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

RCA RADIOTRON
DIVISION

APPLICATION NOTE NO.94
June 22, 1938

APPLICATION NOTE ON OPERATION OF THE 6AF6-G

The electron-ray tube now in general use as a tuning indicator consists of two main units: (1) a triode, which operates as a d-c amplifier, and (2) an electron-ray indicator having a single ray-control electrode. Both units are mounted in a single glass envelope and connected internally for proper operation. This construction is desirable when the space required by the tube is readily available and when the receiver does not furnish more avc voltage than is necessary to swing the grid bias of the triode from zero to cut-off with a very strong signal applied. However, when space or avc voltage requirements are not easily satisfied, the 6AF6-G may be used to advantage.

The 6AF6-G is a very short electron-ray tube having a 6.3-volt, 150-milliampere heater. The small size has been obtained by omitting the amplifier unit and by employing a special structure. Because of its small size, the 6AF6-G can be mounted in positions which are impractical with the combination type of electron-ray tube. These new mounting positions may lend some novelty to the appearance of a receiver and may obviate the necessity for using the usual harness cable.

An important feature of the 6AF6-G is that it has two ray-control electrodes, mounted on opposite sides of the cathode, each terminating at a base pin. Thus, two shadow angles can be obtained, each independent of the other. A photograph of the 6AF6-G (actual size), a sketch showing the target with open shadow angles, and socket connections are given in Figs.1A, 1B, and 1C, respectively.

Consisting only of an indicator unit, the 6AF6-G is designed to operate in conjunction with a separate d-c amplifier. Separation of amplifier and indicator units provides increased flexibility in electrical and mechanical design. For example, a separate amplifier may be used with each ray-control electrode in such a manner that one pattern closes with low avc voltage to permit easy tuning of weak signals and the second pattern closes with high avc voltage to permit easy tuning of strong signals. In another arrangement, a single-tube d-c amplifier is used with both ray-control electrodes in such a manner that one pattern closes at a low voltage while the second pattern does not change appreciably; then, when the first pattern is nearly closed, the second pattern starts to close rapidly.

Ratings and Typical Operating Conditions for the 6AF6-G

Heater Voltage		6.3	volts
Heater Current		0.15	ampere
Target Voltage	90 min. to	135 max.	volts
Ray-Control-Electrode Supply Voltage		135 max.	volts
Typical Operation:			
Target Voltage	100	135	volts
Target Current (for 100° shadow angle)*	0.9	1.5	milliamperes
Ray-Control Electrode Voltage for Shadow Angle of 0° (approx.)	60	81	volts
Ray-Control Electrode Voltage for Shadow Angle of 100° (approx.)	0	0	volts

*With both ray-control electrodes connected together. Subject to wide variation.

The curves of Fig.2 show the relations between shadow angle, target current, and ray-control electrode voltage for target voltages of 100 and 135 volts. These curves, together with the characteristics of a d-c amplifier, may be used to predict the performance of the tuning indicator.

Tuning-Indicator Circuits Using the 6AF6-G

The 6AF6-G can be used in a variety of circuit arrangements. One of the simplest is shown in Fig.3. In this circuit, a type 6J5 or 6J5-G is used as a d-c amplifier, which feeds one or both ray-control electrodes of a 6AF6-G. The values of R recommended for the circuit of Fig.3 provide a nearly linear relation between shadow angle and control voltage. Four curves are shown: the solid-line curves correspond to 135 volts on the target and the dashed-line curves correspond to 100 volts on the target. Because cut-off voltages are rather low, it is suggested that a second d-c amplifier of the remote cut-off type be used to actuate the second ray-control electrode. With such an arrangement, the pattern controlled by the 6J5 is suitable for tuning weak signals and the pattern controlled by the remote cut-off tube is suitable for tuning strong signals. Overlapping of the sharp cut-off pattern is not important in such a circuit, because tuning of strong signals is accomplished with the aid of the remote cut-off pattern. It is interesting to note that when R equals 1.5 megohms, the shadow angle remains at approximately zero degrees for values of control voltage greater than the cut-off voltage of the amplifier. Little or no overlapping occurs with R equal to 1.5 megohms, because the ray-control electrode current causes sufficient voltage drop in R to prevent excessive overlapping.

