The Construction of Television Receivers

Basic Circuit Details and a Preliminary Outline of Two Experimental Models

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After an extended period of experiment, Mr. Wilder presents us with preliminary details of two very practical television receivers. It must be admitted that even the simpler circuit is quite a fearsome affair, and it is obvious that a full understanding of the function of the various components will be possible only after careful study. The material has been prepared on the assumption that the interested reader has already made a close study of the previous articles in this series and that he is familiar with modern high-frequency receiver practice.
—EDITOR.

At the beginning of this series, a promise was made to describe a television receiver that, once built, would work. Now that we have covered all the important circuit considerations and now that there is a good possibility of television signals being available, we can proceed to fulfill that promise.

In order to cover the subject adequately, the constructional details of two separate receivers will be given. Both of these are experimental assemblies and while they are both capable of effective operation, it is not suggested that they represent perfection. They are so arranged, however, that general experimental work is made readily possible. The first receiver is a relatively simple one employing straight r.f. amplification of the signal and a three-inch cathode-ray tube electrostatically deflected. The second receiver is actually a modern high-fidelity unit using a superheterodyne r.f. section and a viewing tube in which electromagnetic deflection is employed. The simpler receiver will doubtless have the greater appeal. The picture is, of course, quite small and the available definition will be only fair. However, it is our belief that once a picture of some kind is resolved, the fascination and challenge it presents will quickly lead to more simplification and refinement until a truly worthwhile receiver results.

From the photographs of the t.r.f. receiver it can be seen that the apparatus is divided into two units: one containing the power supplies and sweep circuits; the other including the r.f. amplifier, the video amplifier and synchronizing separation circuits and the cathode-ray tube itself. The r.f. end of this receiver consists of three stages and a diode detector. This is followed by two stages of video amplification and the double-diode synchronizing impulse separation circuit. The sweep circuits are of the multivibrator type, a single tube of the double-triode type being used

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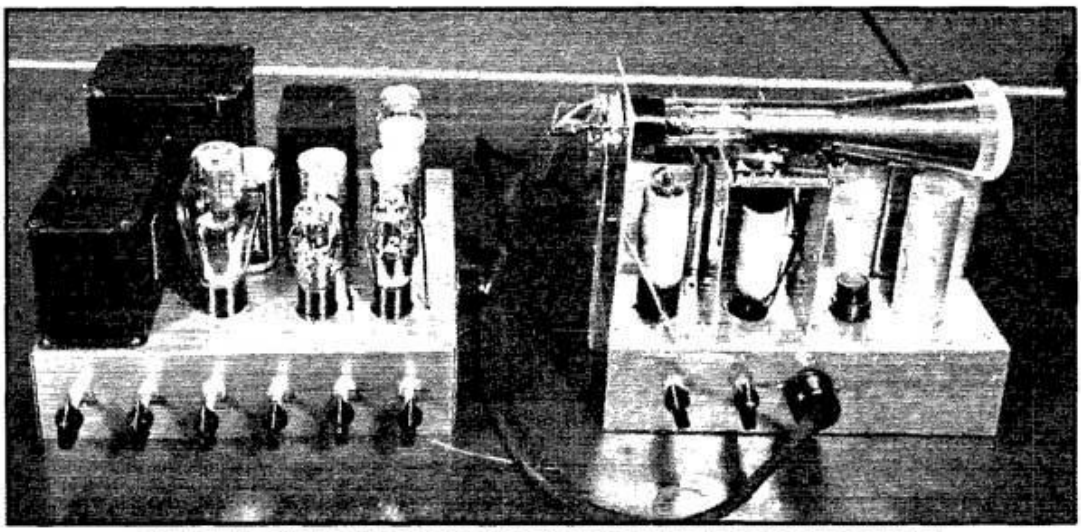


THESE TWO UNITS COMPRISE THE SIMPLE T.R.F. TELEVISION RECEIVER

A three-inch cathode-ray tube provides an inexpensive viewing device and the remaining equipment has been reduced to a practical minimum. Power supplies and sweep circuits are on the left chassis, the r.f. amplifier, video amplifier, sync. separator and c.r. tube being on the right-hand chassis.

former for coupling LF4 to 19.

