



RCA MANUFACTURING COMPANY, INC.

A RADIO CORPORATION OF AMERICA SUBSIDIARY

Harrison, New Jersey

**RCA RADIOTRON
D I V I S I O N**

APPLICATION NOTE No.65
September 10, 1936

APPLICATION NOTE ON TUNING-INDICATOR CIRCUITS FOR THE 6E5 AND 6G5

The 6E5 and 6G5 are electron-ray tubes intended for use as tuning indicators in radio receivers. Both tube types have the same external appearance and base-pin connections, but their cut-off voltages are different. This Note discusses the characteristics of several practical tuning-indicator circuits that employ these tube types.

Fig. 1 shows the variations in plate current, target current, and shadow angle vs d-c grid voltage for the 6E5. Fig. 2 shows these relations for the 6G5. Both tube types have brilliant fluorescent areas when they are operated from either 100- or 250-volt power-supply sources. For 250-volt operation, the 6E5 cuts off at -8 volts and the 6G5 cuts off at -22 volts; for 100-volt operation, the 6E5 cuts off at -3.3 volts and the 6G5 cuts off at -8 volts. A 1.0-megohm resistor should be connected in the plate circuit of either tube type for 250-volt operation; a 0.5-megohm resistor should be used in this position when the plate-supply voltage is 100 volts.

250-Volt Operation of the 6E5 and 6G5

Fig. 3 is a typical tuning-indicator circuit for either the 6E5 or the 6G5. Because the a.v.c. circuit is not delayed, the grid of the tuning-indicator tube can be connected to the a.v.c. filter, as shown. The 6E5 should be used in this circuit when the maximum a.v.c. voltage is approximately 8 volts; the 6G5 should be used when the maximum a.v.c. voltage is approximately 22 volts. However, the fluorescent area of either tube type overlaps when the a.v.c. voltage exceeds the cut-off voltage of the tube. In the event that overlapping occurs, a resistor (R_s) may be connected as shown in order to reduce the maximum a.v.c. voltage to the cut-off voltage of the tube. The value of R_s is easily determined: a strong signal is applied and R_s is adjusted until the shadow angle is nearly zero. If the required value of R_s is low enough to reduce the a.v.c. voltage appreciably, it is desirable to obtain the d-c controlling voltage for the 6E5 or 6G5 from the audio-diode circuit. Because the audio-diode circuit must be tapped in order that the controlling voltage will equal the cut-off voltage of the tube, a separate a-f filter is required for the tuning-in-

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indicator tube. Two electrically equivalent circuits of this type are shown in Fig. 4. Either the 6E5 or 6G5 may be used with these circuits when the maximum diode-circuit voltage exceeds 22 volts; the 6E5 should be used when the maximum diode-circuit voltage is less than 22 volts.

When the a.v.c. system is delayed, the tuning-indicator tube should be actuated through its own filter by the audio-diode circuit. If the 6E5 or 6G5 is actuated by the a.v.c. voltage in a delayed a.v.c. system, the indicator tube will not operate until the carrier voltage at the diode exceeds the delay voltage. The circuit of a typical delayed a.v.c. system, with connections for the tuning-indicator tube, is shown in Fig. 5. In the event that overlapping occurs with this circuit, a resistor (R_3) may be connected as shown in order to reduce the controlling voltage to the cut-off voltage of the tube. Resistor (R_3) does not reduce the a.v.c. voltage in this circuit.

The 6E5 or 6G5 can be used as a combination second-detector and tuning-indicator tube when it is connected as shown in Fig. 6. The usual values of grid resistor and condenser are used; the audio voltage is obtained from the grid resistor, as shown. The plate and target circuit is filtered for audio frequencies in order to prevent the pattern from fluctuating at an audio-frequency rate. When this circuit is used, the 6E5 or 6G5 should be placed close to the last i-f transformer. With the recommended plate-target resistance, the no-signal shadow angle is less than 90 degrees, because the initial plate-target voltage is adjusted to a low value for good sensitivity. The sensitivity is high for weak signals and decreases with increasing signal strength. An important feature of this circuit is that the edges of the fluorescent area do not overlap, regardless of signal strength, because the d-c plate current remains constant over a wide range of signal voltages. This circuit is of interest for low-price receivers.

