third rail, which was in service at the time, were receiving severe shocks.

Fig. 13 is a sketch illustrating in cross-section the arrangement of the bare auxiliaries and third and traction rails.

On examination, it was found that the inconvenience to the men only resulted when these bare cables were insulated (not grounded). A thorough investigation gave the following results:—

Contact, by means of the hands to these bare cables and the traction rails, did, at times, cause unpleasant sensations of such magnitude as to be conclusive to one experienced to such that a considerable potential, much greater than that shown by a potential meter, existed.

The sensations were only experienced by making and breaking contact. They were, therefore, not due to alternating potential.

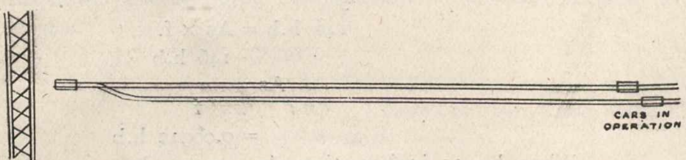

Fig. 11.—Street Rails with Load Some Distance from Structural Ironwork.

As the sensations were not due to alternating potential, they were not the result of induction caused by the few volt variations of the voltage of the third rail.

As the shocks were rapidly experienced if making and breaking were carried out rapidly, such could not be due to the discharge of inductance (induced statical charge), as in the case of a so-called static condenser.

When readings were taken with a potential meter. the lineal deflections of the needle were the same whether the low or high range terminals of the instrument were used. Such unexpected action of the meter, however, is explainable. For voltage is only one of the factors necessary to produce a deflection of the needle, as it simply forces the amperage through the resistance. So that $C = \frac{I}{R}$ is only true when the amount of C is sufficient. In Fig. 14, consider the meter as having two ranges: the resistance coil of the lower one having with the resistance coil of the movable coil a resistance of 2,000 ohms; and the higher range having, similarly, a resistance of 10,000 ohms. That the voltage of the third rail is 555. That the traction rails have a voltage of five, due to a return drop of five volts. That the insulation resistance between the third rail and the bare auxiliaries is four-tenths of a megohm. That the insulation resistance

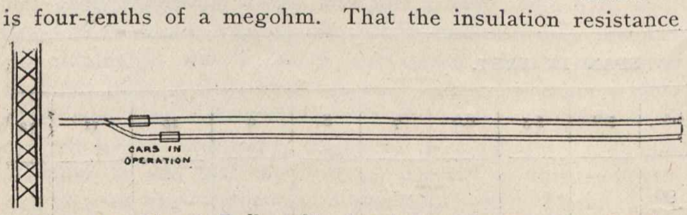

Fig. 12.—Street Rails with Load near to the Structural Ironwork.

between the bare auxiliaries and the traction rails is a little over one megohm. That, of course, the third and traction rails are connected to a generating medium. The voltage of the bare auxiliaries will then be 400.

Now, by $C = \frac{I}{R}$, the 2,000-ohm resistance requires for a true deflection $\frac{400}{2,000} = \frac{200}{1,000}$ amperes, or 200 milliamperes. But, when the meter is connected to the bare cables and the traction rails, the total resistance controlling the C is 2,000 + 400,000 ohms; which, by $C = \frac{I}{R}$, permits of the transmission of only $\frac{400}{402,000} = \frac{1}{1,005}$ amperes, or, roughly, one milliampere. But it has been shown that 200 milliamperes are needed for a true deflection under the condition of potential existing. As a result, only one-two-hundredth of a true deflection will be obtained. This is, the meter, instead of showing a potential of 400 on the lower range of the scale will only show one of 2.

Similarily, the 10,000-ohm resistance requires for a true deflection $\frac{400}{10,000} = \frac{40}{1,000}$ amperes, or 40 milliamperes. But the total resistance governing the amount of C transmitted is 10,000 + 400,000 ohms; which amount of C, therefore, is $\frac{400}{410,000} = \frac{1}{1,025}$ amperes, or, roughly, one milliampere. But, in this case, it was shown that forty milliamperes are required to produce a true deflection. As a result, only one-

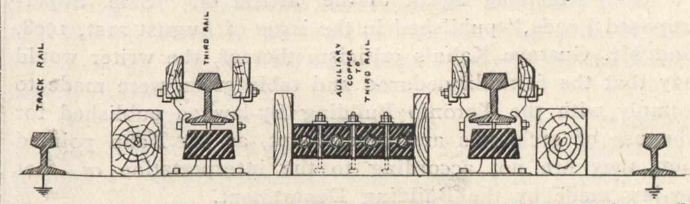

Fig. 13.—Arrangement of Bare Auxiliaries, Third Rails and Traction Rails.

fortieth of a true deflection will be obtained. That is, instead of a high range showing a potential of 400, it will only show one of 10.

Now, two volts potential by the lower range and ten volts potential by the higher range are read by a deflection of the needle to the same point on the scale. This is, the lineal deflection of the needle of a potential meter, in cases similar to that under consideration, will always be the same whether the low or high range terminals are used. And in somewhat similar cases, where very small potentials are dealt with, as in many instances occur when taking the potential of earthed conductors, the deflections, owing to the small amount of C available, will be so slight as to be unreadable. Many cases have come under the writer's observation where, having obtained a potential of, say, one-quarter of a volt between one earthed conductor and an earthed return and two volts between another earthed con-

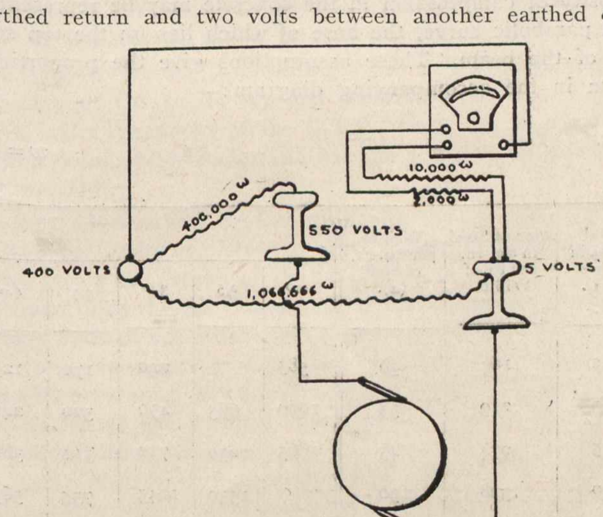

Fig. 14.—Testing Arrangement giving Misleading Readings due to High Insulation Resistance in Series in Test Circuit.

ductor and the same return, he has been unable to obtain readings showing a potential between the two earthed conductors; though, as will be understood, there must have been a potential of one and three-quarters volts.

A Canadian patent has been granted to Walter P. Chapman, C.E., of Toronto, for an instrument to record stresses in members of a bridge or building, either under dead or moving loads, and should prove of great value in design and construction of structures.