TUBES FOR AMATEURS

For Experimenting with
Cathode-Ray Television

By R. S. Burnap

Research and Engineering Dept., RCA Manufacturing Company, Inc., Harrison, N. J.

THE work of amateurs and experimenters has always been important to radio progress. This is largely because many amateurs are highly endowed with a Missourian point of view and a driving curiosity which leads them to prefer the by ways and unknown regions of their hobby rather than the beaten paths. Even though the individual findings of many in this group may be small, the total contributions and accumulated experience of all the radio amateurs and experimenters in the United States have been impressive.

That the radio amateur group has perhaps not yet contributed much to modern television progress is in no way due to lack of ability or resourcefulness on its part, but rather to the fact that this field of investigation requires devices outside the scope of the home workshop.

Of these devices, cathode-ray tubes suitable for television reception are perhaps the most important. Now that such tubes are available to the amateur, one of the major obstacles to his participation in experimental television activities is removed. The fact that the way of the amateur television experimenter is not easy should not be minimized. Even the hardy amateur who likes to pioneer, to build complex apparatus, to tear down and build anew, and who lives in one of the few favored areas which have television transmitters, should recognize that the transmissions in these areas do not as yet have a common standard and that transmitters are often off the air for long periods while changes are being made.

BOTH TUBES ELECTROMAGNETIC

A photograph of two new cathode-ray tubes suitable for television, and known as Kinescopes, is shown in Fig. 1. Both of these tubes are of the electromagnetic-deflection type and utilize a screen material which fluoresces brightly with a yellowish hue. The larger tube, RCA-1800, has a bulb-end 9 inches in diameter and accommodates a picture 5½ inches by 7½ inches in size, while the smaller tube, RCA-1801, has a bulb-end 5 inches in diameter and can show a picture 3 inches by 4 inches.

The electron gun in each of these tubes has been especially designed to give the small spot (Continued on next page)

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(Continued from preceding page) required for high-definition television reception. The conical portion of the bulb of the tube is coated on the inner surface with a conducting material to prevent distortion of the image and spot at the outer edges of the picture. The maximum anode No. 2 voltage for 1800 is 7000 volts and for the 1801, 3000 volts. Lower voltages can be used where it is desired to economize on power-pack cost, but at the sacrifice in either picture definition or brightness.

A diagram of a voltage-supply circuit for the 1800 is shown in Fig. 2. This diagram gives the circuit constants. A bleeder current of two to five milliamperes is adequate. Adjustment of electrode voltages is provided by potentiometers in the bleeder circuit. The video signal and background-control bias are introduced between grid No. 1 and the cathode of the cathode-ray tube.

A typical vertical-deflecting circuit for television reception is shown in Fig. 3. This circuit generates a saw-tooth deflecting current in the following manner. In the 6N7 tube, the triode grid, shown on the left operates as a blocking oscillator. Oscillations are started in the circuit by the feedback action of transformer T. The low grid current which accompanies these oscillations causes a negative bias voltage to build up across the condenser C2 and the grid leak consisting of resistors R3 and R4. After a very few oscillations, this bias voltage becomes sufficiently large to cause the plate current of the triode unit to cut off and, by so doing, to stop oscillations. When the oscillations cease, the charge on C2 leaks off through R3 and R4 to a value such that the circuit can resume oscillations. The tube then blocks again, and the cycle repeats.

Because the grid of the right-hand triode unit is connected to the grid of the first triode unit, the d-c plate current of the former unit rises suddenly to a large value during the period of oscillations. When oscillations stop, the d-c plate current becomes zero and remains zero. Increase in d-c plate current, the plate voltage drops abruptly because of the loss of voltage in resistors R4 and R5. During the period that the d-c plate current is zero, the plate voltage increases at a relatively slow rate, the rate being limited chiefly by the time constant of C4, together with R4 and R5. Because the plate voltage thus goes through an abrupt decrease followed by a relatively slow increase, its variation has a saw-tooth form. This voltage applied to the grid of the 6C5 through C8 and R9 produces a saw-tooth current in the plate circuit of the 6C5. In this manner, saw-tooth current is caused to flow in the vertical-deflecting coils.

In television circuits, it is essential that this saw-tooth wave be synchronized with that generated in the vertical scanning circuit of the kinescope at the studio. Synchronization is accomplished by a vertical synchronizing signal which is transmitted with the picture signal and which consists of a series of voltage pulses. These pulses trigger the blocking-oscillator triode.

FIG. 1.
Photograph of Kinescopes RCA-1800 and RCA-1801

Constants for Fig. 3

[Diagram is on page 15.]

\begin{align*}
C_1, C_4 & = 0.1 \text{ mfd.} \\
C_2, C_3 & = 0.25 \text{ mfd.} \\
C_5, C_6 & = 10 \text{ mfd.} \\
R_1 & = 200,000 \text{ Ohms} \quad \text{Vertical-Speed} \\
R_2 & = 10,000 \text{ Ohms} \quad \text{Controls} \\
R_3 & = 100,000 \text{ Ohms} \quad \text{Horizontal-Speed} \\
R_4 & = 2 \text{ Megohms} \\
R_5 & = 2 \text{ Megohms, Vertical-Size Control} \\
R_6 & = 100,000 \text{ Ohms, Vertical-Peaking Control} \\
R_7 & = 1 \text{ Megohm} \\
R_8 & = 100,000 \text{ Ohms, Vertical-Distribution Control} \\
R_9 & = 10,000 \text{ Ohms} \\
R_{10} & = 50,000 \text{ Ohms, Vertical-Centering Control} \\
R_{11} & = 50,000 \text{ Ohms} \\
L_1 & = \text{Coupling Choke, 100 Henrys} \\
L_2 & = \text{Vertical-Deflecting Coils} \\
L_3 & = \text{Feedback Transformer}
\end{align*}
FIG. 2.
Voltage-supply circuit for RCA-1800.

