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Title Preliminary Report on Measuring Conversion Transconductance

By

Electronic Tube Engineering Div.

Information prepared for

Tests made by

Information prepared by E. O. Vandeven

Countersigned by E. F. Peterson

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PRELIMINARY REPORT ON MEASURING CONVERSION TRANSCONDUCTANCE

Abstract: This paper discusses the various methods of testing for conversion transconductance. Experience to this time has been limited to the 60-cycle method, the JAN standard for measuring conversion transconductance.

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Conversion transconductance is defined as being the ratio of the change in intermediate frequency plate current corresponding to a change in radio frequency grid voltage, all the other electrode potentials remaining constant. In the JAN 60-cycle method of test shown in Fig. 1, the extreme condition of intermediate frequency equal to zero (D-c) is employed. A 60-cycle signal is applied to the oscillator grid of magnitude sufficient to draw rated grid current. On the signal grid is applied another 60-cycle signal in phase with the one on the oscillator grid and equal to one-half volt peak. Under these conditions a certain plate current will flow. This current must be bucked out of the differential plate current meter by adjusting the plate bucking voltage. The relative phase of the grid voltages is now reversed and the change in plate current read in the differential plate current meter. This current divided by twice the peak volts on the signal grid gives conversion transconductance. It is necessary to divide by twice the peak voltage because at any instant the signal grid voltage actually changes by twice its instantaneous value when the relative phase of the grid voltages is reversed. That is, it will go from 0.2 volts minus to 0.2 volts plus, a 0.4 volt change of the signal grid voltage with respect to the oscillator grid voltage. Thus if $1/2\sqrt{2}$ R.M.S. volts is applied to the signal grid, the differential plate microammeter will be direct reading in micromhos.

Since it is necessary to read values of conversion transconductance as low as 0.5 micromhos, it is necessary that the differential plate current meter be able to read 0.5 microamp on its lowest scale. This requires the use of a meter whose lowest range is no more than 10 microamps. Since the sensitivity of this meter is extremely high, the slightest variations in electrode potentials in the balanced condition will cause considerable flickering on the meter. This is especially true in the case of the heater voltage. It was found that a D-c heater supply was necessary to read the lower values of micromhos.

The problem of meter protection is very great in this type of circuit. It is necessary to achieve balance on the differential plate current meter with relatively large values of plate current flowing through the tube. The circuit in Fig. 1 includes protective resistors in series with the differential plate current meter in making an initial blance. In the final balance these are shorted out by a push button switch.

Another meter hazard is the plate condenser. If the push button is closed before this condenser is fully charged, it will charge through the differential plate current meter, knocking the needle off the scale.

It is necessary that the tube reach its quiescent operating condition before conversion transconductance may be read. If this is not done, the balance point will change before the phase can be reversed and conversion transconductance read.

In general, operation of the 60-cycle method is sufficiently delicate to require a well-trained operator, preferably one who knows how the equipment works.

Other methods of testing conversion transconductance are permissible if they correlate with the 60-cycle method. The most important of these are the A.F., the R.F., and the self-oscillating methods.

The A.F. method, shown in Fig. 2, consists of applying audio voltages of, say, 1000 and 1250 cycles to the oscillator and signal grids respectively and measuring the 250 cycle component in the output by means of a wave analyzer. This method has the advantage of requiring no initial balance or difference readings. If the plate load resistor is 10,000 ohms, and one R.M.S. volt is applied to the signal grid, the wave analyzer voltmeter reading at 250 cycles equals conversion transconductance in micromhos divided by 100. The wave analyzer however, is a rather sensitive instrument and must be zero adjusted frequently.

The R.F. method of measurement is shown in Fig. 3 and has the advantage of not requiring a wave analyzer. The R.F. voltages are applied to the signal and oscillator grids and the I.F. voltage developed across the tuned circuit is read. Conversion transconductance in micromhos is then equal to the I.F. voltage divided by the tuned circuit impedance in megohms, assuming that one R.M.S. volt is applied to the signal grid.

The self-oscillating method, Fig. 4, utilizes the oscillator section of the tube to supply one of the R.F. signals, but is otherwise similar to the R.F. method. This system seems to be most desirable of the four methods of testing for conversion transconductance, as it requires a minimum of components and should be simple to operate.

As mentioned previously, only the 60-cycle test has been set up so far. However, the latter three methods will be set up and an attempt made to correlate results with the 60-cycle standard.