The two ray-control electrodes may be connected together when it is desired to change both shadow angles in unison. However, this connection may not be desirable when a sharp cut-off d-c amplifier is used, because the pattern may overlap on strong signals.

Fig.4 shows the circuit and shadow-angle characteristics of one pattern of a 6AF6-G operated by a type 76 at target voltages of 100 and 135 volts. These curves show that accurate tuning of large signals cannot be accomplished with the 76 - 6AF6-G combination, because nearly zero shadow angle is obtained at low control voltages. For this reason, it is suggested that a remote cut-off amplifier be used with the second ray-control electrode to facilitate tuning of strong signals.

The remote cut-off types 6K7, 6K7-G, 78, 6U7-G, and 6D6 connected as triodes may be used as control tubes. Because each of these tube types has a remote cut-off grid, the shadow angle can be reduced to a low value at either high or low control voltages by using the proper value of R. The family of curves in Fig.5 shows the relation between shadow angle and control voltage for various values of R with 135 volts on the target. A suitable cut-off voltage can be chosen easily from these data. Fig.6 shows similar data for 100-volt operation. The data in Figs.5 and 6 obtain when one or both ray-control electrodes are actuated by the same d-c amplifier.

The circuit and shadow-angle characteristics of an interesting circuit using only one of the above-mentioned remote cut-off pentode-type tubes are shown in Figs.7 and 8. In this circuit, the screen of the d-c amplifier tube controls the angle of a pattern having a sharp cut-off characteristic and the plate controls the angle of a pattern having a remote cut-off characteristic. The values of R_1 and R_2 in this circuit are so chosen that the angle of the first pattern closes at a low voltage while that of the second pattern remains substantially constant; then, when the first pattern is nearly closed, the shadow angle of the second pattern decreases rapidly. The control voltages at which the shadow angles become small are shown on the curves. Note that the shadow-angle characteristic of the remote cut-off pattern is substantially flat over a range of control voltage; throughout this same range, the shadow angle of the second pattern changes rapidly. At high values of control voltages, the shadow-angle of the remote cut-off pattern changes rapidly and the second pattern remains closed. Fig.8 shows the shadow-angle characteristics for 100 volts on the target with values of R_1 and R_2 adjusted for approximately the same cut-off voltages as obtained with 135-volt operation.

Actual Size

FIG. 1A

VIEW OF SHADOW PATTERNS

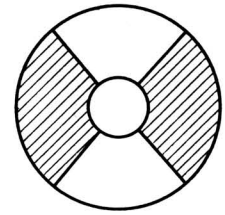
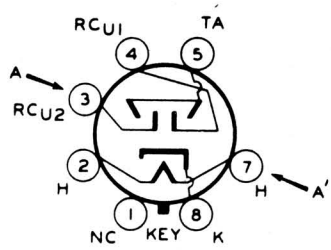


FIG. 1B

BOTTOM VIEW
OF SOCKET CONNECTIONS

AA' = PLANE OF RAY-CONTROL ELECTRODES



7AG

H = HEATER
K = CATHODE
NC = NO CONNECTION
RC_{U1} = RAY-CONTROL ELECTRODE OF UNIT No.1
RC_{U2} = RAY-CONTROL ELECTRODE OF UNIT No.2
TA = TARGET

