RCA MANUFACTURING COMPANY, INC.
A RADIO CORPORATION OF AMERICA SUBSIDIARY
Harrison, New Jersey

RCA RADIOTRON
DIVISION

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APPLICATIONS NOTES

APPLICATION NOTE ON THE 6F5

Many modern broadcast receivers require at least two stages of audio amplification in order to obtain rated power output. The gain necessary in the first stage depends upon the a-f voltage developed by the detector, which is usually a diode, and the input-voltage requirements of the second audio stage. When the number of tubes in the audio amplifier is restricted to two, it may be necessary to use a high-gain first-stage tube in order to meet the input-voltage requirements of the output stage, especially when a low-percentage modulated carrier is to be received. The 6F5, the all-metal high-mu triode intended for use in high-gain resistance-coupled amplifier circuits, can be used to advantage in this case.

The 6F5 may also be used to advantage in receivers having more than two a-f amplifier stages. For example, the high gain obtainable through the use of a 6F5 in the first stage of a three-stage amplifier makes it possible to feed to the first a-f tube only a part of the total audio voltage developed by the detector. The smaller the fraction of the total detector output voltage that is fed to the first a-f tube, the larger the per cent modulation that can be handled with small distortion. The utilization of less than maximum a-f voltage is not serious in a high-gain amplifier.

To understand why utilizing a part of the diode voltage is desirable, let us consider that the characteristics of a certain diode are as shown in Fig. 1. For a given carrier voltage (E_1, or E_2, ---- E_{15}) at the detector, the ordinate and abscissa indicate, respectively, the d-c current through and the d-c voltage across a suitably by-passed resistance (R) connected in series with the diode; the ratio of the d-c voltage across R to the d-c current through R equals the resistance of R. Hence, the intersection of a load line (whose cotangent is R) with any single carrier-voltage curve determines the value of the d-c current flowing in the circuit. Thus, if an unmodulated carrier voltage having a value E_9 is impressed across the input of the circuit consisting of R, suitably by-passed and the diode in series, a d-c voltage (E_o) will be developed across R and a d-c current (I_o) will flow in the circuit.

The audio voltage appearing across R is usually fed to the grid of the first a-f tube through a coupling condenser; the grid of this a-f tube is grounded through a high resistance (R_2). When the carrier is modulated, the diode load (R_d) is then essentially $R_d = R \times R_2/(R + R_2)$. The reciprocal of the slope of the line (BC) equals R_d; BC passes through point (E_o, I_o). If the per cent modulation is such that the minimum amplitude of the carrier is less than E_4, small carrier amplitudes will be cut off. Therefore, the maximum per cent modulation that can be handled by this circuit is $(E_9-E_4)/E_9$. On the other hand, if R_2 is connected to only a portion of R, then the load line for a modulated signal may be represented by DE. Thus, signals that are modulated up to approximately $(E_9-E_1)/E_9$ per cent can be rectified with little distortion. In other words, as the fraction of the total diode voltage (R_1/R in Fig. 2) coupled to the first a-f tube becomes smaller, the slope of the operating line approaches that determined by the unmodulated carrier. Hence, the per cent modulation of the signal can be increased before diode-current cut-off occurs. If the change in the slope of the operating line is small, nearly 100 per cent modulation can be handled without distortion due to diode-current cut-off.

Diode biasing of the grid of the 6F5 does not produce this type of distortion, but is not generally suitable because of the probability of plate-current cut-off, even with relatively small signal voltages applied to the diode circuit. The use of a 6F5 in the first a-f stage of a high-gain amplifier, connected as in Fig. 2, permits the detection of highly modulated signals with little distortion.

The design of a receiver may be such that, even though a part of the audio voltage developed by the diode is applied to the grid of the 6F5, the signal voltage at the grid of the second a-f tube may be more than necessary. Under these conditions, the plate resistor of the 6F5 may be tapped, so that only a fraction of the voltage developed across this resistor is applied to the grid of the second a-f tube. This circuit will tend to minimize plate-circuit distortion in the 6F5, caused by plate-current cut-off during the negative voltage excursions of the signal. Figure 2 shows a circuit that permits the rectification of highly modulated carriers with little distortion and also tends to minimize any plate-circuit distortion.