Fig. 7 is a circuit for obtaining high sensitivity on weak signals. The volume control is part of the diode load; the audio signal and the controlling voltage for the 6E5 or 6G5 are obtained from the arm of the volume control. Resistor (R_5) and condenser (C_4) constitute the audio filter for the 6E5 or 6G5. Resistor (R_8) is used to obtain an indication on the 6E5 or 6G5 when the volume control is in the zero-output position. The value of R_8 is determined by setting the volume control for normal audio output with a strong signal applied and then adjusting R_8 until the shadow angle is very nearly zero. Thus, for strong signals, the controlling voltage is limited by the setting of the volume control. For weak signals, the volume-control setting is advanced; consequently, the audio output and the controlling voltage of the 6E5 or 6G5 are increased. When the audio amplification of the receiver is low, resistor (R_9) may be added in order to prevent overlapping at advanced settings of the volume control. The value of R_9 is determined by trial.

As mentioned previously, either the 6E5 or the 6G5 may be used as a tuning indicator when the maximum controlling voltage exceeds 22 volts. Under this condition, it is necessary to tap the diode load at the proper point for each tube type in order to prevent overlapping. When this is done, the ratio of the controlling voltage applied to the 6G5 to that applied to the 6E5 is 22/8. Thus, the 6G5 is always actuated by more controlling voltage than the 6E5 for the same total diode-circuit voltage. Because

of this voltage difference, the shadow-angle change is greater for the 6G5 than for the 6E5, as shown in Fig. 8. In this figure, one ordinate is used for both tube types; the abscissas are in the ratio of 22/8. For example, if the maximum diode-circuit voltage is 30 volts, a 6E5 would be tapped at the 8-volt point and a 6G5 would be tapped at the 22-volt point. When the total diode-circuit voltage is reduced to 7.5 volts, a 6E5 would be controlled by $8/30 \times 7.5 = 2$ volts and the shadow-angle change would be 20 degrees; the 6G5 would be controlled by $22/30 \times 7.5 = 5.5$ volts and the shadow-angle change would be approximately 52 degrees.

The total change in shadow angle from the zero-signal angle is not the only measure of the sensitivity of these tube types. In actual operation, the tuning dial is rocked about the resonant frequency. For this reason, the rate of change of shadow angle (tuning index) at any point on the shadow-angle curve is a good indication of the facility with which a receiver can be tuned to the carrier frequency from a nearby frequency. Fig. 8 shows the rate of change of shadow angle vs controlling voltage for both tube types. From these curves, it is seen that the change in shadow angle for small changes in controlling voltage is greater for the 6E5 than for the 6G5 over the major portion of the operating range. Thus, the tuning index of the 6E5 is greater than that of the 6G5 over a wide range of controlling voltages.