FIG. 1C

AVERAGE CHARACTERISTICS

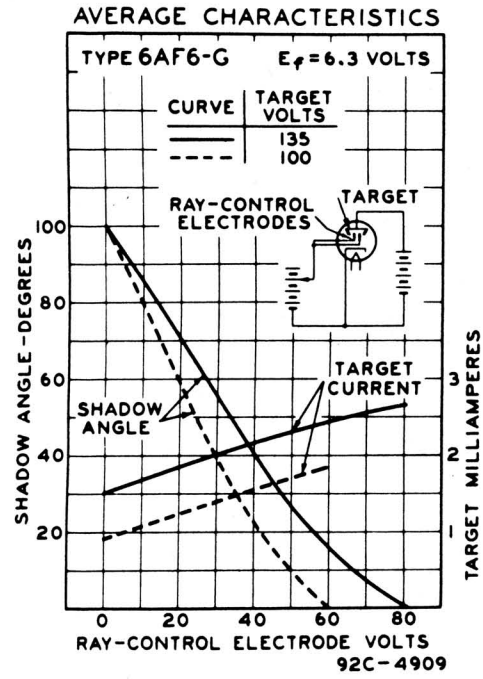


FIG. 2

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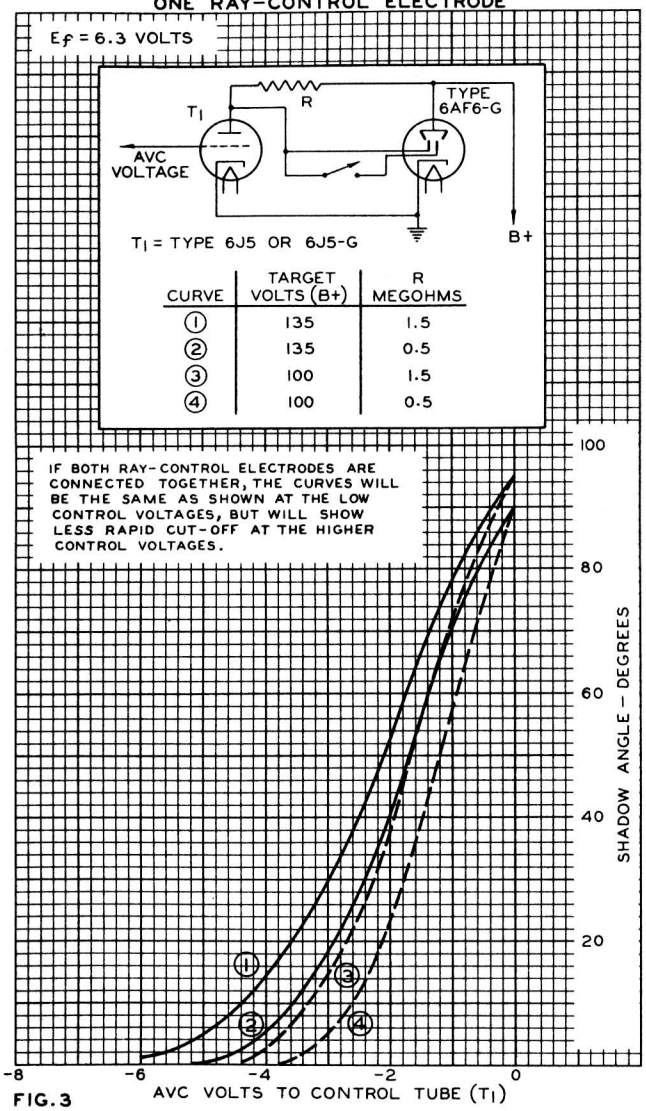
6AF6-G
OPERATION CHARACTERISTICS
WITH TRIODE TYPE 6J5 OR 6J5-G CONTROLLING ONE RAY-CONTROL ELECTRODE



