may be called the power lag. The method is to get two independent voltages, U_1 and U_2 , differing in power phase by $\pi/2$ and to add together suitable fractions of these, such as $U_1 \sin \phi$, $U_2 \cos \phi$. The resultant is equal to U_1 , but with the power phase turned through ϕ . The unknown small voltage is connected in series with an auxiliary voltage and a voltmeter, and the phase of the latter voltage is turned until the maximum deflexion is obtained.

XXXIX. *On a Method of Measuring Power in Alternating Current Circuits.* By ALBERT CAMPBELL, B.A.*

[Abstract.]

THE circuit in which the power is to be measured is connected across the supply circuit in series with a small non-inductive resistance. By means of a transformer the small voltage on this resistance may be transformed into one whose power phase is π behind the voltage on the resistance. This is added to the voltage on the circuit to be measured, and then reversed and added again. The difference of the squares of these effective resultants is shown to be equal to a constant into the power to be measured. If there is any direct current it must be measured separately by a Weston voltmeter or other suitable instrument.

XL. *Note on obtaining Alternating Currents and Voltages in the same Phase for Fictitious Loads.* By ALBERT CAMPBELL, B.A.*

[Abstract.]

WHEN testing instruments for the measurement of large amounts of electrical power or energy, it is usually desirable to do so by means of fictitious loads, *i. e.*, by applying to the instrument under test current and potential-difference representing the required load. In order to obtain a fictitious

* Read November 9, 1900.

non-inductive load with alternating currents, the potential difference and currents should be in the same phase. The current for the instrument under test is got by means of a transformer worked on a 100-volt circuit. The potential-difference in the same phase is got by allowing the current to flow through a non-inductive resistance, and increasing the voltage at the ends of the resistance to the required amount by means of another transformer.

XLI. *On the Magnetic Field produced by Electric Tramways.*
*By Prof. A. W. RÜCKER, Sec.R.S.**

THE following calculations were made during the inquiry which has recently taken place on the Magnetic Field produced by Electric Tramways. In the course of the discussion it became evident that the gentlemen who represented the Tramway Companies had arrived at similar results; and Mr. Parry has published in the 'Electrician' for Aug. 10, 1900, a full account of this part of the theory. I had worked out both the "source and sink" and the "Fourier-Bar" theories, given below, before I was aware of the fact. The former is perhaps as accurate as the assumption that the earth is homogeneous will allow; and it was *a priori* improbable that the Fourier-Bar theory would represent the facts near the terminals of the line. The following results confirm this view; but this part of the subject was developed in consequence of a statement by the Engineers that the "Fourier-Bar" theory agreed with the results of experiments conducted by themselves, and which are not further referred to in this paper.

There is no difficulty in the calculations; and my only object in publishing some account of them is to draw attention to the fact, which is not, I think, generally recognized, that the leakage currents on a homogeneous earth affect directly only the horizontal force, while the vertical disturbing force is due only to the difference of the effects of

* Read December 14, 1900.