Simplified and Inexpensive Unit for Use with Any Suitable R.F. Chassis

A low-cost and relatively simple chassis-type outfit including sweep oscillators and amplifiers, synchronizing separator and amplifier, video amplifier and picture tube. Low-voltage operation with a three-inch tube simplifies the insulation problem.

A Deflection and Video Chassis for Television Reception

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THE beginning of regular scheduled television broadcasts in the New York area and the prospects of similar scheduled broadcasts in several other areas has greatly increased the interest of amateurs in this field. Many of them have built receivers so that they can obtain first hand experience in a field in which many things must be considered that can be neglected in ordinary sound radio. Many experimenters want a relatively simple and inexpensive receiver, yet one that will give clear pictures easily viewed. The television video and deflection chassis to be described was designed with this in mind.

A three-inch picture tube was selected as being a reasonable compromise between cost and picture size. The picture is large enough for two people to view with ease. Definition is such that with a good i.f. and r.f. system movie subtitles and other small print can be read. The particular tube used allowed resolution down to over 250 lines on the standard test pattern. This unit can be fed either from the second detector or first video stage of any of the many r.f. and i.f. units that have been described to date.[1] The input signal must be of negative polarity. That is, the voltage corresponding to a bright portion of the picture must be negative.

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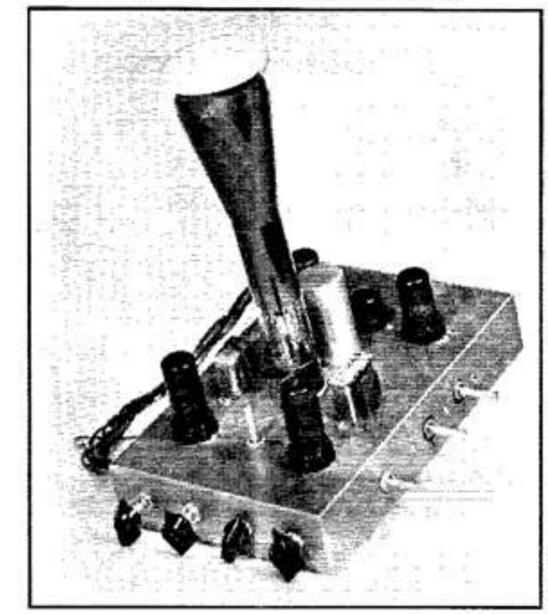

Using an ordinary oscilloscope tube, this video and synchronizing unit is inexpensive and simple to build. It can be fed from any type of television r.f. end the builder prefers to use.

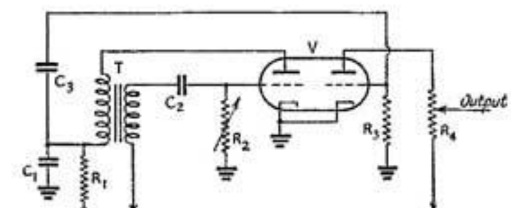

Fig. 1 — **Basic circuit of sweep oscillator and amplifier.**

Sweep Circuits

The simplicity of the sweep circuits is the chief recommendation for this unit. Fig. 1 shows the basic sweep circuit used. It will be noted that there are very few parts. Tube *V* can be of any of the sharp cutoff double triodes now available. Both the 6F8G and the 6N7 have been used successfully. The 6F8G has the advantage that it draws more plate current as an amplifier and therefore is capable of greater output at lower plate voltages. The 6N7 has the advantage that it is a single ended metal tube and is slightly smaller physically. Transformer *T* is one of the special television sweep oscillator transformers of which there are several on the market today, and which are now quite reasonable in cost ($1.75 list).

