ELECTRON TUBES

Application Note

AN-159

Efficient Deflection and High-Voltage Circuits for RCA-27MP4 Kinescope

A horizontal-deflection system and high-voltage supply using the new ferrite-core transformer, RCA-235T1, has been developed to provide a high voltage of 18 kilovolts together with adequate deflection voltage for kinescopes such as the RCA-27MP4 having horizontal-deflection angles of about 85 degrees and diagonal-deflection angles of about 90 degrees. The required tube complement includes one RCA-6CD6-G horizontal-output tube, one RCA-6W4-GT or RCA-6AX4-GT damper diode, and one RCA-1B3-GT high-voltage rectifier. The horizontal-deflection circuit, shown in Fig. 1, along with a conventional vertical-deflection circuit employing a 6W6-GT vertical-output tube, operates from a B-supply voltage of 265 volts. The B-power consumption for both horizontal-deflection and vertical-deflection circuits is less than 37 watts.

Associated Deflection Components

The horizontal-deflection circuit, shown in Fig. 1, utilizes the RCA-219D1 deflecting yoke, which is especially designed to provide the good corner resolution desirable with large rectangular kinescopes. Two ferrite-core coils are used for linearity control and width control. The width control has an inductance range of approximately 3.9 millihenries to 22 millihenries. The approximate inductance range of the linearity control, RCA-213R1, is 1.5 millihenries to 8.3 millihenries.

Lead Dress

Special attention must be given to wiring techniques utilized with horizontal-deflection and high-voltage circuits to minimize stray capacitance and to prevent corona or arc-overs. It is particularly important to dress the 1B3-GT plate lead away from other leads and the chassis. Other leads having relatively high pulse voltages are: 6CD6-G plate lead, 6W4-GT cathode lead, and leads to transformer terminals 3, T, 4, and 5.

Adjustments

Correct adjustment of the DRIVE control is important for proper circuit performance. The drive should first be increased until a white

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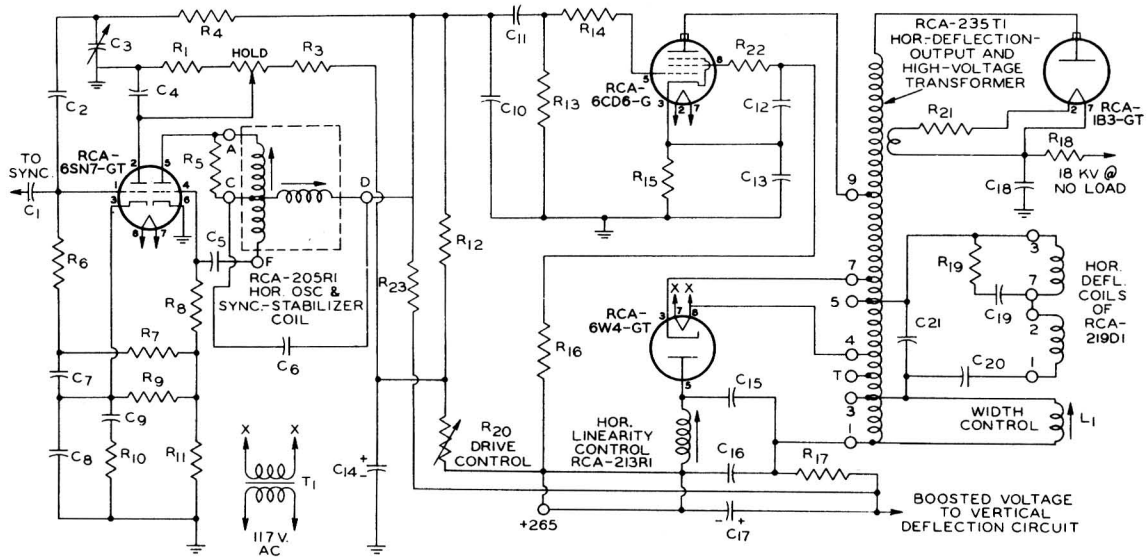
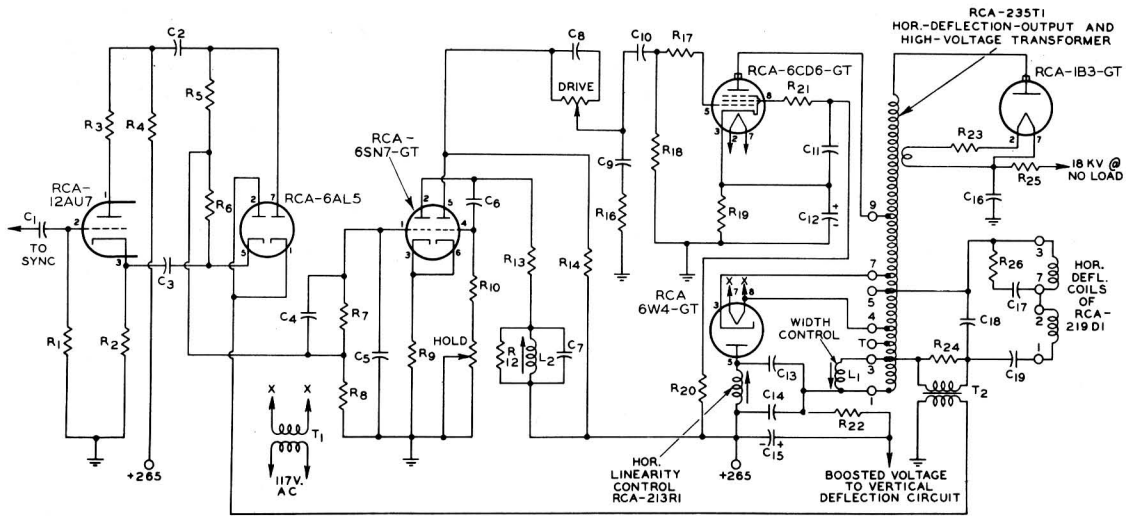
vertical bar appears near the center of the raster, and should then be decreased until this bar just disappears. The linearity control should then be adjusted for best linearity. Because minimum cathode current in the 6CD6-G occurs in this circuit very near the optimum setting of the linearity control, a preliminary adjustment of linearity may be made by setting the linearity control for minimum voltage across the 6CD6-G cathode resistor. The optimum setting of the linearity control for best linearity and high-voltage regulation is at the point which provides slightly less inductance than that which produces minimum current in the 6CD6-G. The 6CD6-G cathode current at this point is 3 to 4 milliamperes greater than the minimum value. The adjustment of drive is somewhat dependent upon the linearity adjustment and should be rechecked after other adjustments are completed.