When the 6F5 is used in conjunction with a 6H6, the all-metal twin diode, the combination may be used as a detector, a.v.c. tube, and first a-f amplifier. A variety of circuits are possible with this combination, because each of the two diodes in the 6H6 has its own cathode and corresponding base pin.

TENTATIVE CHARACTERISTICS OF THE 6F5

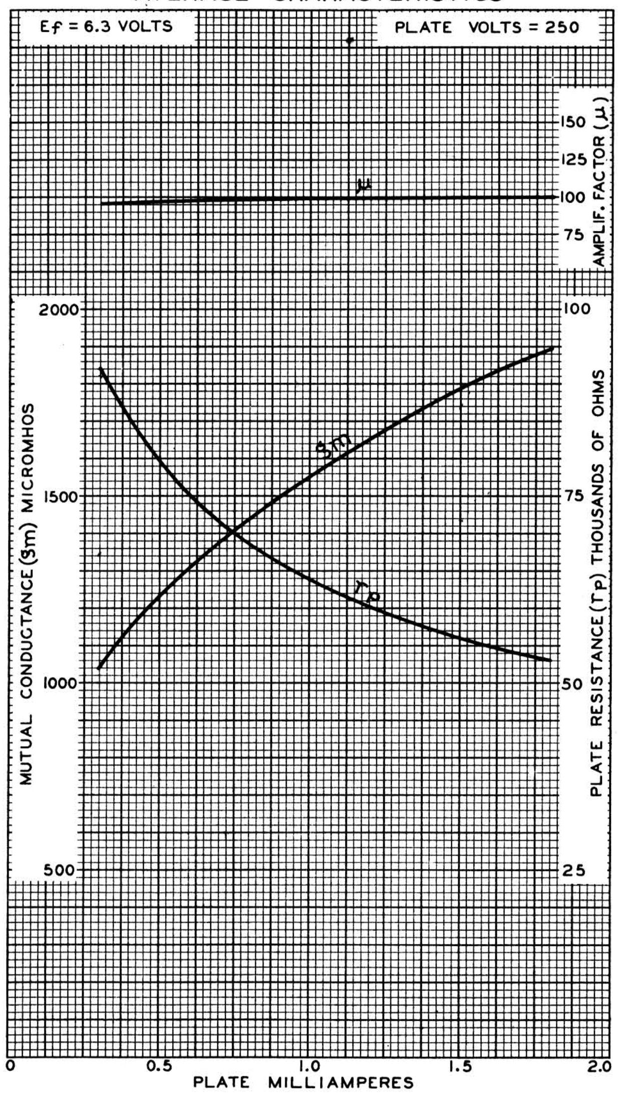
Heater Voltage (A.C. or D.C.)	6.3		Volts
Heater Current	0.3		Ampere
Plate Voltage	250	max.	Volts
Grid Voltage	-2		Volts
Plate Current	0.9		Milliamperes
Plate Resistance (r_p)	66000		Ohms
Amplification Factor	100		
Grid-Plate Transconductance	1500		Micromhos
Input Capacitance	6		μμf
Output Capacitance	12		μμf
Grid-Plate Capacitance	2		μμf

Note: The d-c resistance in the grid circuit of the 6F5 should not exceed 1.0 megohm.

Cunningham Radiotron

RCA-6F5

AVERAGE CHARACTERISTICS



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DIODE CHARACTERISTICS SHOWING DIODE DISTORTION OF A HIGH-PERCENTAGE MODULATED CARRIER