The left-hand part of tube *V* is the oscillator. The polarity of the transformer *T* is such that it

[1] *QST*, April and May, 1938, December, 1938, January, 1939.

causes the tube to start oscillating. This oscillation, however, is accompanied by a flow of grid current through the grid resistor R_2 and develops a negative bias on the grid of the tube and on the grid condenser C_2, blocking the tube and cutting off the plate current. The charge on C_2 then slowly leaks off capacitor C_2 through resistor R_2 until a point is reached at which the tube can again start oscillating. The cycle then repeats.

During the time that the tube is oscillating it is drawing plate current. This plate current flows through R_1, causing a voltage drop that appears across C_1. When the tube is blocked the charge leaks off C_1, allowing the capacitor to become more positive. The charge leaks off at an exponential rate determined by the product of R_1 and C_1, the time constant of the circuit. If the ratio of the time constant R_1C_1 to the period of oscillation,

$$\left(\frac{1}{\text{sweep frequency}}\right)$$

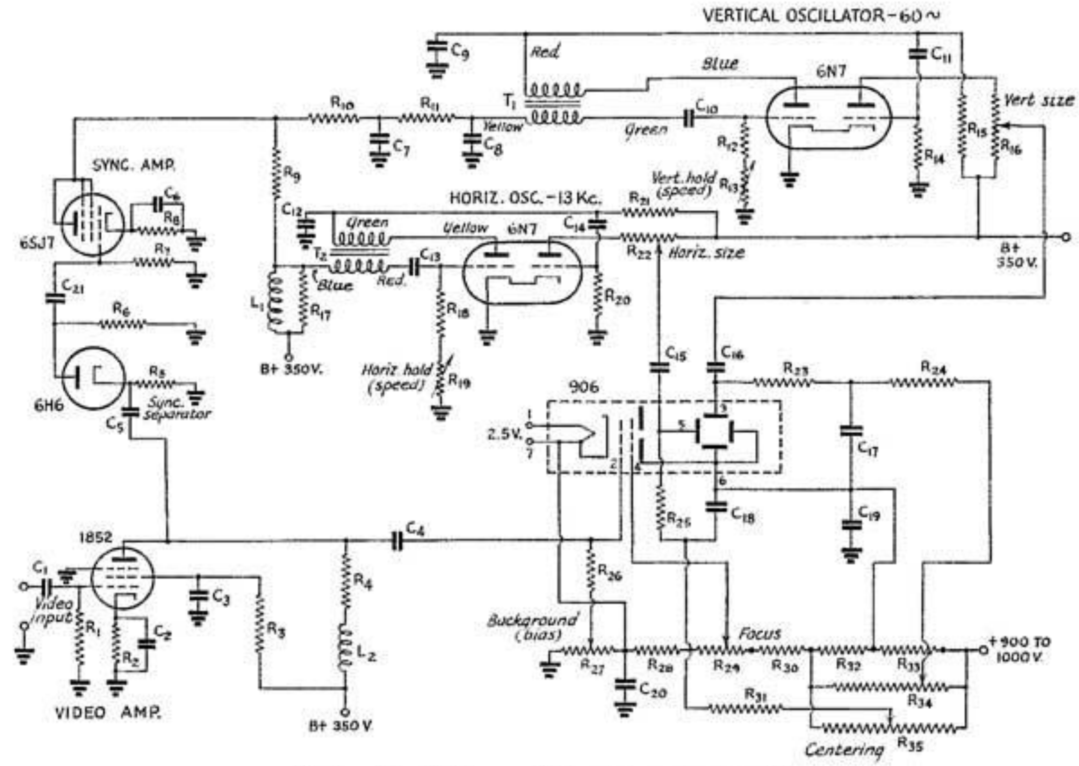

Fig. 2 — Circuit diagram of the video and sweep unit.