C1: 82 μμf, 500v., mica
C2: 82 μμf, 500v., mica
C3: Locking range control, 8-70 μμf, mica trimmer
C4: 0.05 μf, 400v.
C5: 330 μμf, 500v., mica
C6: 0.01 μf, 600v., oil-filled
C7: 0.05 μf, 400v.
C8: 0.02 μf, 400v.
C9: 0.5 μf, 400v.
C10: 750 μμf, 500v. mica
C11: 0.003 μf, 600v.
C12: 0.25 μf, 400v.
C13: 4 μf, 200v. electrolytic
C14: 10 μf, 450v. electrolytic
C15: 0.05 μf, 600v.
C16: 0.05 μf, 600v.
C17: 10 μf, 450v., Type DEE or equivalent
C18: 500 μμf, 30000v.
C19: 120 μμf approx., 2000v.
C20: 0.25 μf, 600v.
C21: 125 μμf approx., 4000v.
L1: Width Control, 3.9-22 mh
R1: 0.12 megohm, 1 watt
R2: Potentiometer, 50000 ohms, 2 watts
R3: 47000 ohms, 1 watt
R4: 0.15 megohm, 1 watt
R5: 8200 ohms, 0.5 watt
R6: 0.33 megohm, 0.5 watt
R7: 0.82 megohm, 0.5 watt
R8: 0.15 megohm, 0.5 watt
R9: 82000 ohms, 1 watt
R10: 3900 ohms, 0.5 watt
R11: 0.33 megohm, 1 watt
R12: 68000 ohms, 1 watt
R13: 0.47 megohm, 0.5 watt
R14: 100 ohms, 0.5 watt
R15: 150 ohms, 5 watts
R16: 12000 ohms approx., 5 watts
R17: 2000 ohms, 1 watt
R18: 0.22 megohm, 1 watt
R19: 1000 ohms, 0.5 watt
R20: Potentiometer, 25000 ohms, 2 watts
R21: 0.68 ohms approx., 0.5 watt
R22: 47 ohms, 0.5 watt
R23: 1 megohm, 1 watt
T1: Heater transformer insulated for 2500 volts peak

Fig. 1 - Horizontal-Deflection and High-Voltage Circuit.

