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CATHODE HEATER LEAKAGE TESTER

Filed May 6, 1932

Fig. 1.

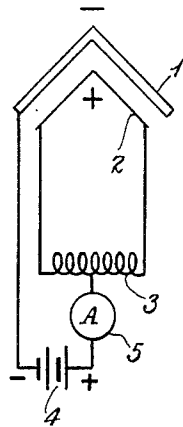
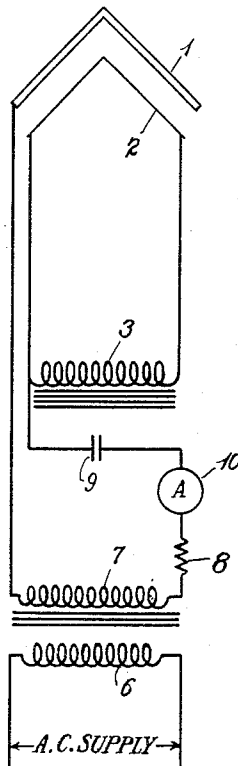


Fig. 2.



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CATHODE-HEATER LEAKAGE TESTER

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This invention relates to an arrangement for indicating electrical insulation leakages between the cathode and heater elements of indirectly heated audion vacuum tubes.

It is the object of this invention to provide a testing circuit for the determination of the insulation leakage between the cathode and heater elements of indirectly heated audion tubes which gives an accurate indication of that leakage free from any extraneous effects.

It is a further object of my invention to design a testing circuit for the purposes set forth which is particularly adapted to meet the requirements for ruggedness as well as accuracy demanded thereof for field service testing operations.

The commonly-used indirect heater type audion tube utilizes an electron-emitting cathode element, electrically insulated from a heater element which heats the cathode element by conduction. In radio and electrical circuits which utilize tubes of the normal type with an electrical potential difference maintained between the cathode and heater elements, it is generally desirable that the insulation resistance between the cathode and heater elements be maintained above 90,000 ohms. Chemical impurities in the ceramic or other materials utilized as the electrical-insulating and heat-conducting medium between the cathode and heater elements may cause a permanent or intermittent lowering of the electrical resistance. In some circuits, a lowering of this resistance may change the characteristics of the tube circuit network, thereby detrimentally affecting the performance of the apparatus embodying the tube and circuit combination, or an intermittent lowering of this insulation resistance may cause undesirable fluctuations in the network potentials which may be amplified or relayed, or both, to the output circuits of the apparatus embodying the tube. In the case of radio receivers, these potential fluctuations are amplified and reproduced as undesirable noises in the loudspeakers.

In factories where audion tubes are manufactured and subjected to tests before being released to the commercial trade, it is cus-

tomary to determine the cathode-heater insulation resistance by applying a direct current potential in series with a micro-ammeter between the cathode and heater elements.

This commonly-used method is fairly satisfactory for factory production requirements, but the sensitive instrument required has not been found sufficiently rugged for the practical service requirements of radio technicians in the field. Another objection to this method is applicable to factory as well as field testing, and relates to the rectifying action between the cathode and heater elements. Practical tests have indicated that this rectifying action is not uniform as between tubes of different manufacture, or between tubes produced in the same factory. One method employed by factories for this test consists of applying a 16-volt potential in series with a micro-ammeter between the cathode and heater elements, so that the cathode element is maintained negative with relation to the heater element to which the positive side of the 16-volt potential is connected.

Since the heater is also necessarily operated with a normal electric current load during the test in order to determine the effect of thermal expansion on the leakage, it is obvious that the heated cathode will emit electrons, some of which will be attracted to the positive heater. The electric current corresponding to this electron flow will be indicated by the meter while the meter is also indicating the current which flows because of any appreciable insulation leakage which may exist. Thus in a tube in which the insulation resistance may not be affected by heating of the elements, a greater current will flow between the elements while they are heated than will flow while the elements have ambient temperature.

The above mentioned objections are overcome by the applicant's invention which may be best understood by reference to the accompanying drawing in which

Fig. 1 shows a testing circuit previously employed in the art, and

Fig. 2 shows the applicant's novel circuit, with the same parts common to the two fig-

ures designated by the same reference numerals.

