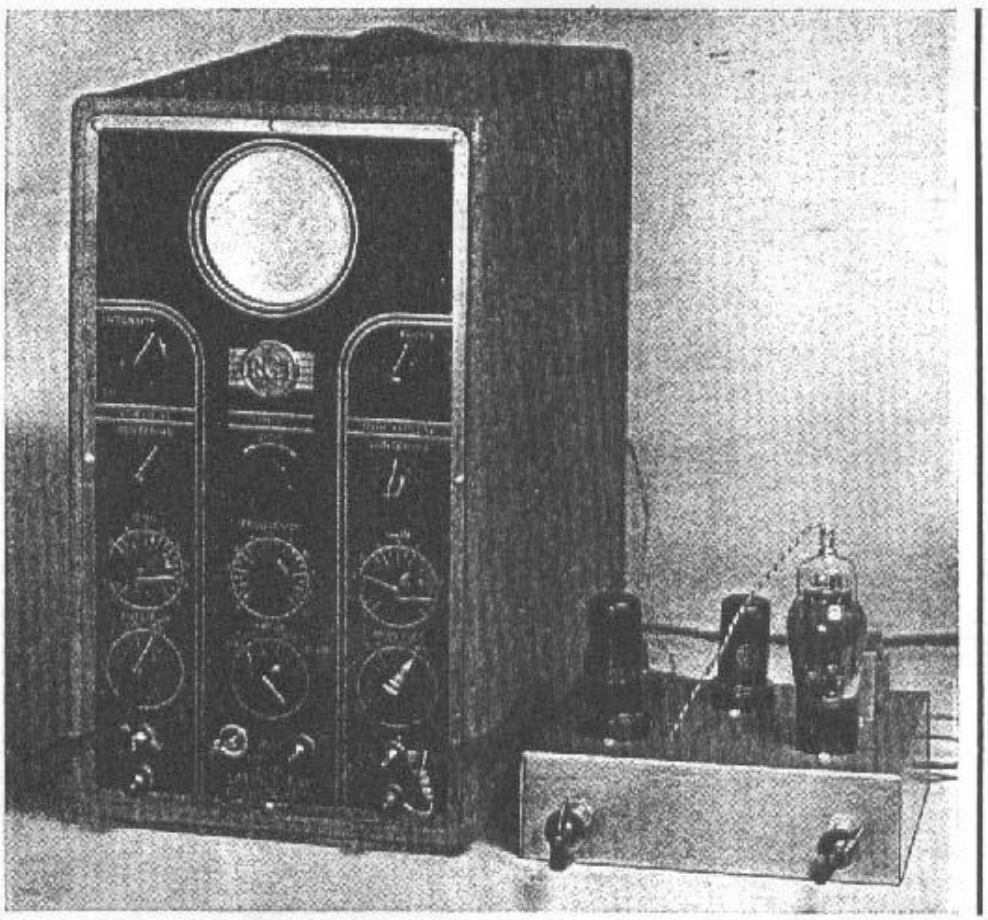

Believe it or Rip! This is a television receiver!

Use Your Oscilloscope for Television Reception

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Why not enjoy television programs? If you have an oscilloscope, a few tools, and a very few parts, you can build your receiver. The ideal set for the experimenter, ham or the serviceman to own.

WHILE working on television receiver circuits, it occurred to the author that a great many radio amateurs and service men already have on hand a large part of a television receiver in the Cathode Ray Oscillographs that they use in their other radio work. The adaptor to be described, was designed to convert these oscillographs into television receivers in as simple a manner as possible and yet not destroy the usefulness of the oscillograph for regular test work. The circuits shown are for everything after the second picture detector. Something will be said about the r-f and i-f and of the receiver later.

The components found in a television receiver from the second picture detector on are the video amplifier, the two sweep oscillators and their associated amplifiers and amplitude controls, the sync. separator and sync. amplifier, and the cathode ray tube for viewing the picture and its associated power supply and controls. Of these, the usual cathode ray oscillograph contains the sweep amplifiers and gain controls, the picture tube and all its associated controls and power supply. The oscillograph also contains one sawtooth oscillator. Consideration was given to using this oscillator as one of the sweeps, but it was decided that it would be more desirable to use an external circuit.