C_1 — 0.25-μfd. 400-volt paper.
C_2 — 50-μfd. 25-volt electrolytic.
C_3 — 4-μfd. 350-volt electrolytic.
C_4 — 0.1-μfd. 400-volt paper.
C_5 — 0.01-μfd. 400-volt paper.
C_6 — 10-μfd. 25-volt electrolytic.
C_7 — 0.003-μfd. 400-volt paper.
C_8 — 0.01-μfd. 400-volt paper.
C_9 — 0.25-μfd. 400-volt paper.
C_{10} — 0.001-μfd. 400-volt paper.
C_{11} — 0.05-μfd. 400-volt paper.
C_{12} — 0.01-μfd. 400-volt paper.
C_{13} — 0.001-μfd. 400-volt mica.
C_{14} — 0.001-μfd. 400-volt paper.
C_{15} — 0.001-μfd. 1000-volt paper mica.
C_{16} — 0.1-μfd. 1000-volt paper.
C_{17} — 0.25-μfd. 200-volt paper.
C_{18} — 0.25-μfd. 200-volt paper.
C_{19} — 0.5-μfd. 1000-volt oil-filled paper.
C_{20} — 0.5-μfd. 150-volt paper.
C_{21} — 0.1-μfd. 400-volt paper.
R_1 — 0.25 megohm.
R_2 — 150 ohms.
R_3 — 60,000 ohms.
R_4 — 3000 ohms.
R_5 — 200,000 ohms.
R_6 — 10,000 ohms.
R_7 — 0.25 megohm.
R_8 — 2500 ohms.
R_9 — 10,000 ohms.
R_{10} — 10,000 ohms.
R_{11} — 10,000 ohms.
R_{12} — 2 megohms.
R_{13} — 2-megohm potentiometer.
R_{14} — 10 megohms.
R_{15} — 0.5 megohm.
R_{16} — 0.25-megohm potentiometer.
R_{17} — 3500 ohms.
R_{18} — 10,000 ohms.
R_{19} — 50,000-ohm potentiometer.
R_{20} — 2 megohms.
R_{21} — 100,000 ohms.
R_{22} — 100,000-ohm potentiometer.
R_{23} — 1 megohm.
R_{24} — 50,000 ohms.
R_{25} — 0.5 megohm.
R_{26} — 0.5 megohm.
R_{27} — 50,000-ohm potentiometer.
R_{28} — 0.25 megohm.
R_{29} — 0.5-megohm potentiometer.
R_{30} — 0.5 megohm.
R_{31} — 50,000 ohms.
R_{32} — 100,000 ohms.
R_{33} — 100,000 ohms.
R_{34} — 0.5-megohm potentiometer.
R_{35} — 0.5-megohm potentiometer.
L_1 — 300-turn coil (RCA No. 33541, with resistor removed).
L_2 — 75-turn coil (RCA stock No. 33538). If possible the exact number of turns on this coil for each particular receiver should be determined by experiment.
T_1 — Vertical oscillation transformer (RCA Stock No. 32898).
T_2 — Horizontal oscillation transformer (RCA Stock No. 32899).
All fixed resistors ½ watt IRC insulated.
All potentiometers small Clarostat carbon units.

is made sufficiently large the discharge current will be essentially a sawtooth. The amplitude of this sawtooth will be greater if either C_1 or R_1 is smaller, but will be approximately constant regardless of the values of R_1 and C_1 so long as their *product* is the same. However, there are some other considerations. The larger R_1 the smaller the plate voltage applied to the oscillator and the smaller the plate current. If R_1 is made too large there will not be enough plate voltage to make the tube oscillate. The values shown for C_1 and R_1 in the low-frequency oscillator represent a compromise which gives a capacitor, C_1, of reasonable size.

The sawtooth appearing across C_1 is then coupled through C_3 to the grid of the right-hand side of V, which serves as an amplifier. C_3 must be large enough to transmit the lowest frequency components of the sawtooth. The amplifier side of the tube obtains its grid bias from the grid current flowing through R_3 on the positive peak of the sawtooth. This causes the tip of the sawtooth to be flattened very slightly, but this flattening occurs well within the region that is blanked out by the blanking pulses of the transmitter and is therefore not objectionable. The load resistor R_4 on the amplifier should be large enough to give sufficient gain, yet not so large that any of the high frequency components of the sawtooth are lost. The largest load that can be used on the high-frequency sweep is about 100,000 ohms.

