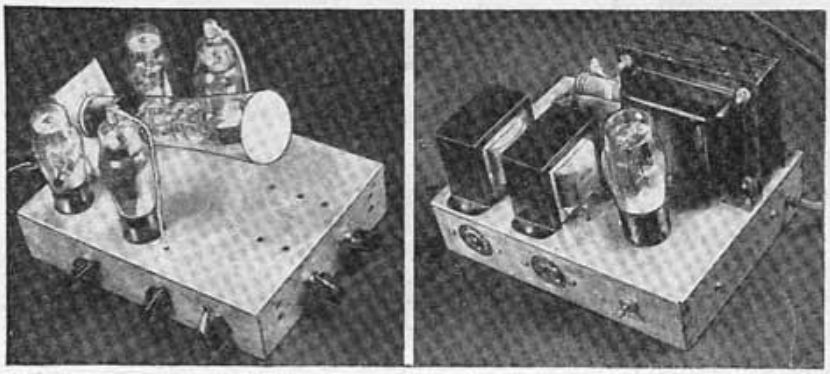

Part 1 of the 2" C-R Tube Television Receiver appeared in the March issue. The set described has picked up excellent images from leading 441 line stations. With slight changes, a 3" C-R tube can be substituted.

●

Left—2" C-R tube and Sweep-Oscillator unit; Right —power supply.

Low-Cost Experimental *Television Receiver*

Howard C. Lawrence, Jr., W2IUP/3

Part 2—Sweep Oscillators and Power Supply

● THE equipment mounted on the *sweep oscillator* chassis is the circuit for separating the horizontal (line) and vertical (frame) synchronizing pulses from each other, the two sweep oscillators and their amplifiers, the cathode-ray tube for viewing the picture, and the voltage divider for supplying the proper potentials to this latter tube. The circuit for this unit is shown in Fig. 4. Perhaps it would be well to explain briefly the functions of the various parts before going into the construction and adjustment of the unit. The network for separating the horizontal and vertical pulses from each other is made up of R1, C1, R10, R11, R12 and C6. This circuit separates the pulses according to their frequency. The high frequency line synchronizing pulses pass through the small condenser, C1, and develop a voltage across R1, whereas the low frequency frame synchronizing pulses are blocked by C1 and thus develop no voltage that can be applied to the grid of the line oscillator tube. The amount of control voltage applied to this tube is determined by the potentiometer, R1. The R-C combination R10, that portion of R11 between the tap and R10, and the condenser, C6, form a simple low-pass filter to eliminate the high frequency synchronizing pulses from the signal applied to the grid of the low frequency oscillator.

The oscillators and their amplifiers are similar to those used in many cathode-ray oscillographs. The design in this case is somewhat simplified by their being required to work at only one frequency whereas in an oscillograph they must work over a very wide range of frequencies. R2 is a grid current limiting resistor necessary with gas filled tubes. R3 and R4 form a voltage divider to provide the proper operating bias for the 885. By keeping the bleeder current in this divider relatively large the effect of varying R1 on the sweep frequency and amplitude and the effect of R6 on the amplitude can be kept at a minimum. The size of C2 and the total resistance of R5 + R6 determine the frequency at which the circuit will oscillate. R6 has been made large enough that the frequency may be varied over quite a large range to allow for any slight differences in voltage, tubes, etc., that there may be in different sweep circuits built to these specifications. The type 57 triode amplifier follows conventional amplifier design. The size of the amplitude control potentiometer R7 is a compromise between the large size necessary to maintain a linear sweep and the small size necessary to retain the high frequency components of the saw tooth wave to be amplified.[1]

The Sweep Oscillator circuits and connections to the 2" cathode-ray tube are here shown. Also the power supply circuit.

The low frequency sweep is similar to the high frequency sweep in most respects. In this case the R12 and C6 also form a filter to keep the low frequency oscillator from affecting the high frequency oscillator. The condenser, C7, has been returned to

(Continued on page 743)

[1] G. R. Mezger, "Oscillograph Amplifier Design." *Du Mont Oscillographer*, Aug. and Sept. 1937, Page 4. (Du Mont Laboratories publication.)

