revenue for 1914 should have been 0.237 per cent instead of 6.717 per cent, and a similar percentage for the total of all taxes should have been 6.717 per cent instead of 5.702 per cent. The detailed total for Hawaii in the last column also should have been 5.176 per cent instead of 1.763 per cent. The following table compiled from the data in this committee's report shows the total comparative taxation figures as they should appear:

TABLE SHOWING RAILWAY OPERATING REVENUE, TAXES AND PERCENTAGES OF TAXES TO REVENUE FOR EIGHTY-THREE ELECTRIC RAILWAYS FOR YEARS ENDED IN 1904 AND 1914

	1904		1914	
	Amount	Per Cent of Railway Operating Revenue*	Amount	Per Cent of Railway Operating Revenue*
Railway operating revenue	\$140,183,165	...	\$237,968,085	...
Municipal taxes	4,378,048	3.125	8,108,476	3.410
State and county taxes	3,997,172	2.850	7,307,440	3.070
Federal tax	565,792	0.237
Total taxes	8,375,220	5.975	15,981,708	6.717

*United States percentage.

In a recent editorial the *Engineer* of London expressed the belief that field for the split-phase system of electrification such as has been installed on the Norfolk & Western Railway was limited in Great Britain, owing to the complications on the locomotives notwithstanding its great advantages in the use of the rugged induction motor with an overhead system having but one wire. The direct-current system was considered best suited to conditions on the British Isles.