<table>
<thead>
<tr>
<th>Circuit Component</th>
<th>3,000 Volts</th>
<th>6,000 Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>( E_a )</td>
<td>2 mfd, 3,000 Volts</td>
<td>2 mfd, 6,000 V.</td>
</tr>
<tr>
<td>( C_a )</td>
<td>1 Megohm, 6 Watts</td>
<td>1 Megohm, 25 Watts</td>
</tr>
<tr>
<td>( R_s )</td>
<td>100,000 Ohms, 1 Watt</td>
<td>100,000 Ohms, 3 Watts</td>
</tr>
<tr>
<td>( R_t )</td>
<td>135,000 Ohms, 1 Watt</td>
<td>150,000 Ohms, 2 Watts</td>
</tr>
<tr>
<td>( R_h )</td>
<td>85,000 Ohms, 1 Watt</td>
<td>165,000 Ohms, 4 Watts</td>
</tr>
<tr>
<td>( R_s )</td>
<td>12,000 Ohms, 0.5 Watt</td>
<td>55,000 Ohms, 2 Watt</td>
</tr>
<tr>
<td>( E_x )</td>
<td>2,300 Volts RMS</td>
<td>10,000 Ohms, 0.5 Watt</td>
</tr>
<tr>
<td>( RT )</td>
<td>Type 879</td>
<td>Type 878</td>
</tr>
</tbody>
</table>

Specifications:

- 4,500 Volts
- 2 mfd, 4,500 V.
- 1 Megohm, 12 Watts
- 100,000 Ohms, 2 Watts
- 150,000 Ohms, 2 Watts
- 70,000 Ohms, 1 Watt
- 10,000 Ohms, 0.5 Watt
- 3,400 Volts RMS
- Type 878

- 6,000 Volts
- 2 mfd, 6,000 V.
- 1 Megohm, 25 Watts
- 100,000 Ohms, 3 Watts
- 165,000 Ohms, 4 Watts
- 55,000 Ohms, 2 Watt
- 10,000 Ohms, 0.5 Watt
- 4,600 Volts RMS
- Type 878

\( a = \text{Anode No. 2} \)
\( b = \text{Anode No. 1} \)
\( c = \text{Grid No. 2} \)
\( d = \text{Grid No. 1} \)

H = Horizontal-Deflecting Coils
V = Vertical-Deflecting Coils
T = Power Transformer

FIG. 3.
Vertical-deflecting circuit for RCA-1800 or RCA-1801. [See table, p. 14]
(Continued from preceding page) oscillation. In practice, the circuit of a hand triode unit is adjusted to function slightly slower than the rate of the synchronizing pulses. Hence, when the pulses are applied, the action of the blocking oscillator is speeded up to the proper rate for synchronization. Controls are provided so that the circuit can be adjusted for optimum operation. (Continued on next page)

![Circuit Diagram](image)

**FIG. 4**
Horizontal-deflecting circuit for RCA-1800.

- \( R_e = 0.25 \text{ Megohm, Horizontal-Size Control} \)
- \( R_f = 0.5 \text{ Megohm} \)
- \( R_a, R_b = 100 \text{ Ohms, Non-inductive} \)
- \( R_{10} = 200 \text{ Ohms} \)
- \( R_{12} = 8000 \text{ Ohms, 5 Watts} \)
- \( R_{13} = 5 \text{ Ohms, Horizontal-Centering Control} \)
- \( L = \text{Horizontal-Deflecting Coils} \)
- \( T_1 = \text{Feedback Transformer} \)
- \( T_2 = \text{Output Transformer} \)

- 0.005 mfd.
- 0.001 mfd.
- 0.05 mfd.
- 0.5 mfd.
- 100 Ohms
- 00,000 Ohms
- 10,000 Ohms
- 00,000 Ohms
- 0,000 Ohms
- Horizontal-Speed Controls
A typical horizontal-deflecting circuit for the 1800 is shown in Fig. 4. In this circuit, a 6N7 and an output stage generate a synchronized, saw-tooth current in a manner similar to that described for the vertical-deflecting circuit. However, the horizontal-deflecting circuit operates at a much higher frequency than the vertical-deflecting circuit. Because the horizontal-deflecting frequency is high, the deflecting current decreases very rapidly on the return portion of the deflecting cycle. This rapid decrease in current causes shock-excited oscillations in the plate circuit of the output stage. To damp out these oscillations, a Type 1-v tube is connected across the primary of the output transformer T2. When oscillation starts, the primary first applies a high positive voltage to the cathode of the 1-v and then applies a negative voltage. As soon as the cathode becomes negative with respect to the plate of the 1-v, the 1-v conducts current. Thus, the flow of current through the 1-v quickly damps out the oscillations caused by shock excitation.

CUTS DISTORTION

A deflection yoke is shown in perspective in Fig. 5. This yoke is designed to minimize pin-cushion distortion and defocusing of the spot at the edges of the picture.

FIG. 5.
Perspective view of a deflection yoke.