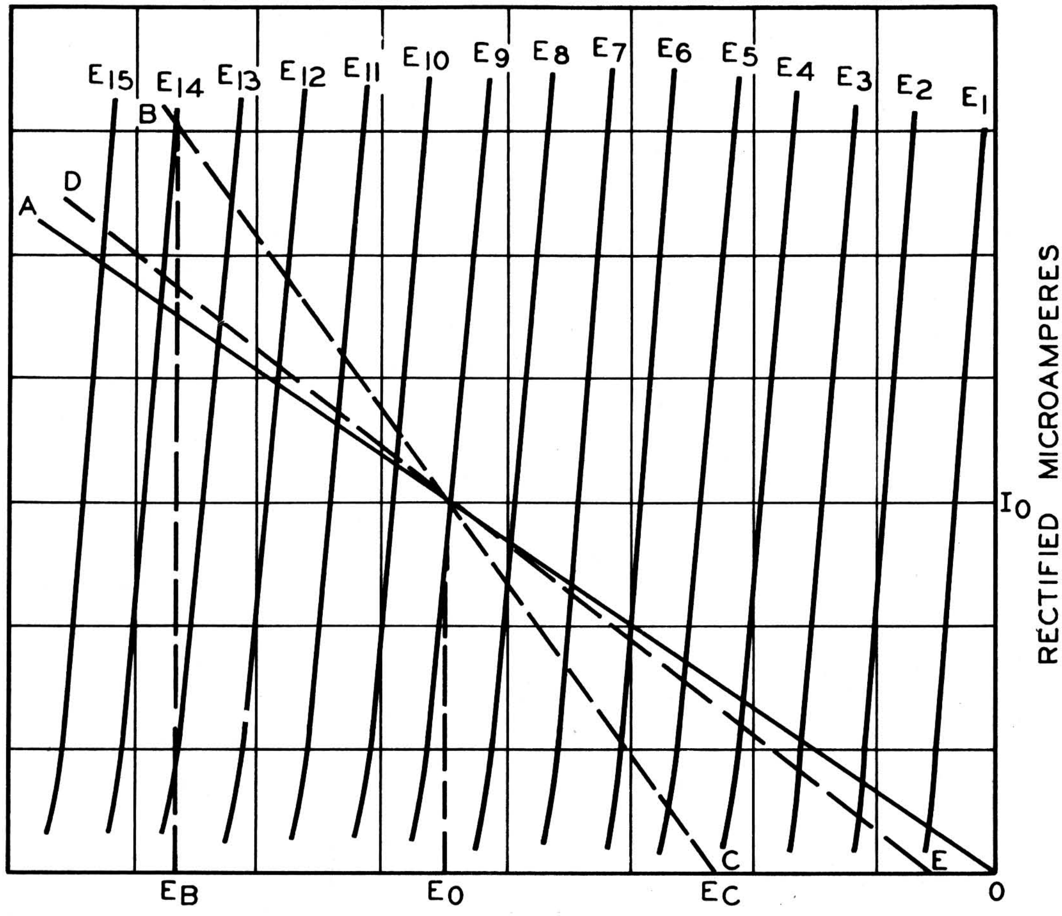

FIG. 1

LOW-DISTORTION CIRCUIT USING THE 6F5 IN A HIGH-GAIN AMPLIFIER

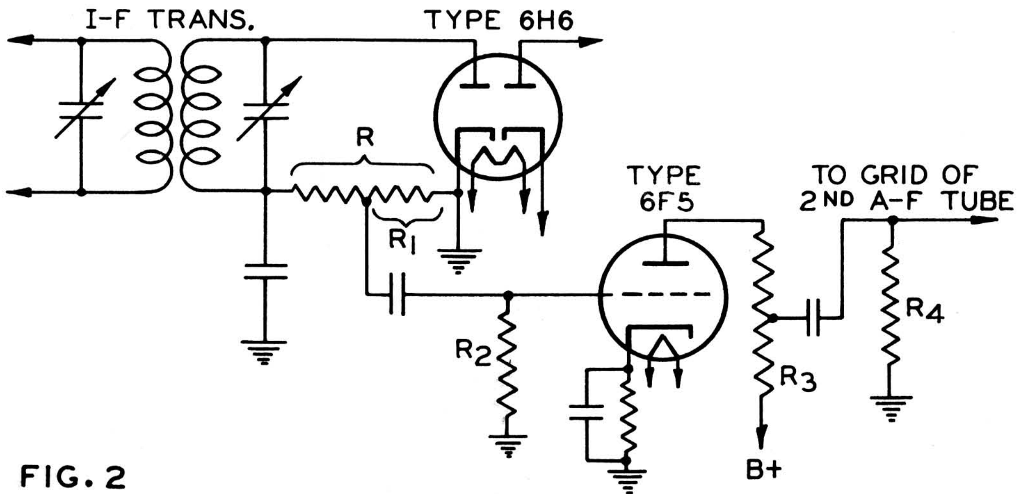

FIG. 2