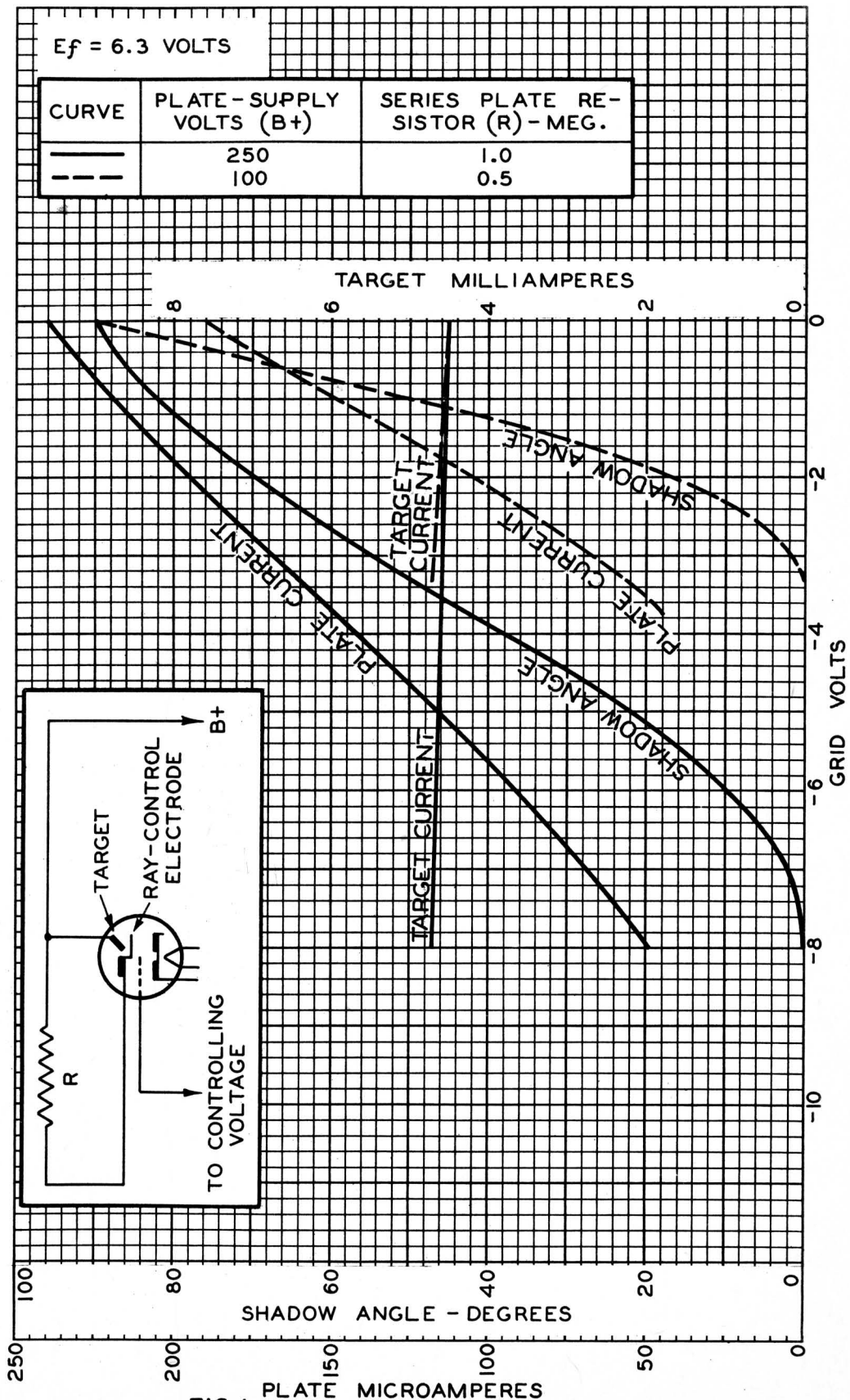
100-Volt Operation

Fig. 9 shows the variation of shadow angle and tuning index vs controlling voltage for both tube types when the B-supply voltage is 100 volts. One ordinate is used for corresponding curves and the abscissas are in the ratio of 8/3.3, the respective cut-off voltages of the 6G5 and 6E5. These curves show that the total change in shadow angle from the zero-signal angle is greater for the 6G5 than for the 6E5; however, the tuning index is greater for the 6E5 than for the 6G5 over the major portion of the operating range. When the maximum diode-circuit voltage is less than 8 volts, the 6E5 should be used; either tube type may be employed when the maximum diode-circuit voltage is greater than 8 volts.

