Using Electromagnetic-Deflection Cathode-Ray Tubes in the Television Receiver

Scanning, Synchronizing and Power Supply Circuits and Construction for Five- and Nine-Inch Kinescopes

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THIS article describes the construction of synchronizing, scanning, and power supply equipment for use with 5-inch and 9-inch Kinescopes of the electromagnetic-deflection type. The 9-inch outfit was shown in the photograph of the receiver in Mr. C. C. Shumard's December article,[1] and the 5-inch outfit is equally well suited for use with the same receiver. Another 5-inch Kinescope arrangement, with electrostatic deflection, will be described in a subsequent article.

Scanning Circuit

Fig. 1 shows the circuit of a scanning unit suitable for use with either Type 1801 (5-inch) or 1800 (9-inch) Kinescope. A composite signal consisting of both vertical and horizontal synchronizing impulses of negative polarity is supplied from the receiver to the post marked "sync. input." The constants of the circuit associated with the first 6N7 are so chosen that the vertical impulse alone is delivered to the vertical oscillator and the horizontal impulse alone is delivered to the horizontal oscillator. A good discussion of the operation of the blocking oscillator, discharge tube, and output circuits used to generate sawtooth deflecting currents in the deflecting yoke will be found in the bulletins on the RCA 1800 and 1801, and will, therefore, not be repeated here.

The apparatus of Fig. 1 is mounted on a chassis 8 × 17 × 3 inches, with a front panel 8¾ × 19 inches, as shown in Figs. 2 and 3. This is suitable for rack mounting, or the unit may be mounted back of a wooden panel in a cabinet with the balance of the receiver. Of the various controls required, it is desirable to place on the front panel the two fine-speed (frequency), the two size, and the two centering adjustments, making six panel controls. The rest of the controls may be screwdriver adjustments located on the rear of the chassis. Fig. 4 shows the layout of parts on the scanning chassis. The deflection outputs are brought to a socket mounted at the rear, into which is plugged a 4-wire cable from the deflecting yoke in the Kinescope unit. Each of the two pairs in this cable should be twisted.

The horizontal centering control is a 50-ohm General Radio Type 214A potentiometer which has been center-tapped. The tap can be easily made to a single turn raised about 1/16 inch with a small screwdriver. The raised portion is cleaned and a light flexible lead attached with ordinary rosincore solder. A small square of cambric slipped under the raised turn will insulate and support the connection.

The peak voltages between the 6L6G plate and other socket connections are very high and the usual wafer socket will almost surely break down. A good ceramic socket should be used for the 6L6G tube.

The scanning power-supply requirements are moderate, and therefore this supply is conveniently incorporated into the scanning chassis. A separate transformer with 1500-volt insulation is used for the filament of the 1-V tube and is mounted on the underside of the chassis.

Kinescope Power Supplies

The scanning unit described will provide ample deflecting currents for either the 5-inch or 9-inch Kinescope. The 5-inch tube is operated at 3000 volts second anode, the 9-inch tube at 6000 volts. The circuits of the power supplies for the two Kinescopes are shown respectively in Figs. 5 and 6. The Kinescope itself is housed separately and

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[1] C. C. Shumard, "A Practical Television Receiver for the Amateur," *QST*, December, 1938; also, by the same author, "Construction and Alignment of the Television Receiver," *QST*, January, 1939.

In this article, picture-reproduction systems alternative to those described in October *QST* are presented from the practical circuit and construction standpoint. The circuits are for magnetic-deflection television-type tubes as contrasted with the oscilloscope-type tubes previously considered, and dovetail into the receiver circuit described in the December and January issues. The larger screen area (five- and nine-inch diameter as compared with three-inch and smaller oscilloscope tubes) naturally makes for better picture reproduction. In a subsequent issue similar information on using the new electrostatic-deflection tubes will be given.

connected to its power supply by a cable enclosed in grounded copper braid, and to the scanning unit by the 4-wire cable mentioned previously. The high-voltage cable requires four wires for the 1801 and five for the 1800. The second-anode leads for both tubes, and first-anode lead for the 1800, should be automobile high-tension wire.