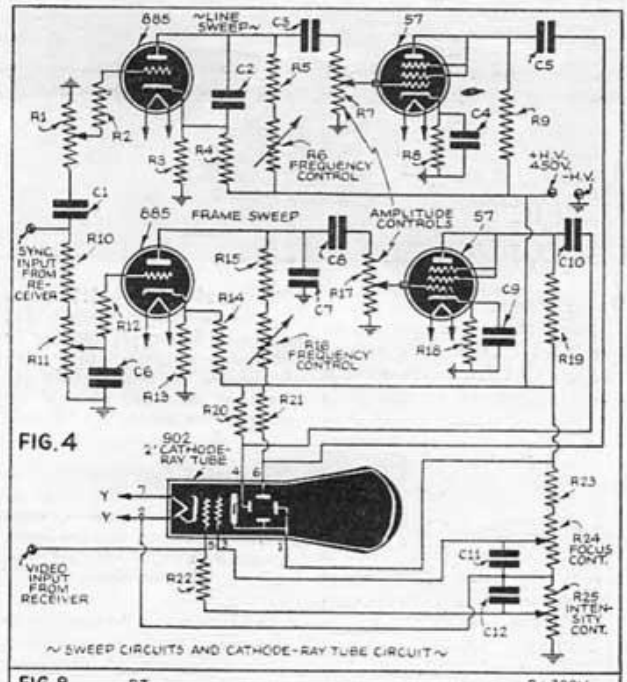

FIG. 4

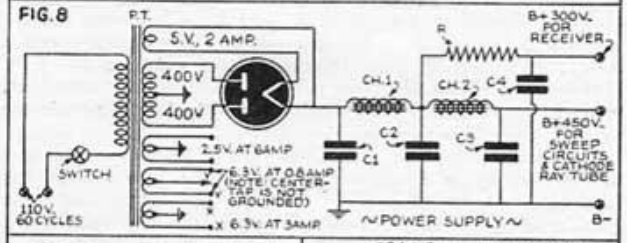

FIG. 8

FIG. 5

FIG. 6

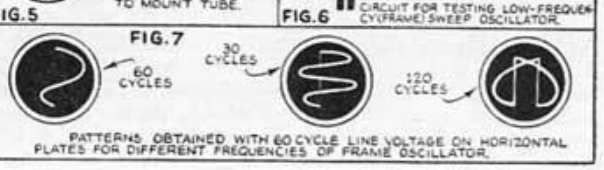

FIG. 7

Low-Cost Television Receiver

(Continued from page 716)

ground instead of to the cathode of the 885 in order to include R13 as a current limiting resistor in the discharge circuit. If this had been done in the case of the high frequency sweep the return time of the beam would have been too long. The compromise on the size of the amplitude control potentiometer led to the use of a much higher resistance because of the lower frequency of oscillation. The large size of C10 is necessary to give good low frequency response.

If desired, type 884 and 6J76 tubes may be used as sweep oscillators and amplifiers. These tubes have 6.3 volt heaters, but since the heater drain on the power transformer is such that it is usually necessary to provide an extra heater transformer, and since a 2.5 volt heater winding will be needed later should a type 906 3" cathode-ray tube be used, there is no real advantage in the use of 6.3 volt tubes.

This unit was built on a 7 x 9 x 2 inch steel chassis. Only good quality parts should be used in the construction, if stability of operation is to be expected. Heater current wires should be twisted to reduce the magnetic field around them and the wiring of the two sweep circuits should be kept apart so that they do not interact. The two-inch cathode-ray tube is mounted on a stand made of sheet aluminum, the approximate position of the tube socket being shown in Fig. 5. The exact position can be determined by inspection of the deflection plates in the tube; the two plates nearest the screen should be horizontal, and the two plates that are connected together within the tube should be toward the bottom and right of the picture. If a tube socket of the type that mounts in a circular hole by means of a locking ring (Amphenol) is used, the socket may be rotated to the proper position after the tube is in place. The focus and intensity controls are mounted on the front of the chassis below the viewing screen. The frequency, amplitude, and synchronizing controls are mounted along the sides of the chassis near the tubes with which they are associated. The picture will help to make this clear. A terminal strip is provided on the back of the chassis for connection to the receiver output.