The amplitude of the output is first set to be a little larger than needed by adjusting R_1 and is then controlled by R_4. R_1 could be made variable and R_4 fixed, but this would cause the frequency and size controls to interlock, a change in size often throwing the picture out of sync. Controlling the size by means of R_4 does not affect the shape of the horizontal sawtooth because the control is in a relatively low-impedance circuit.

Other Circuit Elements

The video stage is a conventional 1852 video amplifier with high-frequency inductance compensation in series with the plate load. Much better compensation can be obtained by using a combination of series and shunt compensation[2] but successful use of this method requires the use of test equipment not available to most experimenters. Use of this latter method allows compensation to the same frequency with nearly double the plate load and therefore more gain.

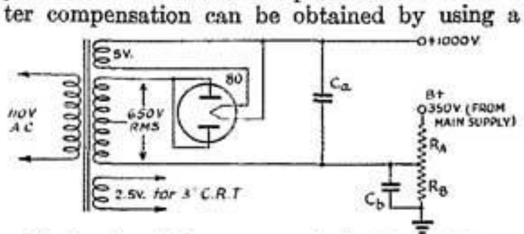

Fig. 3 — A suitable power supply for the cathode-ray tube can be made from a cheap broadcast receiver power transformer.

T — Any small power transformer giving upwards of 650 volts r.m.s. across the complete winding.
C_a — 0.5 μfd. 1000-volt.
C_b — 4μfd. 300-volt electrolytic.
R_a, R_b — 100,000 ohms. In some cases it may be desirable to make R_a smaller to get a higher output voltage.

A 6H6 diode separates the sync from the video. The sync is then amplified by a 6SJ7 amplifier connected as a triode. A low-pass filter keeps the high-frequency sync out of the low-frequency sweep, while the high-frequency sync appears across the inductance L_1 in the plate load.

The voltage divider for the cathode ray tube is conventional and needs little comment. It may be advisable to alter the size of some of the filter capacitors in this part of the circuit, since a well-filtered "B" supply will not require as much filtering in this part of the circuit as will a poorly-filtered supply.

One of the cheapest ways of obtaining the high voltage for the cathode ray tube is to connect a broadcast-receiver power transformer to a half-wave rectifier as shown in Fig. 3. A small transformer rated at 325 volts each side of centertap will give 800 or 900 volts in this sort of circuit. By adding this to part of the "B" voltage used to supply the other parts of the chassis the necessary 1000 or so volts may be obtained.

Mechanical Construction

This unit was constructed on a 7- by 11- by 2-inch steel chassis. Focus, background (brightness), and the two hold (speed) controls were brought out on one end of the chassis. The vertical size control is on top of the chassis while the centering and horizontal size controls are on one side. One side of the chassis is free of controls so that it can be bolted to an r.f. and i.f. chassis to form a complete unit. Small Clarostat potentiometers were used to save space. Since the centering controls are operating at a potential considerably above that of the chassis it was considered desirable to insulate them by first mounting them on a small piece of Masonite which is then bolted to the chassis. Precautions should be taken to see that the wiring of the two sweep oscillators and their amplifiers is separated as much as possible so that these circuits do not interact and cause poor interlace of the picture. The wiring of the video amplifier should be such that the capacity to ground of leads carrying video voltages is as low as possible.

Operation

Operation of this unit is the same as has been described in previous articles and so need not be repeated here. Should it be found that the sweeps are synchronizing only on parts of the picture, adjustment of R_5 to a larger value will clear up the trouble.

[2] Seeley and Kimball, "Analysis and Design of Video Amplifiers," Part 2, *RCA Review*, January, 1939.