The usual gas discharge type of oscillator found in oscillographs has too long a return time at 13 kc. to be of value in a television receiver. Past experience has also shown that gas discharge tube oscillators are more subject to noise and less stable as to frequency than the type of oscillator shown in the circuit diagram. Furthermore, the number of tubes in the final circuit would not be changed because all present tubes are double purpose tubes.

In designing and building television sweep oscillator and synchronizing circuits, it is necessary to make sure that no horizontal synchronizing signal, or signal from the horizontal oscillator itself gets into the vertical oscillator circuit. Any such coupling would destroy the interlace, making the two

sets of lines in the picture fall on top of each other and decrease the apparent definition in the vertical direction. It was found that it is possible to combine the functions of sweep oscillators and sync. separator and amplifier into two tubes as shown without destroying this interlace. The sync. separator was combined with the vertical oscillator because the separator handles the lowest level signal and there would therefore be less possibility of this signal getting into the vertical oscillator. Grounding the plate of the triode used as the separating diode further shields the separator from the oscillator. Using the grid whose connection is on the top of the tube as the diode plate and running the lead directly to the amplifier tube as shown in the picture completes the isolation.

The Circuit

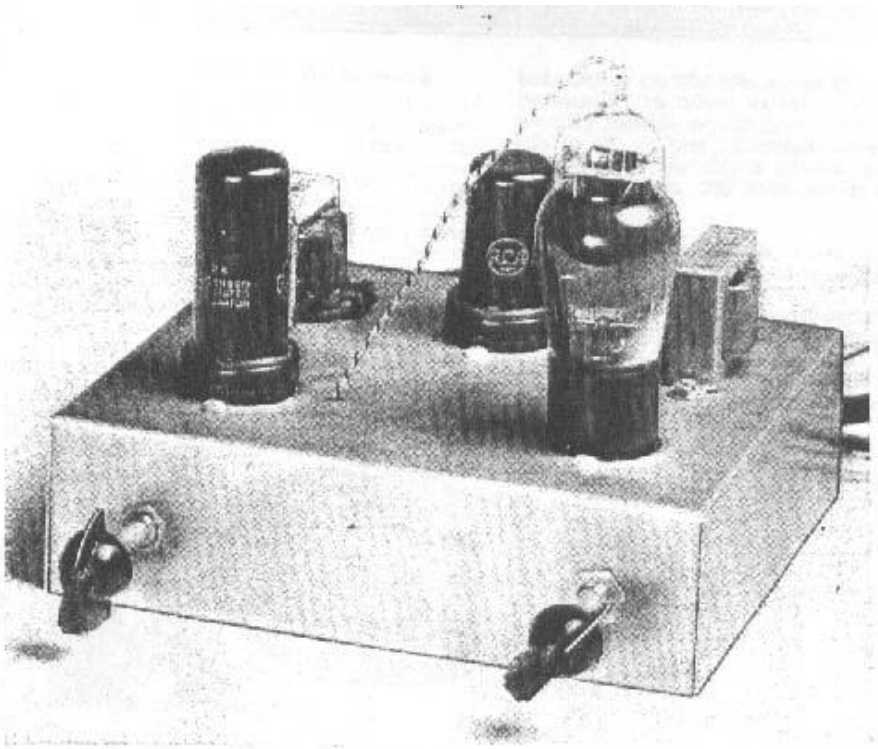
The circuit is shown. For clarity, all tubes have been shown as single tubes in the schematic diagram. Base pin numbers are given for the 6F8-G because both triodes are not exactly alike. The 6AC7 is a conventional video amplifier using a high mutual-conductance tube. The signal fed to its grid should be of negative polarity. That is, the voltages corresponding to black parts of the picture are positive with respect to those corresponding to white parts of the picture. This type signal is obtained from a diode second detector, the plate of which is connected to the last i-f transformer and the cathode of which is connected to a load resistor going to ground. The signal is taken off the cathode. It has been assumed that there is a gain control in the i-f stages for use in controlling picture contrast. This gain control usually takes the form of a variable resistor of about 10,000 ohms in series with the cathode resistor of one or two i-f amplifier tubes. If possible, the proper size for the high frequency compensating coil, L_3 should be determined by experiment to give a flat frequency response.

(Note: Analysis and Design of Video Amplifiers—Seeley and Kimball, RCA Review, October, 1937.)

