Particular attention should be paid to the stressing of the galvanometer suspensions, which, to a considerable extent, determines its sensitivity. The suspensions should be stressed with a short-circuited galvanometer. The suspensions are stressed so as to obtain a minimum trembling of the galvanometer pointer. A further relaxation of the suspension tension leads to greater sensitivity, but is inconvenient in operation.

The resistors of the measurement decade (the sectionizing of the switch) should be 3,000 ± 0.001 ohm.

The original slide wire and copper bus are removed. In the center of the carbolite frame a groove 0.1-0.2 mm deep is cut on a lathe. A manganin wire 0.25 mm in diameter is placed into the groove. At both ends of the wire holes are drilled and tapped with an M2 thread. A threaded rod is screwed into these holes and cut flush with the surface of the frame. The wire is soldered to the rods in a stressed condition.

Particular attention should be paid to the treatment (preparation) of the manganin wire before it is placed in position; it should not be sharply bent or stressed. A departure from these requirements may lead to considerable unevenness in the slide-wire scale.

The slide wire is made of 0.3 mm phosphor bronze and silver wire 1.0 mm in diameter.

Since the operating current of the potentiometer is reduced to 1 ma, it is necessary to raise the resistance of the rheostat for setting the operating current. It is advisable to add a switch with 2-3 positions for reducing the series resistance as the dry cell becomes used up. The total compensating resistance should be

\[
R = \frac{U_b - E_s}{I_0},
\]

where \(U_b\) is the maximum emf of the dry battery type "Saturn," equal to 1.65 v; \(E_s\) is the emf of the standard cell, equal to 1.018 v; \(I_0\) is the operating current of the potentiometer, equal to 1 ma. Hence, \(R = 648\) ohm.

The safety resistance in the standard cell circuit can be shorted out after the instrument has been checked. This will provide a more accurate setting of the operating current.

A tumbler switch is provided for short-circuiting the zero-setting galvanometer. This makes the portable potentiometer suitable for checking electronic potentiometers without a source of controlled voltage.

The scale should have, in addition to the three main mounting screws, two locating pins in order not to introduce an error when the scale is mounted after its manufacture.

The calibration is made on a potentiometer installation with a low-resistance potentiometer (KL-48, R-330, etc.). At first the decades are set by adjusting \(R_s\), and then the slide-wire scale is marked off.

PHASE-SENSITIVE VOLTMETER FOR DETERMINING HYSTERESIS LOOPS BY MEANS OF AN ALTERNATING CURRENT

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Ferromagnetic materials are being tested with alternating currents on an increasingly wide scale. Methods and instruments for determining magnetic characteristics of materials under conditions approaching the operating conditions of various magnetic components are becoming especially important, owing to the rapid development of radiotechnology, automation, and computing techniques. It has now become necessary to determine new types of magnetic material characteristics in connection with the special operating conditions of magnetic components used in automation and computing equipment. In the past, it was sufficient to know the basic magnetization curve of the material and its specific hysteresis and eddy current losses for the purpose of designing
and analyzing the operation of electrical machines and transformers. However, at present, this knowledge is insufficient for designing components of automatic and computing devices. The operation of the majority of such magnetic components is characterized by their dynamic hysteresis loop.

The most widespread method of obtaining hysteresis curves over a wide frequency range consists of the cathode-ray oscillograph method [1]. In view of the considerable errors in the oscillographic method of determining hysteresis loops, this method should be considered rather as a qualitative than a quantitative determination. Sufficient accuracy for practical purposes in determining hysteresis loops by means of points is provided by the latest model of the Siemens and Halske (FRG) ferrometer with a mechanical rectifier. Alternating current hysteresis loops can also be obtained by means of ferrometer U542, which is designed for measuring the basic magnetization curve and losses, and also by means of ferrometer MEI, developed for the same purposes.

The main defect of the above ferrometers consists in their narrow frequency range (in ferrometers with mechanical rectifiers, amounting to 50 cps, and in ferrometer MEI to 40-60 and 400-600 cps), and the requirement of a three-phase supply source for the phase shifter.

A voltmeter with a phase-sensitive rectifier [2, 3] has been developed at the VNIIM (All-Union Scientific Research Institute of Metrology) for determining hysteresis loops. This instrument provides characteristics of magnetic materials in annular samples in the range of 50 cps to 10 kc. Moreover, the phase shifter of the instrument is fed from a single phase current of the same generator which feeds the magnetizing winding of the tested sample. The block schematic for testing an annular sample by means of a phase-sensitive voltmeter is shown in Fig. 1.

The voltmeter is made up of a measuring unit consisting of the half-wave phase-sensitive rectifier circuit and a phase shifter. The controlling single-phase voltage $U_{rf}$ is fed to the measuring unit from the circular phase shifter which provides a smooth variation in phase through 360°. The phase shifter consists of a circular slide-wire which is fed from the generator supplying the magnetizing circuit of the sample with two equal voltages $U_1$ and $U_2$ with a phase difference of 90° between them. The phase difference is provided by means of a quadrature amplifier which uses 6Zh1P tubes. In order to provide the equality of voltages $U_1 = U_2$ in a given frequency range, the resistors and capacitors which provide the phase shift are made adjustable. The circular slide wire is wound on an insulated ring (textolite), 140 mm in diameter and 40 mm high. The winding consists of 0.07 mm constantan wire with enamel insulation which is removed from the operating surface of the slide-wire by chemical means. The total resistance of the slide-wire is 60 kilohm. In order to ensure a reliable operation of the sliding contact, the latter is made in the form of a roller pressed against the surface of the slide-wire by means of a spring.

The phase of the voltage is changed by two slides rigidly coupled to each other by mechanical means.