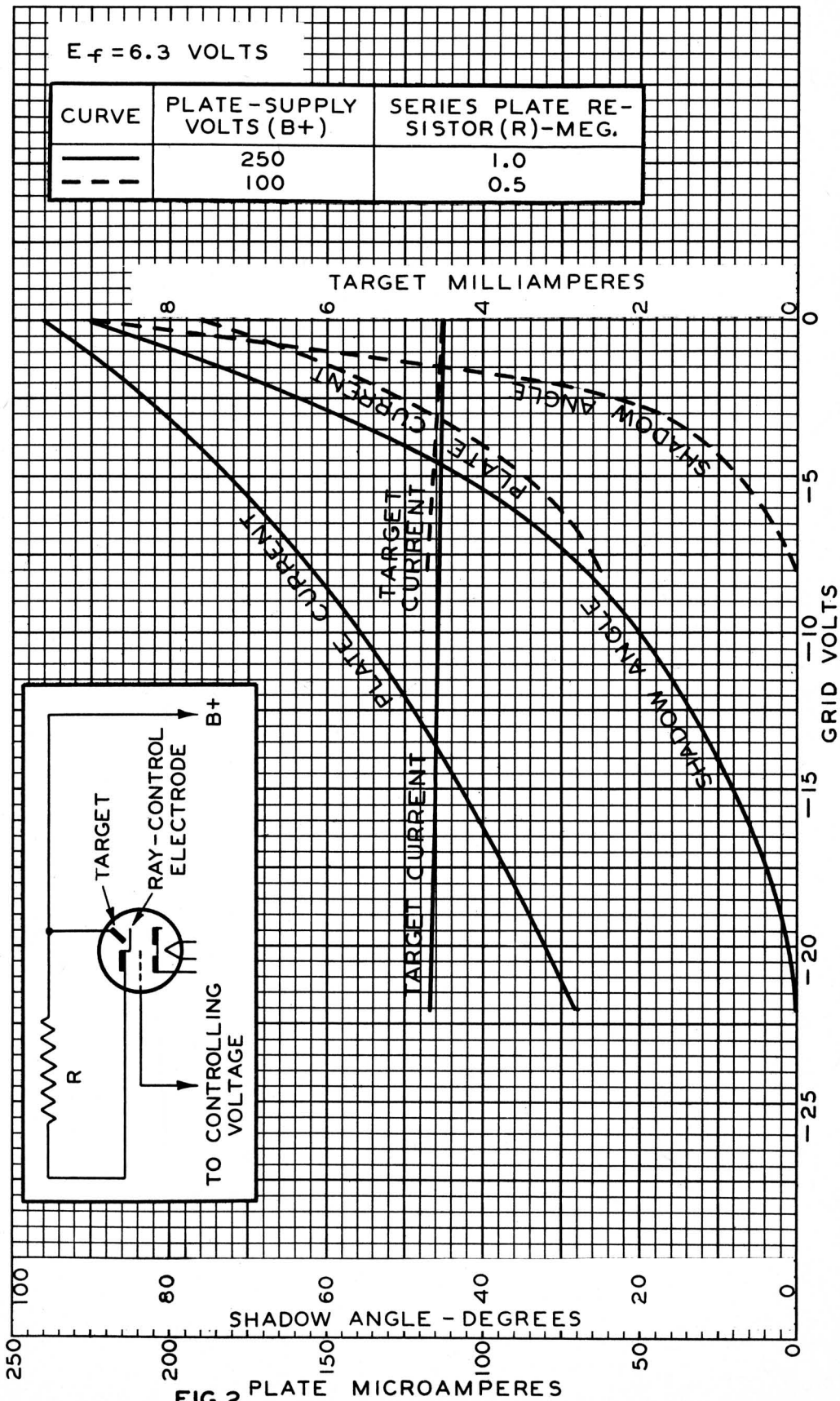
Conclusion

The difference in cut-off voltage between the 6G5 and 6E5 may determine which of these tuning-indicator tubes will be used in a receiver. Receivers having a large number of tubes under the control of the a.v.c. system usually develop a small voltage in the diode circuit; the 6E5 is generally suited for use in these circuits. The diode-circuit voltage may increase beyond the cut-off voltage of the 6G5 in receivers that have comparatively few tubes under the control of the a.v.c system; in such cases, either tube type can be used.