CURVE	TARGET VOLTS (B+)	R MEGOHMS
①	135	1.5
②	135	0.5
③	100	1.5
④	100	0.5

FIG. 3

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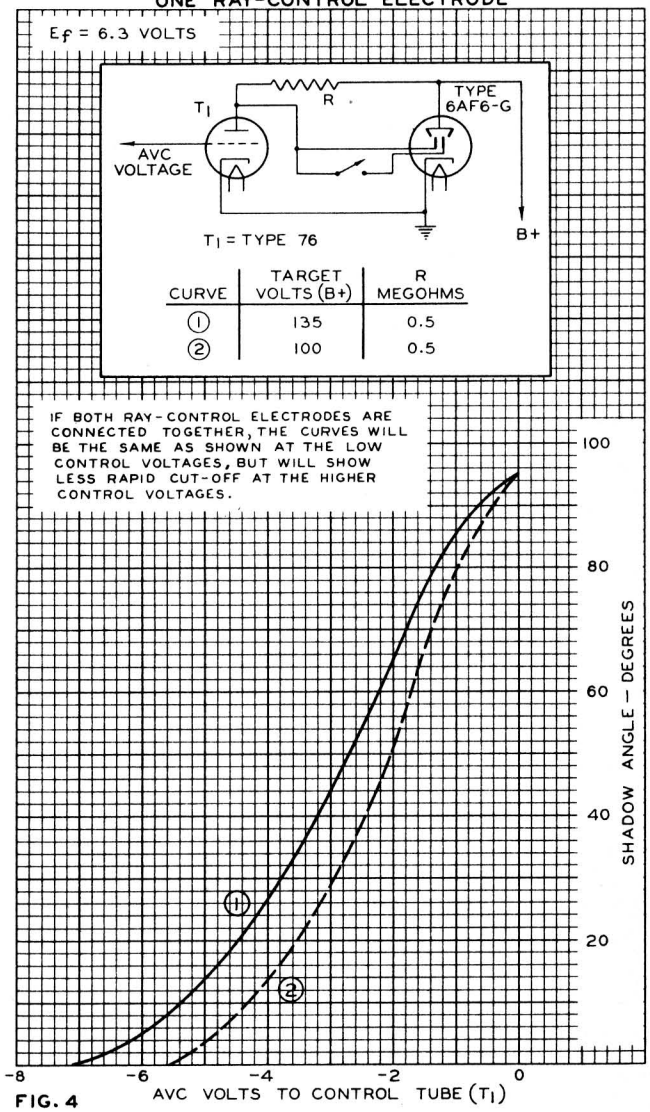
6AF6-G
OPERATION CHARACTERISTICS
WITH TRIODE TYPE 76 CONTROLLING ONE RAY-CONTROL ELECTRODE



CURVE	TARGET VOLTS (B+)	R MEGOHMS
①	135	0.5
②	100	0.5

FIG. 4

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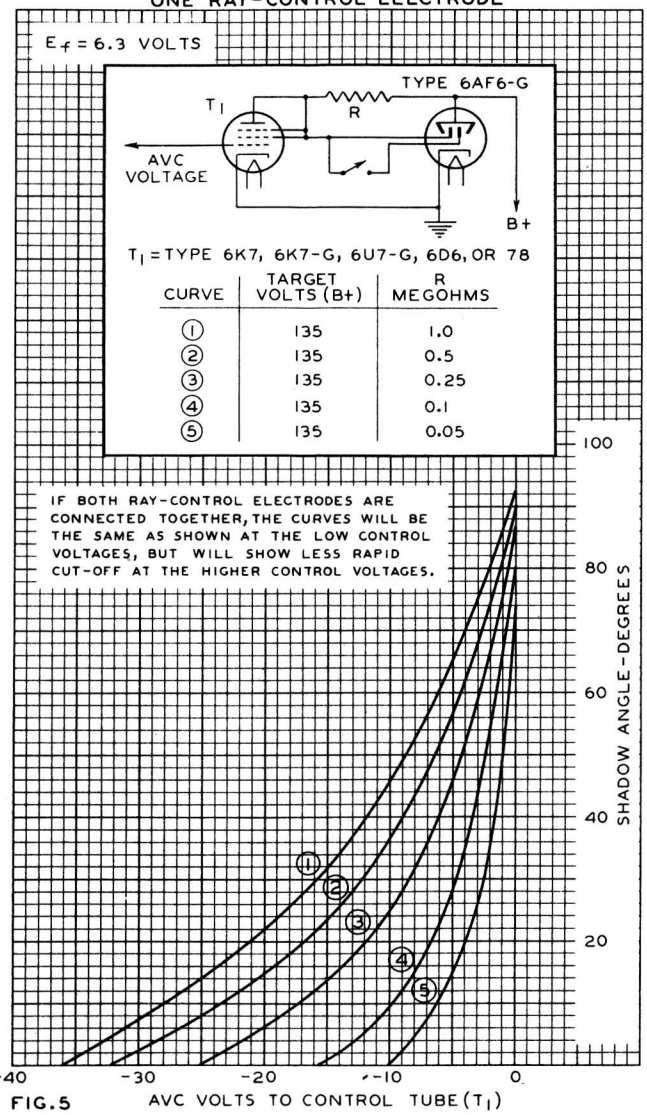
6AF6-G
OPERATION CHARACTERISTICS
WITH PENTODE (TRIODE CONNECTED) CONTROL APPLIED TO ONE RAY-CONTROL ELECTRODE