The capacitor C21, connected between terminals 3 and 5 of transformer RCA-235T1, affects the natural period of the entire circuit and at the same time aids in suppressing undesirable ripple and interference



C1: 0.01 μf, 400v.
C2: 1000 μμf, 500v., mica
C3: 1000 μμf, 500v., mica
C4: 0.005 μf, 400v.
C5: 0.05 μf, 400 v.
C6: 330 μμf, 500v., mica
C7: 3900 μμf, 500v., mica
C8: 1000 μμf, 500v., mica
C9: 390 μμf, 500v., mica
C10: 0.0047 μf, 600v.
C11: 0.25 μf, 400v.
C12: 4 μf, 200v. electrolytic
C13: 0.05 μf, 600v.
C14: 0.05 μf, 600v.
C15: 10 μf, 450v., Type DEE or equivalent
C16: 500 μμf, 30000v.
C17: 120 μμf approx., 2000v.
C18: 125 μμf approx., 4000v.
C19: 0.25 μf, 600v.

L1: Width Control, 3.9-22 mh
L2: Horizontal Oscillator Coil, 10-30 mh approx.
R1: 1 megohm, 0.5 watt
R2: 3900 ohms, 1 watt
R3: 3900 ohms, 1 watt
R4: 3900 ohms, 1 watt
R5: 0.1 megohm, 0.5 watt
R6: 0.1 megohm, 0.5 watt
R7: 0.47 megohm, 0.5 watt
R8: 4.7 megohms, 0.5 watt
R9: 1500 ohms, 0.5 watt
R10: 0.1 megohm, 0.5 watt
R11: Potentiometer, 25000 ohms, 1 watt
R12: 22000 ohms, 0.5 watt
R13: 5600 ohms, 1 watt
R14: 0.11 megohm, 1 watt
R15: Potentiometer, 25000 ohms, 2 watts
R16: 8200 ohms, 0.5 watt

R17: 100 ohms, 0.5 watt
R18: 0.47 megohms, 0.5 watt
R19: 150 ohms, 5 watts
R20: 12000 ohms approx., 5 watts
R21: 47 ohms, 0.5 watt
R22: 2000 ohms, 1 watt
R23: 0.68 ohms approx., 0.5 watt
R24: 6.8 ohms, 0.5 watt
R25: 0.22 megohm, 1 watt
R26: 1000 ohms, 0.5 watt
T1: Heater transformer insulated for 2500 volts peak
T2: Horizontal AFC Transformer, Turns Ratio Primary to Secondary 1:2

Fig. 2 - Horizontal-Deflection and High-Voltage Circuit with Multivibrator-Type Drive Circuit.

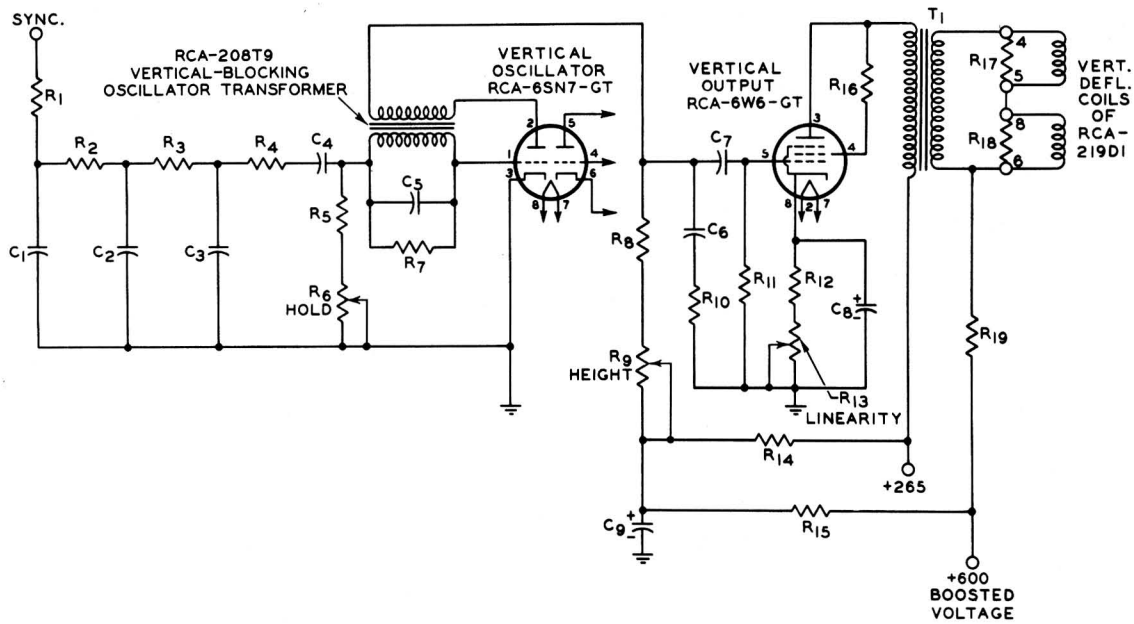
effects. The value of this capacitor is chosen to provide a retrace pulse having a duration and shape which gives best performance, particularly with respect to scanning amplitude and high-voltage output. When this system is used with kinescopes having slightly different deflection angles, the capacitor C21 is adjusted to provide the correct ratio of scanning amplitude to high voltage for each type kinescope used. The required value of C21, which is affected by the capacitance to ground of the 6W4-GT heater winding and the length of the deflecting-yoke leads, should be determined by trial during development work because the physical arrangement of the parts in the system affects the natural period. The optimum value for C21 is between 75 and 200 micromicrofarads. A value of about 125 micromicrofarads is suggested as a suitable initial trial value for use with the RCA-27MP4 kinescope.