Figs. 7 and 8 show the external appearance of the 1801 and 1800 supplies respectively; and Figs. 9 and 10, the undersides of the chassis. The chassis are 8 × 17 × 3 inches, with front panel 8¾ by 19 inches. It will be noted that thorough precautions have been taken to safeguard the operator against the high voltages used. The primary leads of the power transformer run through two pairs of pin jacks which open the 110-volt circuit when the cover is removed from the underside of the chassis. Similar interlocks are located on the Kinescope housing. In addition, a gravity-operated relay with coil connected

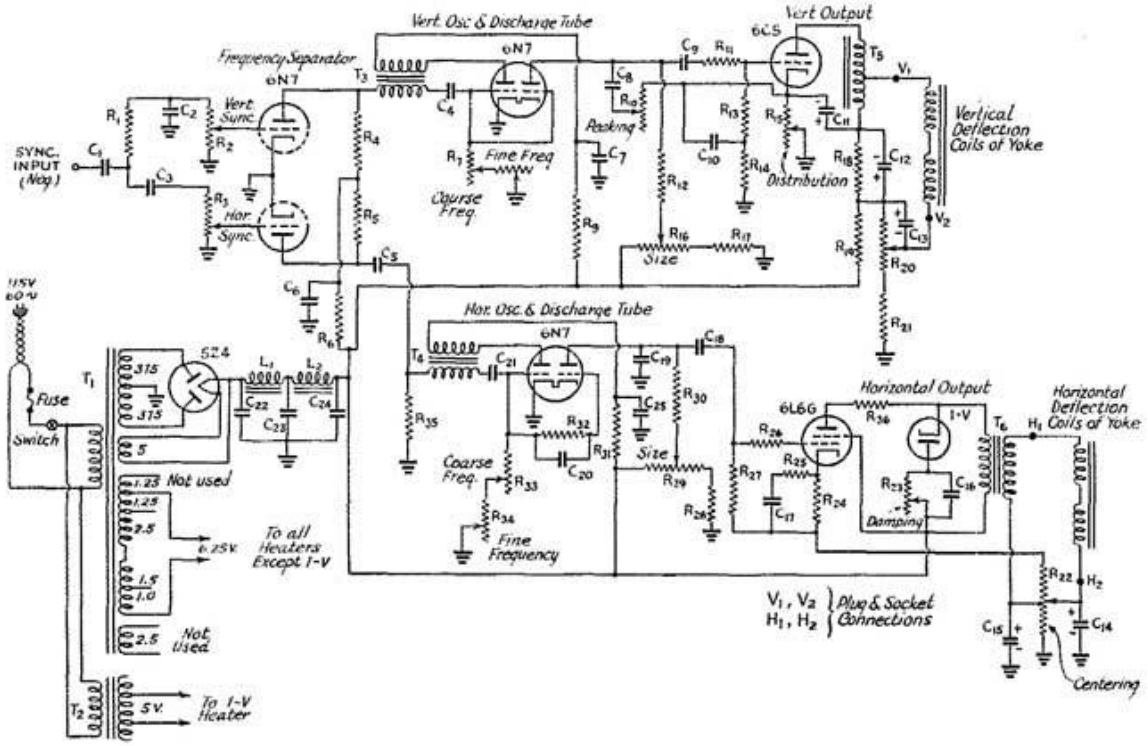


Fig. 1 — Synchronizing and scanning circuit for the 1801 and 1800.