AVERAGE CONTROL CHARACTERISTICS



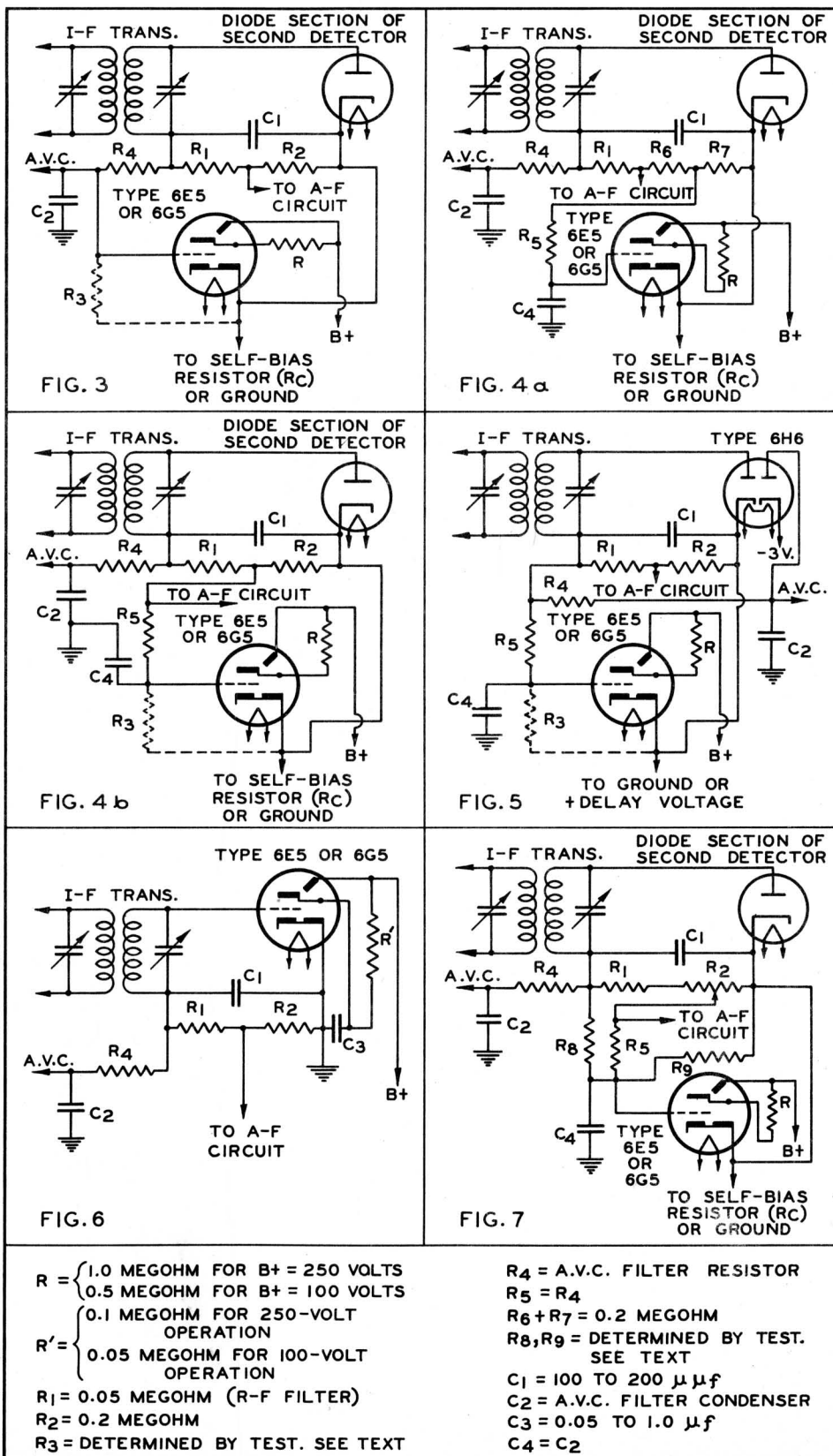
AVERAGE CONTROL CHARACTERISTICS



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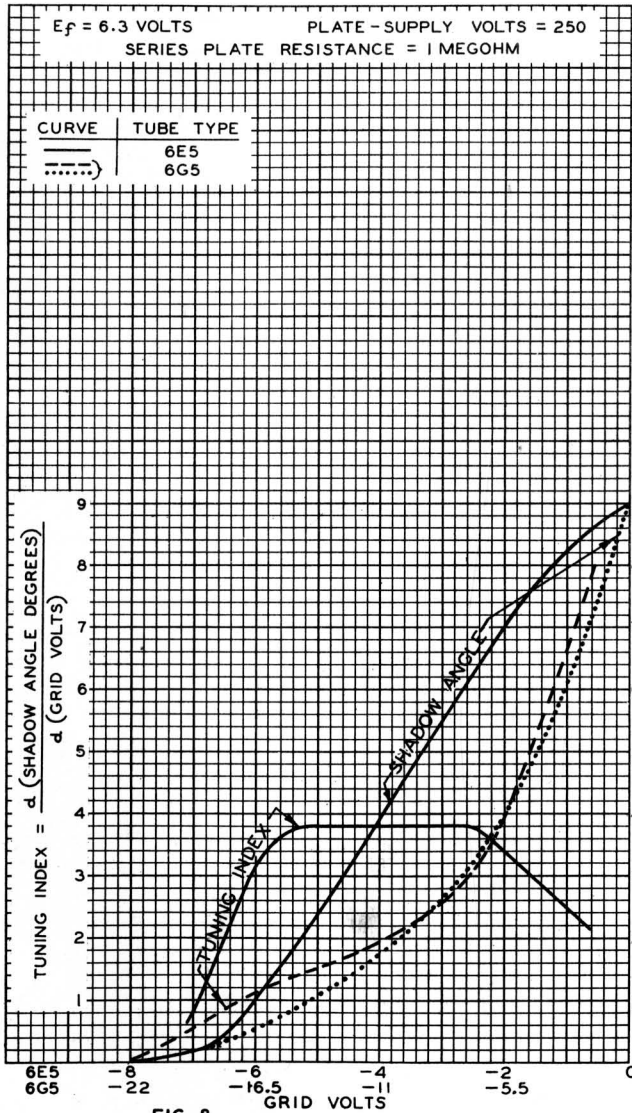
FIG. 2

TYPICAL ELECTRON-RAY TUBE CIRCUITS



The license extended to the purchaser of tubes appears in the License Notice