THE CALIBRATION OF RADIO FREQUENCY GALVANOMETERS AND MILLI-AMMETERS.

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There are numerous methods for calibrating high frequency galvanometers. The purpose of this paper is to add to the list a simple accurate method for calibrating such an instrument at any particular frequency or at all frequencies.

In making a study of the applications of a thermionic voltmeter to high frequency measurements, a method of calibration similar to the direct current, resistance, potential method occurred to the writer. A vacuum tube voltmeter is used to measure the fall of potential across a standard high frequency resistance in series with the galvanometer to be calibrated, in a high frequency measuring circuit. If the hot wire

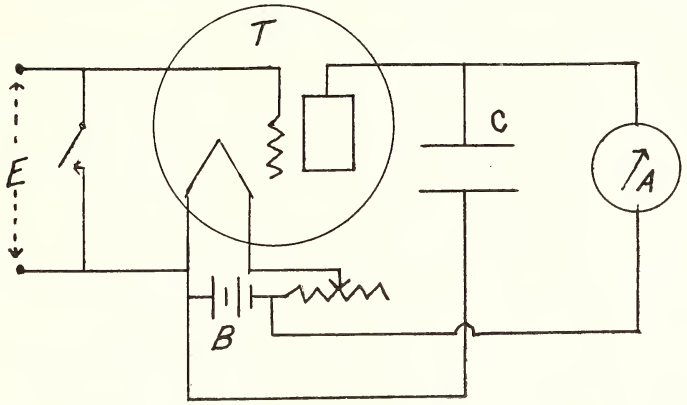

Fig. 1—Diagram of a simple vacum tube voltmeter.

of the galvanometer or the heater wire of the couple is of such dimensions as to have a negligible difference of resistance over a relatively wide range of frequencies, the meter can be calibrated at a median frequency with a high degree of accuracy for a given range. If the radio frequency resistance of the meter varies, the calibration can readily be made for any particular frequency.

The sources of error in high frequency measurements of current are discussed in detail in Circular 74 of the Bureau of Standards and a careful résumé of the subject is made by Herbert Hazel in the Proceedings of the Indiana Academy of Science, volume 36, page 145. Most of the errors mentioned are eliminated in the method outlined below, since the calibration is made under the same conditions at which the galvanometer or milli-ammeter is used.

"Proc. Ind. Acad. Sci., vol. 37, 1927 (1928)."

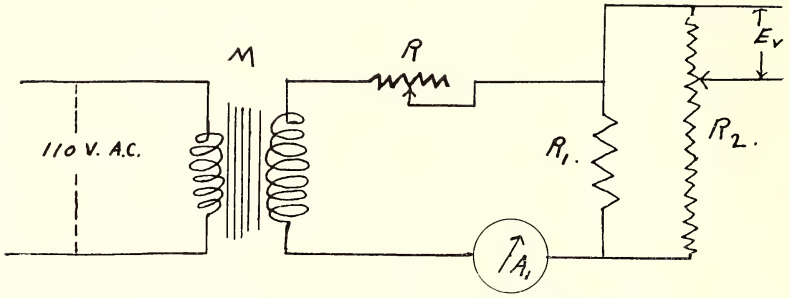

Fig. 2—Suggested type of A. C. calibration potentiometer.

It has been shown by Brown and Colby of the High Frequency Laboratory at the University of Texas, and others, that with certain types of thermionic voltmeters the calibration is independent of frequency.

The writer has investigated this point for the particular circuit used in the voltmeter described in figure 1, and has found that the 60 cycle and the 1000 kilocycle calibration curves are identical.

A detailed diagram of the simple voltmeter is given in figure 1. T is a 201A type vacuum tube; C, a 1 mfd. by-pass condenser; A, a micro-ammeter or calibrated galvanometer; B, a six-volt storage cell; E, potential terminals of the voltmeter. A is given an initial reading of 40 micro-amperes with E equal to zero, then a 60 cycle calibration curve may be made from .2 volt to 2 volts, using some type of A. C. potentiometer.

It is necessary that the filament current remain fairly constant and the zero reading of the plate micro-ammeter is a more reliable check on this current than a milli-ammeter in the filament circuit.

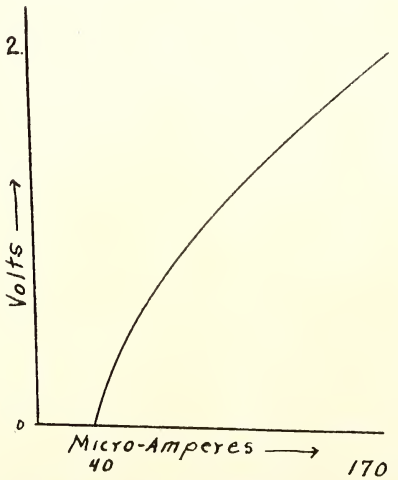

Fig. 3—Calibration curve for vacum tube voltmeter.

Figure 2 gives a suggested type of calibrating circuit which was used by the writer. However, any scheme for giving accurately a known A. C. voltage can be used. M is a 110-5 volt A. C. transformer furnishing a current, measured by A, through a rheostat R to a standard one ohm, non-inductive resistance R_1, across which is a potentiometer R_2. The voltage E may then be applied to the potential terminals of the voltmeter and a curve similar to figure 3 is obtained.

In figure 4 the measuring circuit LC_1R is coupled to a radio frequency oscillator inducing a current in the circuit. If R_h is a standard, variable, high frequency resistance or a standard set of resistances made according to the specifications of the Bureau of Standards Circular No. 74, the current through R may be varied. The potential drop

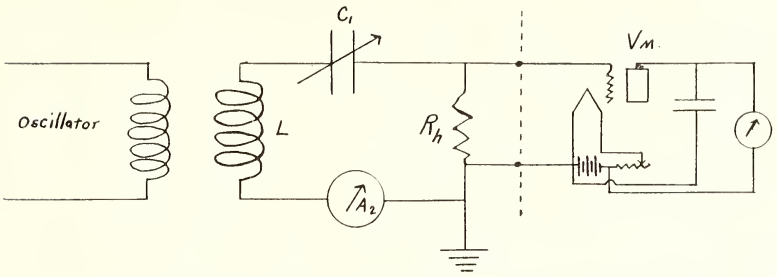

Fig. 4—Calibration circuit for radio frequency galvanometer, A_2.

across R_h may be measured by the vacuum tube voltmeter V_m, and I may be calculated from V=RI. The current I may be changed by a variation of the coupling over a small range without appreciably affecting the frequency.

In conclusion, it is to be noted that this method of measurement may be applied to the determination of radio frequency currents from very small to very large values independent of frequency.