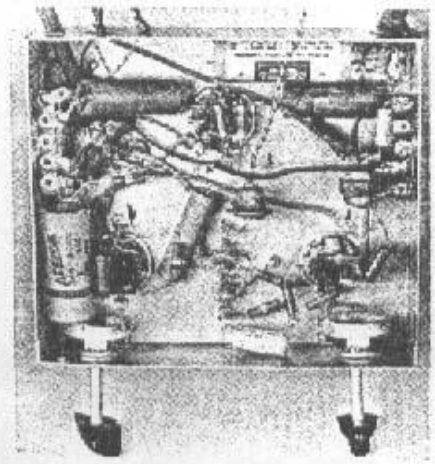
The output of the video amplifier is fed into the grid of the picture tube and to the sync. separator. It is necessary to open up the intensity control grid lead to the oscillograph cathode ray tube and insert a resistor, R-20, so that this grid can be modulated. In the model shown, this resistor was placed right at the tube socket. The grid comes out to No. 2 pin on the tube. In most oscillographs, this grid is several hundred volts negative with respect to ground. For this reason it was decided to include the coupling capacitor C-12 in the oscillograph. Two terminals on the back of the oscillograph allow connection of this capacitor to the adaptor chassis for television reception or to ground for regular oscillograph use.

With the plate resistor, R-10, of the separator diode constant, the point at which separation takes place depends on the size of the cathode resistor, R-9. Larger values of this resistor will cause the lower part of the sync. to be clipped off, while smaller values will allow part of the picture to pass through. R-12 was included to make the amplifier tube do a little clipping on the top of the sync. and help smooth it off. It is not especially effective because its value must be kept small enough to not seriously change the shape of the horizontal sync. pulses. Grid bias for this amplifier is obtained from the grid resistor, R-11.

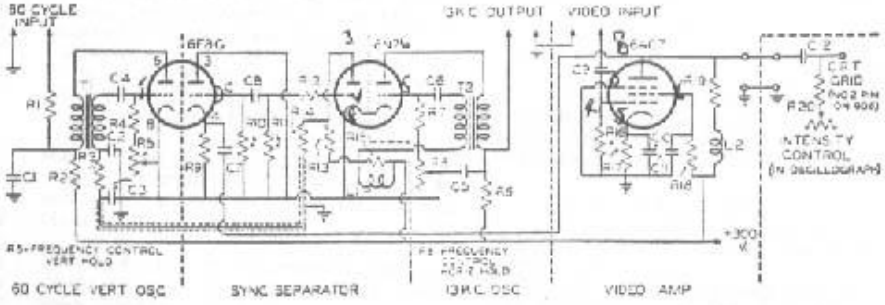
The plate of this sync. amplifier works into the circuit for separating the horizontal and vertical synchronizing pulses from each other. The low frequency pulses appear at the plate of the amplifier and pass through a low-pass resistance-capacity filter consisting of R-14, R-3, C-2 and C-3, to the 60 cycle sweep oscillator. This filter removes the high frequency pulses. As built in the model, the vertical oscillator and the sync. amplifier are on op-



This plus an oscilloscope equals a video receiver!



Underchassis view of the adapter.



R_1—1/4 megohm, 1/2 w. IRC
R_2—1/2 megohm, 1/2 w. IRC
R_3—10,000 ohms, 1/2 w. IRC
R_4—2.0 megohms, 1/2 w. IRC
R_5—2 meg. pot. (Clarostat type 37)
R_6—50,000 ohms, 1/2 w. IRC
R_7—10,000 ohms, 1/2 w. IRC
R_8—50,000 ohms pot. (Clarostat type 37)
R_9—200,000 ohms, 1/2 w. IRC
R_{10}—10,000 ohms, 1/2 w. IRC
R_{11}—1 megohm, 1/2 w. IRC
R_{12}—20,000 ohms, 1/2 w. IRC
R_{13}—10,000 ohms, 1/2 w. IRC
R_{14}—10,000 ohms, 1/2 w. IRC
R_{15}—1,500 ohms, 1/2 w. IRC
R_{16}—1/4 megohm, 1/2 w. IRC
R_{17}—150 ohms, 1/2 w. IRC
R_{18}—65,000 ohms, 1/2 w. IRC
R_{19}—3,000 ohms, 1/2 w. IRC
R_{20}—1/2 megohm, 1/2 w. IRC
C_1—0.5 mfd. 400 volt paper. CD