C_1, C_7, C_9, C_{16} — 0.25-μfd., 400-volt paper.
C_2, C_{21} — 0.001-μfd., 200-volt mica.
C_3 — 25-μμfd., 200-volt mica.
C_4, C_8 — 0.1-μfd., 400-volt paper.
C_5 — 0.005-μfd., 400-volt mica.
C_6, C_{22} — 4-μfd., 450-volt electrolytic.
C_{10} — 0.02-μfd., 200-volt paper.
C_{11}, C_{12}, C_{13} — 8-μfd., 450-volt electrolytic.
C_{14}, C_{15} — 25-μfd., 50-volt electrolytic.
C_{17} — 5-μfd., 50-volt electrolytic.
C_{18} — 0.002-μfd., 400-volt mica.
C_{19} — 250-μμfd., 400-volt mica.
C_{20} — 800-μμfd., 200-volt mica.
C_{23}, C_{24} — 16-μfd., 450-volt electrolytic.
C_{25} — 0.05-μfd., 400-volt paper.
R_1, R_9, R_{31} — 0.1-megohm, ½-watt.
R_2, R_3, R_7 — 0.2-megohm potentiometer.
R_4, R_5, R_{18} — 3000 ohms, 1-watt.
R_6 — 4000 ohms, 2-watt.
R_8, R_{20} — 50,000-ohm potentiometer.
R_{10}, R_{16}, R_{29}, R_{33} — 0.1-megohm potentiometer.
R_{11} — 0.75-megohm, ½-watt.
R_{12} — 1-megohm, ½-watt.
R_{13}, R_{27}, R_{30} — 0.5-megohm, ½-watt.
R_{14} — 1.5-megohm, ½-watt.
R_{15} — 5000-ohm potentiometer.
R_{17}, R_{28}, R_{32} — 5000 ohms, ½-watt.
R_{19} — 5000 ohms, ½-watt.
R_{21} — 50,000 ohms, 1-watt.
R_{22} — 50-ohm center-tapped potentiometer (GR 214A center-tapped).
R_{23} — 15,000-ohm potentiometer.
R_{24} — 330 ohms, wire-wound.
R_{25}, R_{26} — 100 ohms, ½-watt.
R_{34} — 10,000-ohm potentiometer.
R_{35} — 500 ohms, ½-watt.
R_{36} — 100 ohms, 1-watt.
T_1 — Power transformer, 375 volts each side c. t., with 6.3 and 5-volt heater windings (RCA No. 9551).
T_2 — 5-volt filament transformer (Jefferson No. 464-221).
T_3 — Vertical oscillation transformer (RCA No. 9834).
T_4 — Horizontal oscillation transformer (RCA No. 9835).
T_5 — Vertical output reactor (RCA No. 9833).
T_6 — Horizontal output transformer (RCA No. 9836).
L_1, L_2 — 20 henrys, 90 ma., 400 ohms (UTC).
Yoke — Deflecting yoke (RCA No. 9831).

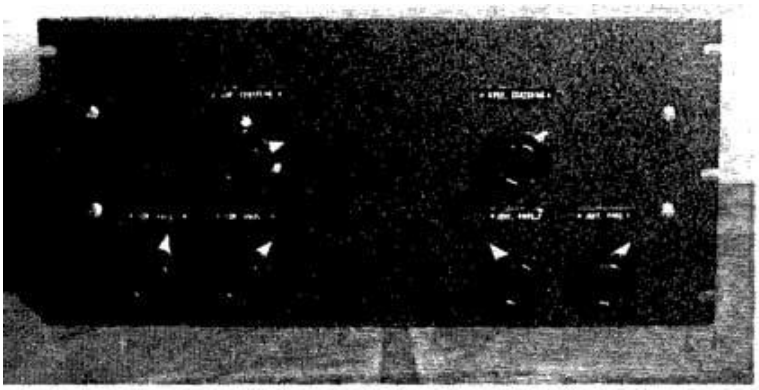


Fig. 2 — Panel view of the scanning unit shown schematically in Fig. 1.

across the power-transformer primary shorts the high-voltage output when the 110-volt supply is disconnected. The chassis itself should be securely grounded. While these precautions may seem elaborate, the subject of high-voltage protection certainly deserves all the attention possible.

The only control located on the high-voltage supply is that of focus. The potentiometer for this job is mounted on a strip of bakelite set back from the front of the chassis, and an insulating coupling is inserted in the controlling shaft. The resistors for the high-voltage divider are mounted on the same bakelite strip. In the case of the 1801 supply, the 879 rectifier tube is also mounted on this strip. This horizontal mounting is permissible only if the tube is mounted with the filament pins in a vertical plane, that is, one above the other. In the case of the 1800 supply, horizontal mounting of the 878 is not permissible, and a convenient and safe arrangement is to support the rectifier inverted in a kind of chimney, so that the plate connection is available beneath the chassis, from which side the tube is inserted. A National 4-pin socket mounted on the cover of the chimney by means of the standoff support supplied with this socket makes a very satisfactory arrangement. The filament leads are brought down alongside the tube. The chimney shown in Fig. 8 is a 3-inch aluminum tube with 1/16-inch wall, 6 inches long. Small holes are drilled in the cover and around the base for ventilation. The hole in the chassis is slightly less than the diameter of the aluminum tube.

The output voltages are brought to a bakelite terminal board equipped with General Radio pin jacks, the leads from the Kinescope being provided with pins for easy disconnection. The other end of the supply cable is connected permanently at the Kinescope housing.