The horizontal-deflection circuit using the RCA-235T1 may be driven with either a blocking oscillator, as shown in the circuit in Fig. 1, or with the multivibrator-type oscillator shown in Fig. 2. Both drive circuits utilize automatic frequency control for better noise immunity and

work equally well in this application. Keyed automatic-gain-control pulses can be obtained from terminal 3, T, 4, 5, or 7 of the transformer RCA-235T1, depending upon the magnitude of the desired positive voltage pulse. The voltage magnitude of the keyed AGC pulses which can be obtained at the various terminals are given in Table I.

B-Supply Voltage

A design-center value of 265 volts is suggested for the B-supply, but some variation in this value is permissible. The minimum design-center voltage is determined by the ability of the circuit to produce an adequate margin of width at low line voltage. A design-center value as low as 255 volts may be sufficient with the circuits shown in Figs. 1 and 2. When B-voltages are specified for particular horizontal-deflection circuits, it is generally advisable not to exceed the recommended voltages. The horizontal-output tube in such a circuit may be operating near its maximum plate-dissipation limit and an increase in supply voltage may cause excessive dissipation. In the circuits of Figs. 1 and 2, however, the 6CD6-G operates below its maximum plate-dissipation rating. Therefore, although a design-center B-voltage of 265 volts is suggested for this circuit, a design-center value as high as 300 volts may be



C1: 0.002 μf, 400v.
C2: 0.005 μf, 400v.
C3: 0.005 μf, 400v.
C4: 0.006 μf, 400v.
C5: 0.001 μf, 400v.
C6: 0.05 μf, 600v.
C7: 0.1 μf, 600v.
C8: 150 μf, 50v., electrolytic
C9: 10 μf, 450v., electrolytic
R1: 22000 ohms, 0.5 watt
R2: 8200 ohms, 0.5 watt
R3: 8200 ohms, 0.5 watt
R4: 82000 ohms, 0.5 watt
R5: 1.8 megohms, 0.5 watt
R6: Potentiometer, 1 megohm, 1 watt
R7: 0.15 megohm, 0.5 watt
R8: 0.39 megohm, 0.5 watt
R9: Potentiometer, 2 megohms, 2 watts
R10: 10000 ohms, 0.5 watt
R11: 1.5 megohms, 0.5 watt
R12: 470 ohms, 0.5 watt
R13: Potentiometer, 1500 ohms, 2 watts
R14: 75000 ohms, 1 watt
R15: 0.2 megohms, 1 watt
R16: 500 ohms, 0.5 watt
R17: 560 ohms, 0.5 watt
R18: 560 ohms, 0.5 watt
R19: 0.1 megohm, 0.5 watt
T1: Vertical-Deflection-Output Transformer, Turns Ratio Primary to Secondary 8:1

Fig. 3 - Vertical-Deflection Circuit.

used without exceeding the tube plate-dissipation limit provided the value of the screen dropping resistor is suitably chosen to give a plate current of approximately the value indicated in Table I. The maximum design-center ultor voltage must always be limited to 18 kilovolts so that operating voltages and currents for the horizontal-output transformer and deflecting yoke will not be excessive.