accompanying them. Information contained herein is furnished without assuming any obligations.

TUNING CHARACTERISTICS



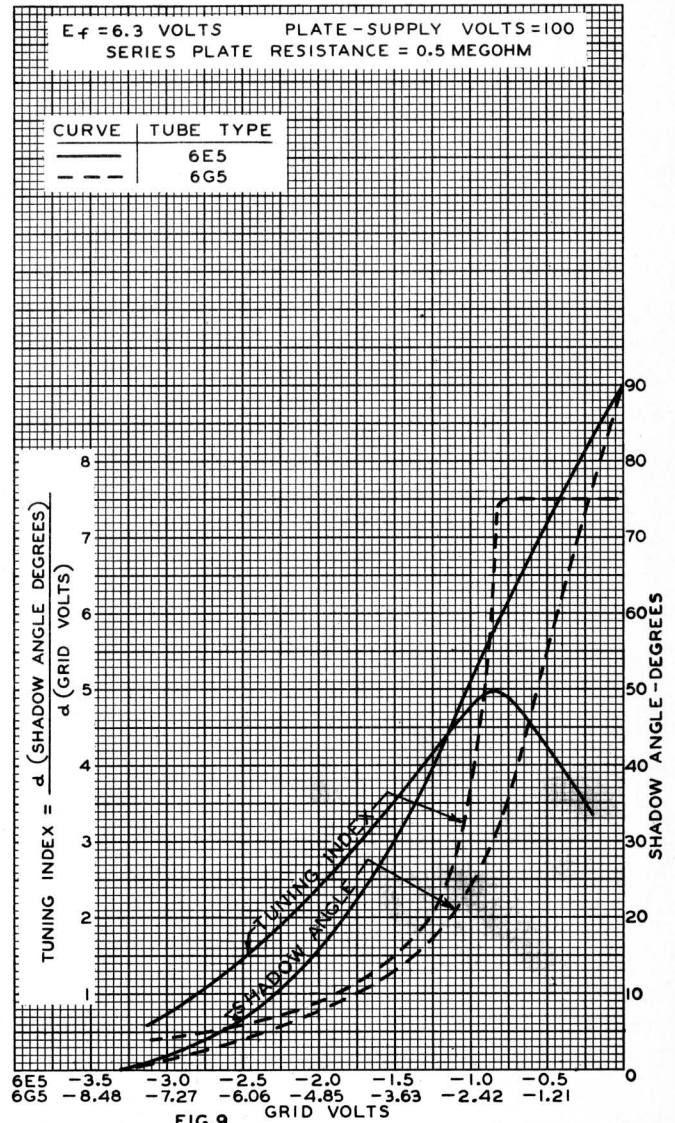
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FIG. 8

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FIG. 9

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