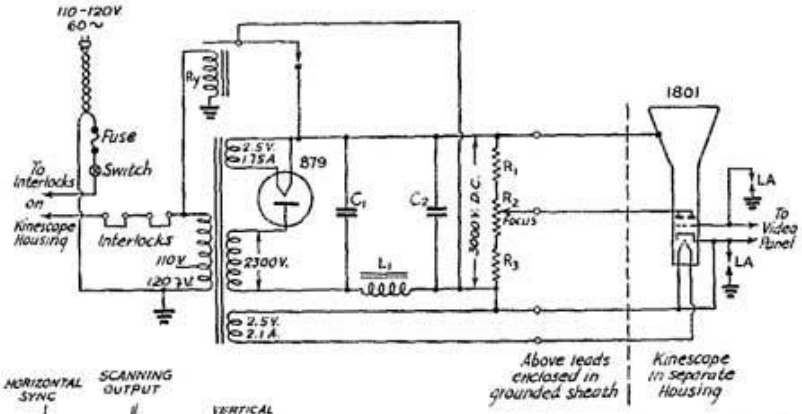


Fig. 5 — Power supply circuit for the 1801.
C1 — 0.025-μfd., 4000-volt (Combined in one unit, RCA No. 9840).
C2 — 0.05-μfd., 3500-volt (Combined in one unit, RCA No. 9840).
R1 — 3 megohms, 3-watt (3 1-meg., 1-watt units in series).
R2 — 0.5-megohm, 1-watt potentiometer.
R3 — 0.25-megohm, 1-watt.
L1 — 1500 henrys (RCA No. 9838).
T1 — Power transformer (RCA No. 9839).
LA — Neon-type lightning arrestor (Brach No. 27A).
Ry — High-voltage shorting relay, gravity operated.

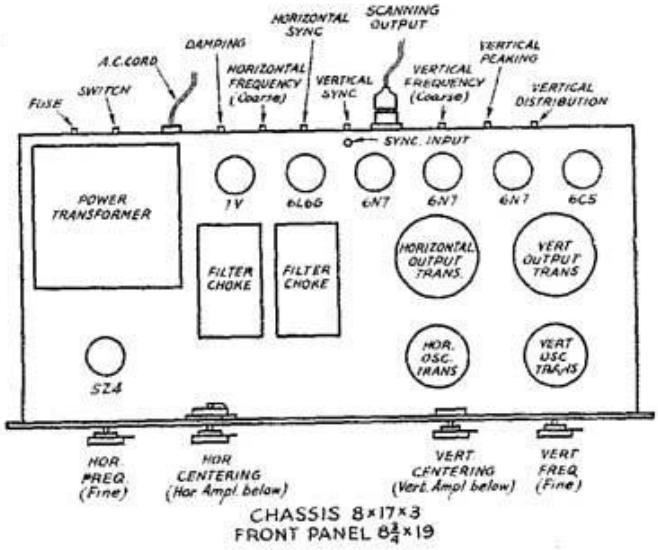


Fig. 4 — Chassis layout drawing for the scanning unit.

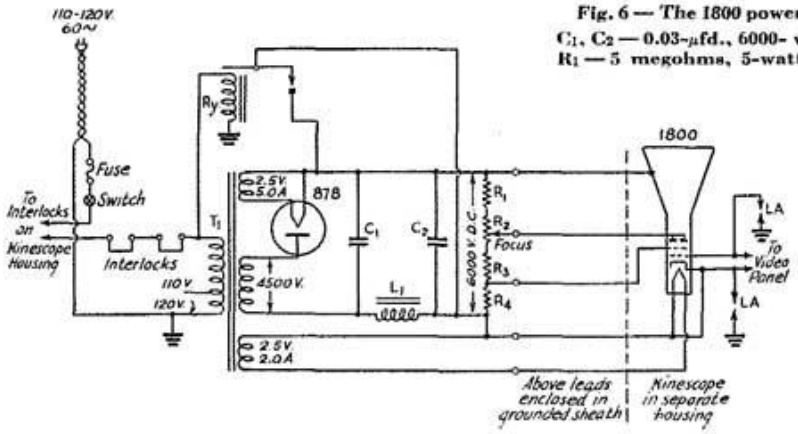


Fig. 6 — The 1800 power supply circuit.