C_2, C_3—0.001 mfd. 400 volt paper. CD
C_4—.002 mfd. 400 volt paper or mica. CD
C_5—0.025 mfd. 400 volt paper. CD
C_6—0.001 mfd. 400 volt paper or mica. CD
C_7—0.1 mfd. 400 volt paper. CD
C_8—0.02 mfd. 200 volt paper. CD
C_9—0.25 mfd. 400 volt paper. CD
C_{10}—30 mfd. 25 volt electrolytic. CD
C_{11}—2 mfd. 300 volt electrolytic. CD
C_{12}—0.1 1,000 volt paper. CD
L_1—300 turn coil (RCA stock No. 33541). Includes coil L mounted on resistor R_{13}
L_2—75 turn coil (RCA stock No. 33538). If possible the exact number of turns on this coil should be determined by experiment
T_1—Vertical oscillation transformer (RCA stock No. 32898)
T_2—Horizontal Oscilation transformer (RCA stock No. 32899)
Tubes—6AC7/1852, 6F8G, 6N7. RCA

sirable to locate most of the filter near the vertical oscillator and shield the wire between R-3 and R-14 as shown in the schematic diagram. The high frequency synchronizing pulses appear across the coil L-1 from which point they are coupled into the horizontal oscillator. Increasing the size of R-15 will give a little more horizontal sync. signal, but this makes the receiver more susceptible to noise.

The oscillators are of the grid blocking type using transformers to obtain feed-back from the plate to the grid circuit. The frequency of oscillation is controlled by the variable resistors R-5 and R-8. In some cases, it may be found desirable to alter the size of the resistors in this frequency control position to reduce the controllable frequency range. This can be done by measuring the total resistance between grid and ground when the controls are set to the proper position and then making the fixed resistor slightly less than this. A variable resistor of about 25 percent of the fixed resistance is then used.

The oscillator tubes draw a pulse of current once each cycle. This pulse is shaped into a sawtooth by the resistor and capacitor R-2 and C-1, in the vertical oscillator and R-6 and C-1, in the horizontal oscillator. The amplitude of the developed sawtooth depends on the product of the R and C. The susceptibility of the oscillator to the synchronizing pulses is greatly influenced by the size of the resistor in this combination. The smaller the resistor, the less the synchronizing pulses control the oscillator. When building the adaptor, the value of R-6 in the high frequency oscillator should be adjusted to give the proper sweep amplitude with the oscillograph gain control almost all the way open. This is because the controls in most oscillographs attenuate the high frequencies quite badly when they are turned down, causing the left edge of the picture to be crowded and bright.

No blocking capacitors are included in the sweep output circuits because these are usually in the oscillograph. The leads for the sweep voltages to the oscillograph terminals should be shielded. R-1 is included in the vertical oscillator output circuit to help isolate the usual ½ megohm volume control from the oscillator. C-1 was made quite large to keep R-2 small, but even with the size used, the oscillograph loading spoils linearity if R-1 is not included. In cases where the input resistance to the oscillograph is over one megohm, R-1 should be omitted. It may be necessary to adjust R-2 to obtain the right amount of vertical sweep for a particular oscillograph.

Possible Oscillograph Changes

While the experimental work on this chassis was done with an RCA Type 155 Oscillograph, most oscillographs are enough alike that what is said here will apply to all. In some cases, it may be necessary to rotate the tube to get the picture right side up, or add a little extra filtering to take hum out of the picture. A two mfd. oil capacitor across the high voltage should be enough. The low voltage on the cathode ray tube in most oscillographs does not give as bright or sharp a picture as could be obtained. An extra capacitor across the input of the high voltage

(*Continued on page* 61)

filter will sometimes increase this voltage.

In operating the receiver, it is well to turn the internal oscillator to the lowest possible frequency to keep it from interfering with the picture.

The front end of the receiver can be any of the many circuits described to date. It may consist of three or four wide band i-f stages using any of the television transformers now on the market and 6AC7 or 6AB7 tubes, a 6H6 second detector, 6AC7 first detector and 6J5 oscillator. For distant reception, an r-f stage can be added. Aside from the tubes and transformers used, this part of the receiver is very much like a sound broadcast receiver.

The sound part of the program can be received either on a separate receiver or taken off the first detector output by a separate i-f system. Circuits for doing this have been published before and will not be discussed in detail here. —30—