In Fig. 1, the electron emitting cathode 1 is normally heated to incandescence by means of a heating current passed through the heater circuit 2 which is energized by a source of alternating current energy induced in the winding 3. The heat generated in heater element 2 is conducted through a suitable layer of ceramic or other material to transmit the heat therefrom to the cathode element, at the same time maintaining those two elements electrically insulated. In order to test the condition of this electrical insulating and heat conducting medium, a 16-volt potential source, for instance a battery 4, is inserted between the midpoint of the heater winding and the cathode element with a micro-ammeter inserted in series. The resistance of the insulating layer could thus be determined by simple application of Ohm's law. With the parts connected as indicated in Fig. 1, the micro-ammeter not only indicates the current resulting from the leakage between the cathode and heater elements but also the current resulting from the electron emission from the cathode element which is attracted to the relatively positive heater element. As explained above, this discrepancy in the reading of the meter as well as the necessity for the delicate instrument 5 are obviated by the applicant's invention as is illustrated in Fig. 2.

The cathode and heater elements as well as the heater winding in Fig. 2 are correspondingly the same as in Fig. 1. Although the heater winding 3 is shown as fixed in the drawing the same may consist of an adjustable winding which is variable by the provision of suitable taps in order to obtain a range of voltages from 1.5 volts to 7.5 volts to enable the testing of all types of tubes. Between a point in the heater circuit and the cathode element is arranged an electrical circuit which includes a condenser or capacitor 9 and a rugged indicating ammeter 10. This ammeter may be of the copper-oxide rectifier type incorporating a D'Arsonval movement, shunted for a sensitivity of 0.001-ampere for full scale deflection. The meter may be of the type shown in the patent to Vivion Johnson, No. 1,811,319 of June 23, 1931. This circuit is energized from a source of alternating current energy which is connected to the primary winding 6 of a suitable transformer. The secondary winding 7 of this transformer has induced therein the alternating current energy for the circuit connected between the heater and cathode elements. A suitable multiplier resistance 8 may be connected in the circuit in order that the same may reach the proper impedance values which will effect a full scale deflection of the meter 10, corresponding to 1 milliamperes, upon a short circuit connection between

the cathode and heater elements. The meter will be capable of reading a range of resistances between the cathode and heater elements as high as 90,000 ohms. Such a resistance value causes a deflection upon the meter of approximately 1 degree which is still capable of observation.

The function of the condenser 9 is to exclude all unidirectional current components such as would ordinarily result from the rectifying action or from the electron emission between the cathode and heater elements.

In a practical embodiment of the invention the various elements have the following approximate values. The condenser 9 is of 0.5 mfd. capacity. The internal resistance of meter 10 is 2,000 ohms. The voltage induced in the secondary winding 7 has an effective value of 10 volts with the calculated inductance of that coil being 4.63 henries. The multiplier resistor 8 has a value of 5167 ohms.

Having described my invention, I claim:—

1. In an alternating current testing circuit for the determination of the leakage resistance of the insulation between the cathode and heater elements of an indirectly heated audion tube, said circuit extending between the cathode and heater elements, a current meter in said circuit, and means for preventing the emission of electrons from the cathode element from affecting the reading of the current meter comprising a condenser in said circuit.

2. In an alternating current testing circuit for the determination of the leakage resistance of the insulation between the cathode and heater elements of an indirectly heated audion tube, said circuit extending between the cathode and heater elements, an inductance coil, a resistor and a current meter in said circuit, and means for preventing the emission of electrons from the cathode element from affecting the reading of the current meter comprising a condenser in said circuit, said coil, resistor, meter and condenser being so proportioned that a short circuit between said cathode and heater elements effects a full scale deflection upon said meter.

3. In an alternating current testing circuit for the determination of the leakage resistance of the insulation between the cathode and heater elements of an indirectly heated audion tube, said circuit extending between the cathode and heater elements, means for impressing a low alternating potential on said circuit across said cathode and heater elements, a current meter in said circuit for indicating current values for varying resistance conditions of said insulation, and means for excluding the effects of rectifying action between said cathode and heater element from said current indications comprising a condenser in said circuit.

4. In a testing circuit for the determina-

tion of the leakage resistance of the insulation between the cathode and heater elements of an indirectly heated audion tube, a source of alternating current energy, a transformer having the primary winding thereof connected to said source of alternating current energy, a circuit including the secondary winding of said transformer connected between said cathode and heater elements, a current meter in said circuit, and means for preventing the emission of electrons from the cathode element from affecting the reading of the current meter comprising a condenser in said circuit.

5. The method of determining the leakage

resistance of the insulation between the cathode and heater elements of an indirectly heated audion tube which comprises applying an alternating current potential between said cathode and heater elements, measuring the current flow through said insulation, and preventing the electronic emission from the cathode from affecting the measuring of the current flow by inserting a condenser in the measuring circuit.

The foregoing specification signed at Greenwood, county of Leflore, Miss., this 5th day of May, 1932.

FLOYD FAUSETT.

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