C_1, C_2 — 0.03-μfd., 6000- volt.
R_1 — 5 megohms, 5-watt (5 1-meg., 1-watt units in series).
R_2 — 0.5-megohm, 1-watt potentiometer.
R_3 — 0.75-megohm, 1-watt.
R_4 — 0.3-megohm, 1-watt.
L_1 — 1500 henrys (RCA No. 9838).
T_1 — Power transformer.
LA — Neon-type lightning arrestor (Brach No. 27A).
Ry — High-voltage shorting relay, gravity operated.

Kinescope Housings

Fig. 11 shows the housings for the 5-inch and 9-inch tubes. Shelby seamless iron tubing, which is available from metal-products distributors in a large variety of sizes and weights, is used for the purpose of providing shielding of the Kinescope from stray static and magnetic fields as well as for safety reasons. The 1801 requires a piece of tubing 16½ inches long and 5½ inches inside diameter. A wall of 1/16 or ⅛ inch is suitable. For the 1800, tubing 15 inches long and 5½ inches inside diameter is used with a conical section cut from thin aluminum. The photograph shows a front fitted with safety glass; this provides mechanical protection to the tube and to the viewer.

It is important that the iron tubing used for shielding should not be magnetized, in order to avoid interference with both focus and deflection. Should demagnetizing be necessary, a suitable coil consists of about 500 turns of No. 18 enamel cotton-covered copper wire random-wound on a 7-inch cardboard form to make a coil about 1¼ inches long and ⅞ inch deep. This may be connected directly to the 110-volt, 60-cycle supply. In operation, while voltage is applied to the coil the iron tubing is passed through the coil and carried several feet to one side before the voltage is removed.

Instead of iron tubing, aluminum tubing can also be used for shielding. The magnetic shielding afforded will not be as effective, however.

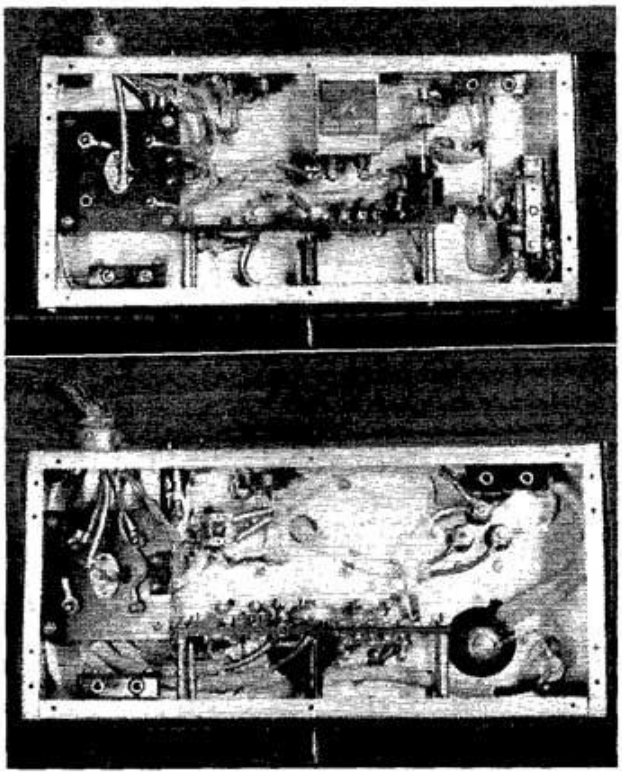
The Kinescope socket is mounted in the center of a 1/16-inch iron disc 7½ inches in diameter, as shown in Fig. 12. A convenient arrangement which permits rotation of the socket is indicated in Fig. 13. A National socket (5-pin for 1801 and 6-pin for 1800) is mounted on a bakelite strip in which has been drilled a single hole to clear the springs, and the mounting plate furnished with the socket is inverted and placed over the top of the socket. Spacers between the plate and the bakelite allow the socket to rotate freely. A bakelite plunger through the hole in the center of the socket rests on a snap switch mounted beneath the socket. This is a Hart and Hegeman switch which snaps closed when pressed. It is connected in series with the high-voltage transformer primary, and thus acts to disconnect the high voltage when the Kinescope is removed from its socket. The reason for this is evident: The second anode lead, carrying the highest voltage, can easily be reached from the front of the tube housing if the Kinescope is removed; this is probably the most accessible high-voltage point in most television receiving equipment and therefore merits particular precaution. The tube housing is fastened to the iron base with angles and wingnuts, and also carries pin-jack interlocks in series with the snap switch mentioned. Thus the high voltage will be disconnected if the Kinescope or its housing is removed.