When this unit is completed, put in all the tubes except the 885 high frequency oscillator. Using the circuit shown in Fig. 6, apply some of the 60 cycle line voltage to the horizontal deflection plates. With the image receiver connected to the power supply (but with the receiver output not connected up) to load the supply in the same manner it will be loaded in actual use, turn on the power. As the cathode-ray tube warms up a horizontal line caused by the A.C. line voltage will be seen on the screen. Adjust the focus control to produce a sharp line and the intensity control to give the minimum intensity necessary. This latter adjustment is to keep from *burning* the screen. As the 885 warms up it will begin to sweep the beam in a vertical direction. The frequency control is then adjusted to give an oscillation frequency of 60 cycles. To aid in this adjustment the patterns that will be produced at 30, 60 and 120 cycles are shown in Fig. 7. The position of the frequency control at 60 cycles should be marked on the chassis for future reference. The 60 cycle line voltage is then disconnected and the 885 high frequency oscillator put in place. With both tubes oscillating a solid green field will appear. If a suitable oscillator is available, the high frequency oscillator can be similarly adjusted to about 13,000 cycles, although this is not necessary. In adjusting the high frequency oscillator a small amount of coupling between the test oscillator and the synchronization input circuit, furnished by a short wire connected to the sync. input and laid near the leads from the test oscillator, will be helpful.

The Power Supply

One power supply is used for the complete image receiver and associated equipment. This power supply is similar to those used with sound receivers, except that the output voltage is slightly higher and greater filtering is used here than is customary in most sound work. In order to keep the output voltage to the cathode-ray tube chassis as high as possible, thus insuring a small bright spot and more nearly linear sweeps, condenser input is used to the filter and the high voltage for the receiver is taken off after the first filter section. Chokes having a relatively low D.C. resistance are desirable in order to keep down the voltage drop in them. It is important to note that the heater winding for the cathode-ray tube is not grounded, since the cathode of this tube is connected to one side of the heater inside the tube.

This power supply was built on a 7 x 9 x 2 inch steel chassis. Two tube sockets were provided for connection to the power cables from the receiver and sweep chassis. The circuit for this supply is shown in Fig. 8.

Receiving a Picture

The antenna used will have considerable effect on the results obtained. It should be an antenna designed for the reception of ultra-high frequency signals. Any of the conventional five meter type antennas will be satisfactory if mounted in the clear and in the highest possible location. The polarity of the transmitting antenna should be determined so that the receiving antenna can be mounted to take advantage of this. Television antennas are in general horizontal. Nine feet is the proper length for a half wave antenna for the two television bands most used at present. A half wave antenna fed at the center with spaced feeders is satisfactory in most cases, while the same antenna fed with twisted pair wire such as is used on many broadcast doublet installations is satisfactory where signal losses in the line can be tolerated. A horizontal antenna should be mounted at right angles to the direction of the transmitter.

To tune in a signal plug earphones into the video monitoring jacks. Tune in the video carrier of the desired station with the main tuning control. This video carrier sounds something like the hum of a radio diathermy machine, except that there is a lot more "hash" present. Next adjust the first detector and antenna trimmers to give maximum signal. Turn up the intensity control on the sweep chassis and adjust the focus control to give the picture sharp edges. Adjust the two size controls to give a rectangle roughly three units high by four units wide. Now set the 60 cycle oscillator control to the 60 cycle position previously marked. A dark horizontal line will be seen moving up or down on the screen. Adjust the low frequency sync. control and the 60 cycle speed control until this line moves slowly off the top of the picture and stays off. The vertical oscillator is then in sync. Care should be taken not to turn up the I.F. gain control

(Continued on following page)