Vertical Deflection

The vertical-deflection circuit, shown in Fig. 3, utilizes one 6W6-GT operating directly from the B-supply with a current drain of approximately 28 milliamperes. The 6W6-GT is triode-connected. A 500-ohm resistor is used between plate and grid No. 2 to prevent parasitic oscillations which are likely to occur if this resistor is omitted. Operation directly from the B-supply permits the use of a lower system B-supply voltage than would be required if vertical deflection were obtained from the boosted B-supply.

The vertical-deflection circuit may also be operated from the boosted B-supply in a circuit in which a single 6S4 and a vertical output transformer having a turns ratio of 18:1 are used. In this case, the design-center B-supply voltage must be increased to 285 volts, and a second damper diode must be used to handle the increased current which flows in the damper circuit as a result of the load on the boosted B-supply. The cathode of the damper tube must also be connected to terminal 5 instead of terminal 7 of the RCA-235T1 horizontal output transformer in order to preserve good horizontal linearity. With this arrangement, the boosted B-supply drain is approximately 14 milliamperes. The 6CD6-G cathode current is approximately 122 milliamperes and the 6W4-GT plate current is approximately 126 milliamperes.

Performance Data

Table I shows typical performance data for the circuits of Figs. 1, 2, and 3, with a line voltage of 117 volts and with the width control set for maximum and minimum width, respectively. The circuits provide adequate deflection to afford some margin of width at a line voltage of 105 volts.

Adjustment of Deflecting Yoke, Focusing Device, and Ion-Trap Magnet

The deflecting yoke should be centered on the tube neck with front coils in contact with the glass funnel of the tube. The focusing device should be spaced at least 3/4 inch from the end of the deflecting coil windings. This spacing is necessary to reduce interaction between the focusing and deflecting fields. The ion-trap magnet should be placed on the tube neck in line with or slightly below grid No. 2, or about 3/4 inches from the tube base. The south pole of the magnet should be adjacent to pin No. 2 and the north pole to vacant pin position No. 8. Centering and adjustment should be carried out as outlined in RCA Application Note AN-153 - "Adjustment Procedure for Kinescope Ion-Trap Magnets". Best edge focus is obtained in the tube when the focusing device is placed as far behind the deflecting yoke as is feasible without interference with the ion-trap magnet. This location of the focusing device reduces the diameter of the electron beam as it passes through the

deflecting yoke, and produces better edge focus. This arrangement requires a stronger field and slightly increases the spot size at the center of the screen, but the overall picture quality is substantially improved.

Table I - Typical Operation of Circuits in Figs. 1, 2, and 3*

	Width Control Setting		
	Maximum Width	Minimum Width	
B-Voltage	265	265	volts
High Voltage:			
At zero beam current	18	17.9	kv
At 140-μa beam current	16.7	16.6	kv
At 200-μa beam current	16.1	16.0	kv
Boosted B-Voltage▲	610	580	volts
Current from Boosted Voltage Supply (approx.)	1	1	ma
6CD6-G			
Cathode Current	116	125	ma
Plate Current	107	116	ma
Grid-No.2 Current	9	8.8	ma
Grid-No.2 Voltage	130	132	volts
Grid-No.2 Input	1.17	1.16	watts
Grid-No.1 Voltage●	-33	-32.5	volts
Peak Plate Voltage	4950	4900	volts
6W4-GT			
Plate Current	108	117	ma
Peak Inverse Plate Voltage	3335	3310	volts
Peak Heater-Cathode Voltage	1950	1945	volts
Pulse Voltage at Terminals of RCA-235T1 Measured to Ground□:			
Terminal 3	1160	1145	volts
Terminal T	1300	1280	volts
Terminal 4	1650	1630	volts
Terminal 5	3350	3330	volts
Terminal 7	3600	3575	volts

6W6-GT (With height control adjusted for full picture height at 18 kilovolts)

Cathode Current	28.5	ma
Plate voltage	228	volts
Plate dissipation	6.5	watts
Grid-No.1 Voltage (cathode bias)	-32	volts
Peak plate voltage	600	volts

* At a line voltage of 117 volts. All values at zero kinescope beam current unless otherwise noted.

▲ Measured at terminal 1 of RCA-235T1.

● Consists of 18 volts cathode bias and 15 volts grid-resistor bias.

□ Consists of positive voltage pulse having a dc component equal to the boosted B-voltage.