CURVE	TARGET VOLTS (B+)	R MEGOHMS
①	135	1.0
②	135	0.5
③	135	0.25
④	135	0.1
⑤	135	0.05

FIG. 5

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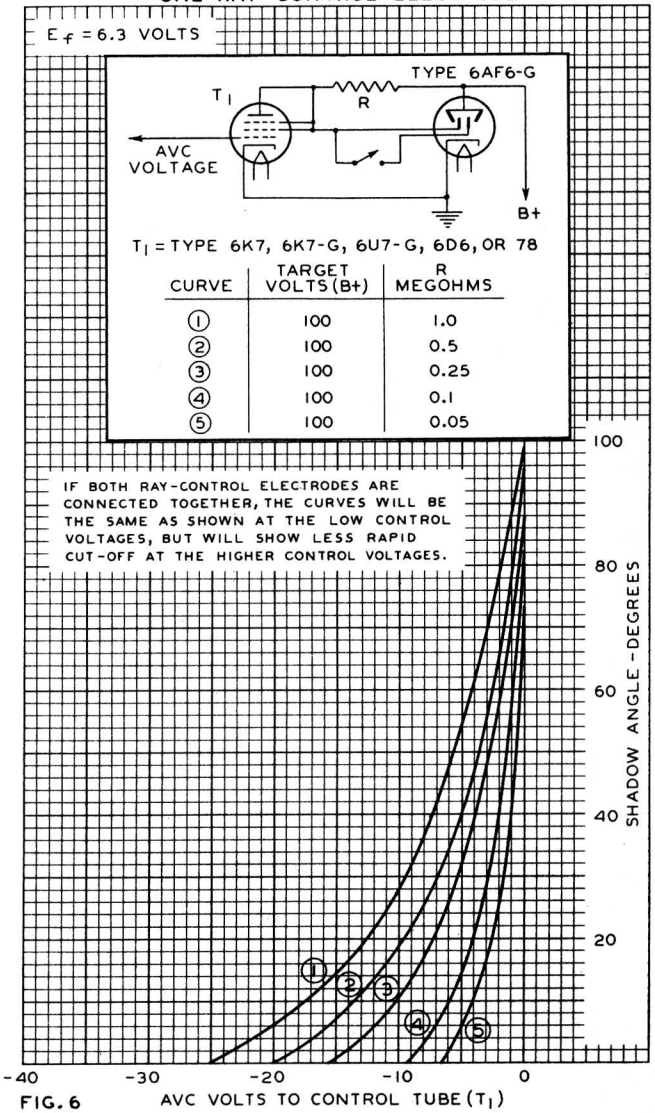
6AF6-G
OPERATION CHARACTERISTICS
WITH PENTODE (TRIODE CONNECTED) CONTROL APPLIED TO ONE RAY-CONTROL ELECTRODE



CURVE	TARGET VOLTS (B+)	R MEGOHMS
①	100	1.0
②	100	0.5
③	100	0.25
④	100	0.1
⑤	100	0.05

FIG. 6

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6AF6-G
OPERATION CHARACTERISTICS
WITH PENTODE CONTROL AS SHOWN IN CIRCUIT