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so far that it overloads one of the stages. This will cut off the sync. pulses and it will be impossible to obtain proper synchronization. Now adjust the high frequency sweep speed and sync. controls until the picture begins to take form. As the proper line frequency is approached a series of dark lines will be seen, sloping downward to the left or right. The wider these lines the nearer the oscillator is to the proper frequency. The picture will suddenly take form as the oscillator jumps into sync. After the picture has been tuned in, the receiver should be *detuned* a little to the low frequency side of the carrier to obtain single side-band reception. This will improve the detail of the picture. If the receiver is *detuning* too far the picture will appear as a "bas-relief." Focus and contrast (I.F. gain) controls should then be readjusted to give the best picture.

Those who wish to experiment when there is no transmitter on the air will find that a self-quenched super-regenerative receiver gives a good signal. Such a receiver radiates a carrier modulated at a high frequency, usually between 15 and 100 kc. When tuned in on the television receiver this signal can be used to synchronize the horizontal oscillator. A series of vertical dark bars will appear on the screen. Several things can be told by inspection of these bars. For instance, if the lines are evenly spaced they indicate a linear horizontal sweep. If the lines are bent at the top it indicates that the horizontal and vertical sweeps are interlocking, and that it is taking the horizontal considerable time to get back in step.

The Sound Receiver

The receiver for the television sound may be any of the conventional types used for ultra-high frequency reception. A superheterodyne is preferable, because it allows better quality reception of the *high fidelity* sound transmitters used in television work.

Parts List for Sweep and Cathode-Ray Tube Section

I.R.C.

R2 —50,000 ohm, ½ watt
R3 —500 ohm, ½ watt
R4 —100,000 ohm, 2 watt
R5 —750,000 ohm, ½ watt
R8 —3,000 ohm, ½ watt
R9 —100,000 ohm, 1 watt
R10—10,000 ohm, ½ watt
R12—20,000 ohm, ½ watt
R13—1,000 ohm, ½ watt
R14—100,000 ohm, 2 watt
R15—750,000 ohm, ½ watt
R18—5,000 ohm, ½ watt
R19—100,000 ohm, 1 watt
R20—200,000 ohm, ½ watt
R21—200,000 ohm, ½ watt
R22—1 meg., ½ watt
R23—50,000 ohm, 2 watt

RCA (Tubes)

2—885
2—57
1—902 C-R tube (2" dia.)
1—80 rectifier

AEROVOX

C1 —.0002 mf. mica
C2 —.001 mf. mica
C3 —.002 mf. mica
C4 —.1 mf. tubular paper
C5 —.005 mf. mica
C6 —.05 mf. tubular paper, 200 volt
C7 —.25 mf. tubular paper, 200 volt
C8 —.1 mf. tubular paper, 200 volt
C9 —10 mf., 25 volt electrolytic
C10—.25 mf., 200 volt tubular paper
C11, C12—.1 mf., 200 volt tubular paper

CLAROSTAT

R1 —50,000 ohm potentiometer
R6 —2 meg. potentiometer
R7 —½ meg. potentiometer
R11—50,000 ohm potentiometer
R16—2 meg. potentiometer
R17—2 meg. potentiometer
R24—50,000 ohm potentiometer
R25—15,000 ohm potentiometer

Parts List—Power Supply

T—Power transformer **(KENYON)** giving 800 volts at 100 ma., center-tapped; 2.5 volts at 6 amps. for the sweep oscillators and amplifiers; 6.3 volts at 0.8 amps. for the 902; 6.3 volts at 3 amps. for receiver; 5 volts at 2 amps. for the rectifier. [In the first model a Thordarson T13R07 and two separate filament transformers were used. (See text.)]

CH1, CH2—30 henry at 75 ma. **(KENYON** K-350)

C1—8 mf., 475 working voltage electrolytic condensers **(AEROVOX)**

C2, C3, C4—8 mf., 450 volt electrolytic condenser **(AEROVOX)**

R—2,000 ohm, 20 watt voltage dropping resistor **(I.R.C.)**

Sw.—S.P.S.T. toggle switch

Radio & Television, April 1940