E. O. Vandeven

E. O. VANDEVEN

COUNTERSIGNED BY: E.F. Peterson

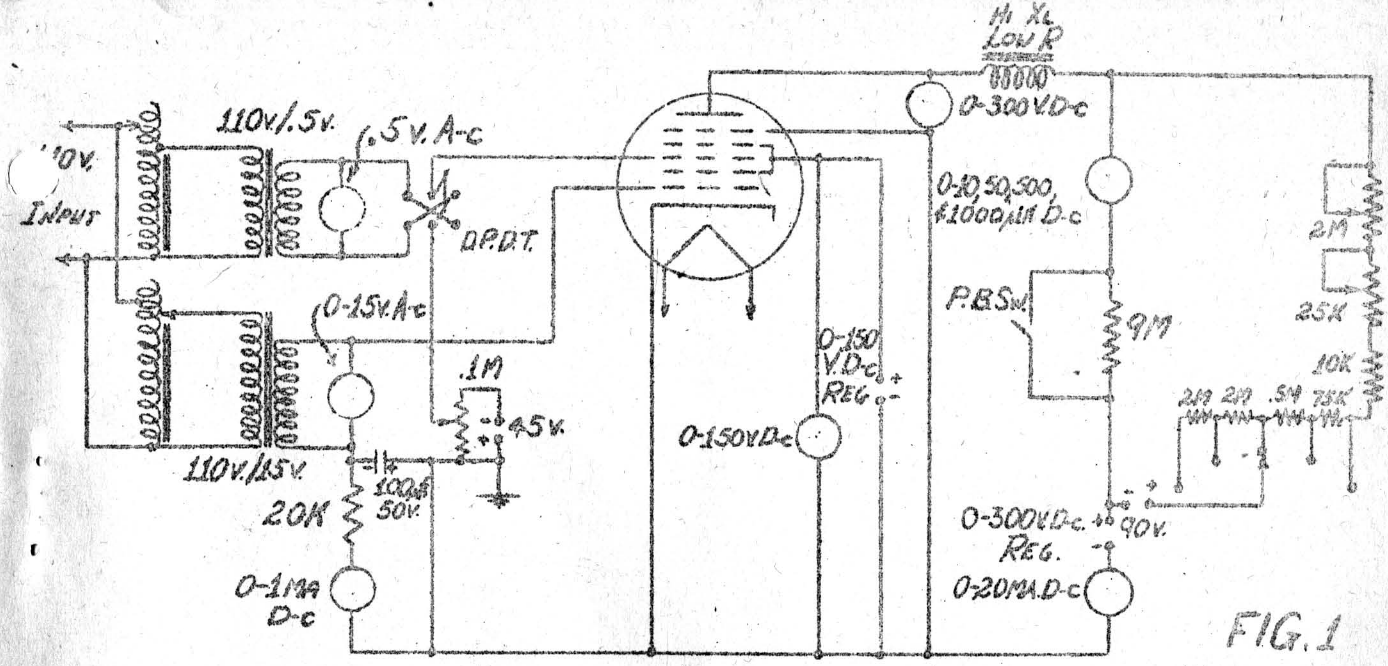

FIG. 1

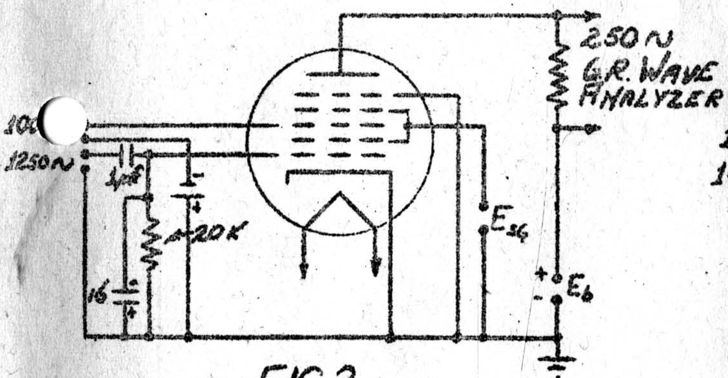

FIG. 2

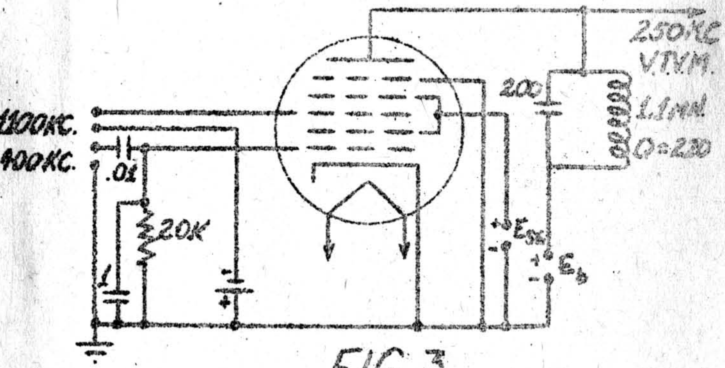

FIG. 3

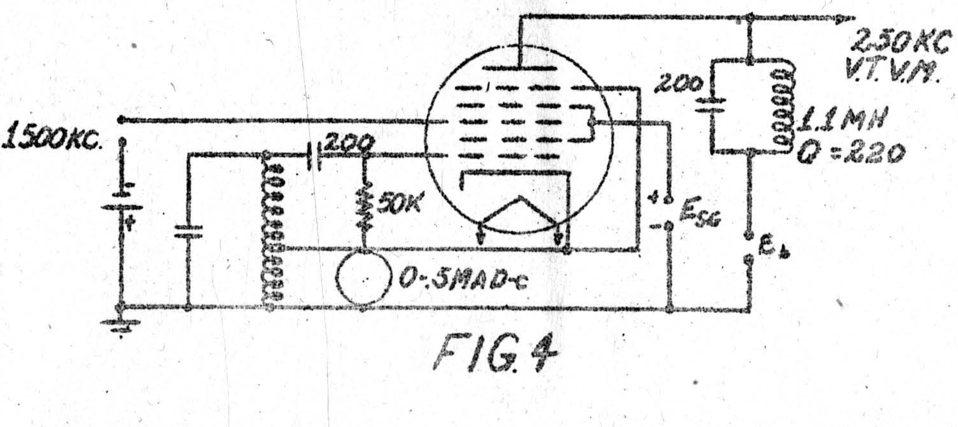

FIG. 4

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