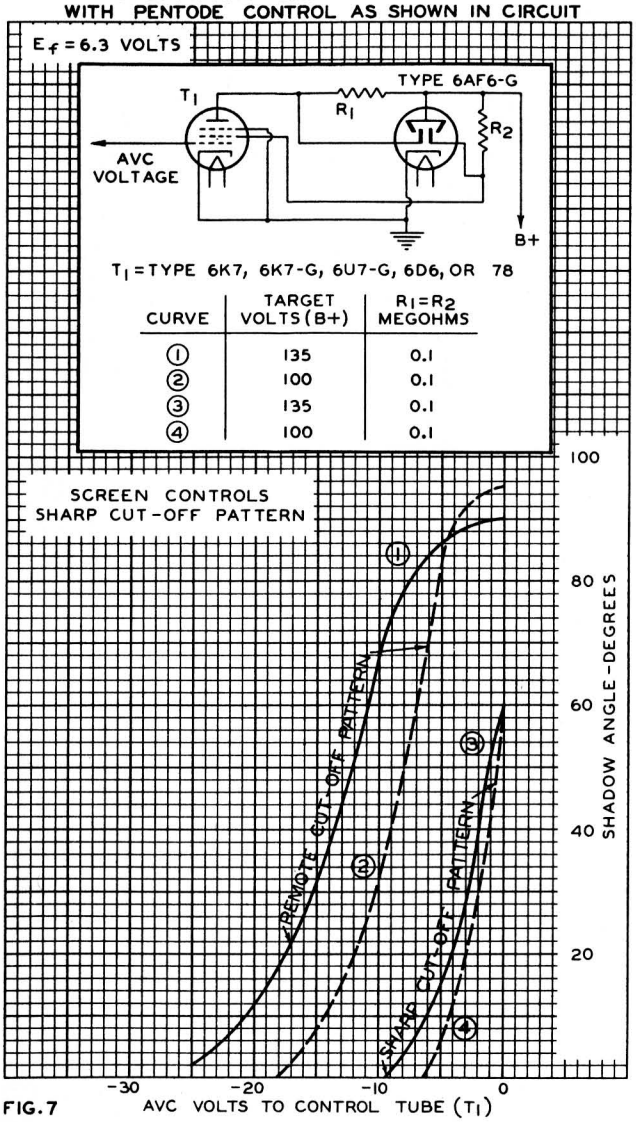

FIG. 7

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6AF6-G
OPERATION CHARACTERISTICS
WITH PENTODE CONTROL AS SHOWN IN CIRCUIT

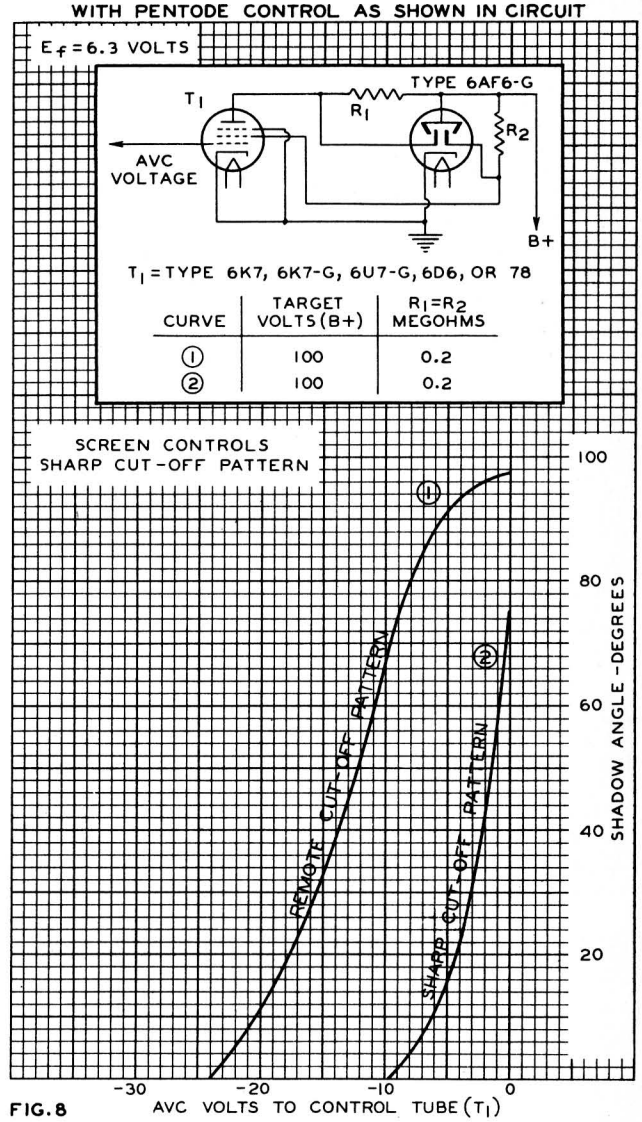

FIG. 8

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