The deflecting yoke is supported directly by the Kinescope; felt strips can be used to keep it firmly in place. The yoke is connected to the scanning chassis by a 4-wire cable and plug previously mentioned. Two connections, grid and cathode, are required from the Kinescope to the

Fig. 3 — Chassis view of the scanning unit.

Fig. 7 (above) — Chassis view of the 1801 power supply.
Fig. 8 (below) — Rear view of power supply for the 1800. The rectifier tube is enclosed in the cylindrical metal container.

Fig. 9 (top) — Under-chassis wiring in the 1801 power supply. The rectifier tube is mounted horizontally from a bakelite strip.
Fig. 10 (bottom) — Below-chassis view of the 1800 power supply.



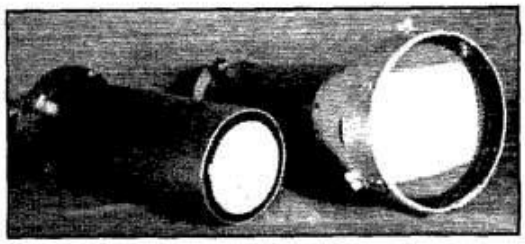


Fig. 11 — The Kinescope assemblies. Seamless iron tubing surrounds the cathode-ray tubes.

video panel; they are made through the porcelain bushings seen in Fig. 12. In order to prevent the possibility of appearance of high voltage at these terminals due to some circuit breakdown, neon lightning arrestors are connected from cathode to ground and grid to ground. These may be seen in Fig. 12. Brach Type 27A arrestors are used, with the clips dismounted from the base

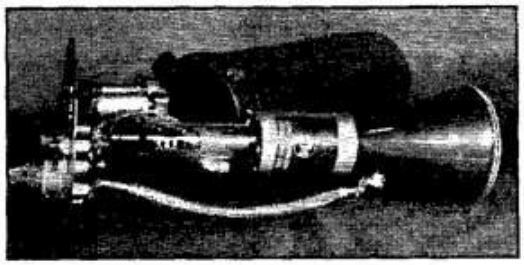


Fig. 12 — The 1801 unit open to show the parts in the assembly.

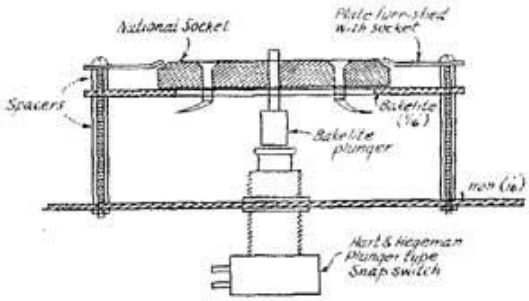


Fig. 13 — Rotatable Kinescope socket with high-voltage disconnect. A plunger-type switch is kept closed so long as the tube is in the socket, but opens the primary circuit of the high-voltage transformer when the tube is removed.

supplied so that no unnecessary capacity is added to the grid circuit. Dismounted, the arrestor with clips has a capacity of about 5 $\mu\mu$fd.

The function of the scanning unit is to supply linear sawtooth deflecting fields to the Kinescope, and the uniform distribution of a received picture requires this linearity. After the outfit has been built, the linearity of scanning can be checked by the method described in the October

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article,[2] using the bar-pattern generator. For the purpose of checking the scanning in the absence of the rest of the receiver, the Kinescope cathode, which normally is connected to the receiver "B" supply, should be grounded. The Kinescope grid is then connected through 0.5 megohm to a bias supply variable from 0 to about 60 volts negative to ground, and the bar-generator signal applied to the grid through a 0.1-μfd. blocking condenser. If the rest of the receiver is available, the bar-generator signal may be applied to the grid of the video amplifier tube.

If it should be necessary to modify the vertical scanning beyond the range afforded by the controls marked "vertical distribution" and "vertical peaking," the resistors R_{11} and R_{12} and the condenser C_{10} may be varied. If the horizontal distribution requires modification, R_{24}, R_{25} and C_{17} may be varied.

[1] J. B. Sherman, "Building Television Receivers with Standard Cathode-Ray Tubes," *QST*, October, 1938.

QST, February 1939