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Title: Amplification Factor - Mutual Conductance Test Set For Lighthouse Tubes

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Fig. 1 is missing PBM

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AMPLIFICATION FACTOR--MUTUAL CONDUCTANCE TEST SET FOR LIGHTHOUSE TUBES.

ELECTRONIC TUBE ENGINEERING DEPT. APRIL 20, 1944

ABSTRACT:

Two semi-independent electronic circuits, one for measuring amplification factor and the other for measuring mutual conductance, are described. The amplification factors measuring circuit makes use of a calibrated voltage to balance out the Ac. plate current due to a grid signal. The mutual conductance measuring circuit uses a method in which a calibrated portion of the input voltage is made equal to the ac output voltage. An electronic circuit is used as the detector in both measurement circuits.

This set has been developed through the combined efforts of W. E. Cronburg, H. M. Owren, and R. O. Ringsmith.

The circuit shown in Fig. 1 consists of three component parts:

1. A voltage regulated power supply.

2. The Amplification Factor (u) measuring circuit.

3. The Mutual Conductance (Gm) measuring circuit.

The voltage regulated power supply is conventional in design. It consists of that portion of the circuit containing the 6X5, 6L6, 6SJ7, and the VR-105 tubes.

The amplification measuring circuit can be simplified to the following:

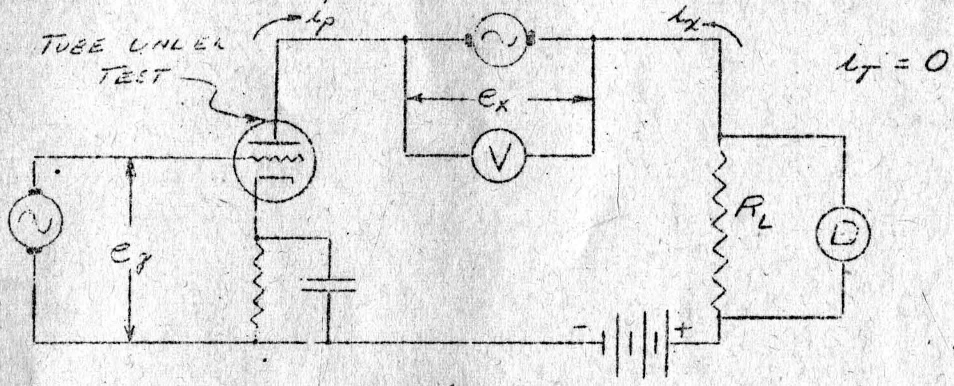

FIG. 2.

If a grid signal e_g is applied to the tube under test an ac plate current, i_p, will be created and cause a voltage drop, $i_p R_L$, across R_L. This will be indicated by the detector, D. If a sufficient voltage e_x, which creates a current, i_x, in the opposing direction to i_p be added, the total ac current i_T flowing in the circuit will be zero. Then the ac voltage drop across R_L is zero and is indicated by the detector. When this occurs:

$$e_x = \mu e_g$$

$$\text{or} \quad \mu = \frac{e_x}{e_g}$$

The voltages e_g and e_x can be measured and from the above equations u can be determined. If e_g is held constant, a voltmeter, V, can be inserted and be calibrated in u directly.

The circuit for measuring G_m can be reduced to the simplified drawing shown in Figure 3. Proof that G_m can be measured with this circuit is as follows:

By definition, $$G_m = \frac{i_p}{e_g}.$$

If the drop across the resistance R_L is equal to e_2, that is, $i_p R_L = e_2$, then:

$$G_m = \frac{e_2}{R_L e_g}.$$

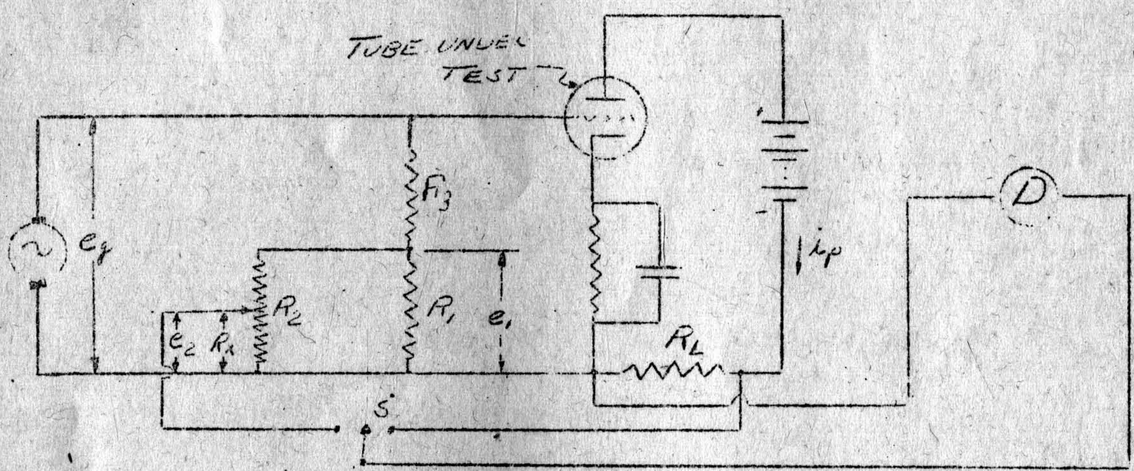

FIG. 3

But,
$$e_2 = \frac{R_x}{R_2} \cdot e_1,$$

and,
$$e_1 = \frac{R_1}{R_1 + R_3} \cdot e_g.$$

Therefore,
$$e_2 = \frac{R_x}{R_2} \cdot \frac{R_1}{R_1 + R_3} \cdot e_g.$$

By substituting this value of e_2 in the equation $G_m = \dfrac{e_2}{R_L \cdot e_g}$

the following expression is obtained:

$$G_m = \frac{R_x R_1}{R_2 R_L (R_1 + R_3)}$$

R_1, R_2, R_3 and R_L are held constant and thus G_m is a function of R_x. This is, of course, only true when $e_2 = i_4 R_L$ -- which is shown by the same reading on the detector when the switch S is placed in first one position and then the other.

This means then that if the above conditions are maintained

$$G_m = K \cdot R_x$$

and the dial controlling R_x can be calibrated directly in values of G_m.

In the actual circuit (see Fig. 1) two ranges of G_m are provided for by switching the potentiometer R2 from across the lower portion of the set of resistors R3, R4 and R5 for the lower range to the upper portion for the upper range. By choosing the resistors as follows:

$$R_2 = 4940\,\Omega,\ R_3 = 140.8\,\Omega,\ R_4 = 10\,\Omega,\ R_5 = 143.8\,\Omega,\ R_6 = 102.8\,\Omega$$

The lower range extends from 0 to 4920 micromhos and the upper range from 4750 to 9750 micromhos. The overlapping is accomplished by having R4 a portion of the parallel circuit for both ranges.

u is measured by throwing switch S1 to the left and adjusting the current to zero. u is then read on M4.

A slight error is introduced by the resistor R6 which is in the plate circuit of the tube under test, but since the value of this resistance is low compared to the plate resistance of the tube under test, the error is neglible.

Provision is made to change the cathode bias resistor from 100 ohms for the GL-464 tube type to 200 ohms for the GL-446 by means of switch S4.

Closing switch S7 provides a grid signal, and the interlock switch is in the plate circuit so that the operator will not be exposed to any high voltages while placing the tube in and out of the socket.

R. O. Ringsmith

R. O. RINGSMITH

COUNTERSIGNED: E. F. Peterson

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