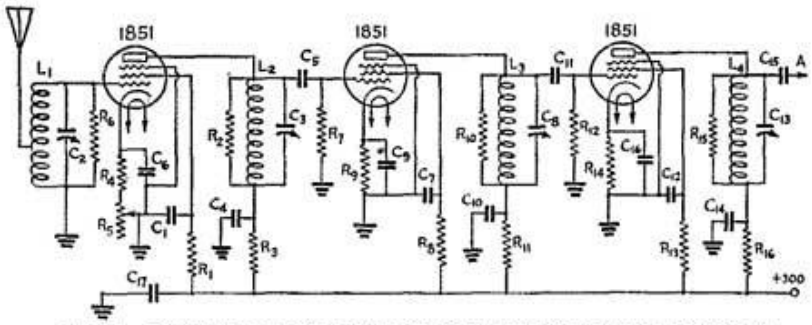


FIG. 1—CIRCUIT OF THE R.F. SECTION OF THE T.R.F. RECEIVER

R_1, R_8, R_{13}, R_{19}, R_{23}—60,000 ohms.
R_2, R_6, R_{10}, R_{15}, R_{20}, R_{24}, R_{26}—2000 ohms.
R_3, R_{11}, R_{16}, R_{17}, R_{45}, R_{46}—5000 ohms.
R_4, R_9, R_{14}, R_{18}, R_{21}, R_{25}—160 ohms.
R_5, R_{28}—10,000-ohm variable.
R_7, R_{12}, R_{22}—.25 megohm.
R_{27}—15,000 ohms.
R_{29}—200,000 ohms.
R_{30}, R_{32}—25,000 ohms.
R_{31}, R_{34}—50,000-ohm variable.
R_{33}—30,000-ohm variable.
R_{34}, R_{47}, R_{48}—100,000 ohms.
R_{35}—100,000-ohm variable.
R_{36}, R_{39}, R_{40}, R_{41}, R_{42}—.5 megohm
R_{37}, R_{38}—1-megohm variable.
R_{43}, R_{44}—1 megohm.
R_{49}, R_{50}—2500 ohms, 5-watt.
R_{51}—500 ohms.
R_{52}—150,000-ohm variable.
R_{53}—10,000 ohms.
All resistors are I. R. C.
C_1, C_4, C_6, C_7, C_9, C_{10}, C_{12}, C_{14}, C_{16}, C_{17}, C_{18}, C_{21}, C_{24}, C_{26} and C_{30}—0.01-μfd. mica.
C_2, C_3, C_8, C_{13}—15-μμfd. max. air.
C_5, C_{11}, C_{37}—0.0001-μfd. mica.
C_{15}, C_{36}, C_{38}—0.001-μfd. mica.
C_{19}, C_{23}, C_{39}—8-μfd. electrolytic.
C_{20}, C_{25}—50-μfd. electrolytic.
C_{22}, C_{31}—0.1-μfd. paper.
C_{27}—0.0015-μfd. mica.
C_{28}, C_{29}—1-μfd. paper.
C_{32}—0.1-μfd., 1000-volt.
C_{33}, C_{34}—0.002-μfd. mica.
C_{35}—0.2-μfd. paper.
C_{40}—0.01-μfd. paper.
C_{41}, C_{42}—0.5-μfd. paper, 1000-volt.
C_{43}, C_{44}—16-μfd. electrolytic.
L_1, L_2, L_3, L_4—6 turns 3/8" inside diameter No. 14 wire with turns spaced 1¼ times wire diameter.
L_5—30 henrys, Kenyon T-153.
L_6—1000 henrys, Thordarson T29C27.
L_7—2000 henrys, two Thordarson T29C27 in series.
L_8—100 henrys, Kenyon T155.
L_9, L_{10}, L_{11}—75 microhenrys (one pie of a National R-100 choke with approximately 9 feet of wire removed from that pie).
Ch.—25 henrys.
R.F.C.—30 turns on ¼" bakelite rod, No. 25 wire.
T_1—Kenyon T-208.
T_2—Kenyon T-206.

vision is made for centering the pattern on the cathode-ray screen by adjustment of potentiometers included in the power pack. There are no controls for the amplitude of the sweep voltages since with the constants given, the sweep amplitudes are such as to fill substantially the whole screen and to provide approximately the proper aspect ratio. Controls for focus and grid bias of the cathode-ray tube are provided in the high-voltage power supply unit. The power supplies are built as a separate assembly not only to facilitate experimental work but to avoid distortion of the image on the cathode-ray tube which would result should the tube be close to the fields generated by the power supply transformers.

Since both receivers were completed immediately prior to the release of the new RCA 1851 steep-slope pentode, it was necessary to use the British tubes of that type. Also, a British low-resistance diode was employed as a detector. It will be noted that the new Type 1851 is specified in the r.f. and video amplifier circuits and that a 955 or a 6H6 is specified for the detector. The normal pentode receiving tubes are incapable of providing sufficient gain and it will be found that the use of the steep-slope pentodes is really essential.

Reviewing the circuits of the power supply and in each. Two high-voltage supplies are made available—one for the cathode-ray tube and the other for the sweep circuits and the receiver proper.

The cathode-ray tube used may be a National Union Type 2003 or the new RCA Type 906. Both of these three-inch tubes employ electrostatic deflection and the electron gun has been designed so that a small enough trace can be obtained to effect a reasonable job of resolving the complete 441-line picture. With the voltage supplied by the power supply specified, sufficient brilliance will be obtained to produce a fairly bright picture in a darkened room. The image is, of course, entirely unsuited for demonstration to the lay public but is adequate for experimental work. No provision has been made in the receiver for d.c. restoration to set automatically the average brightness of the picture. It has been found that manual adjustment of the picture brightness is satisfactory for a simple receiver of this type. Pro-

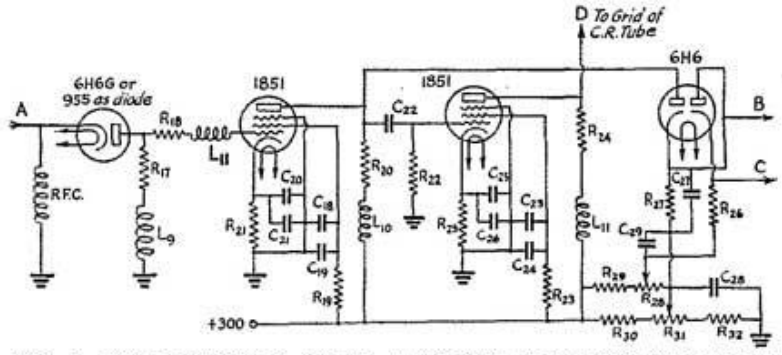
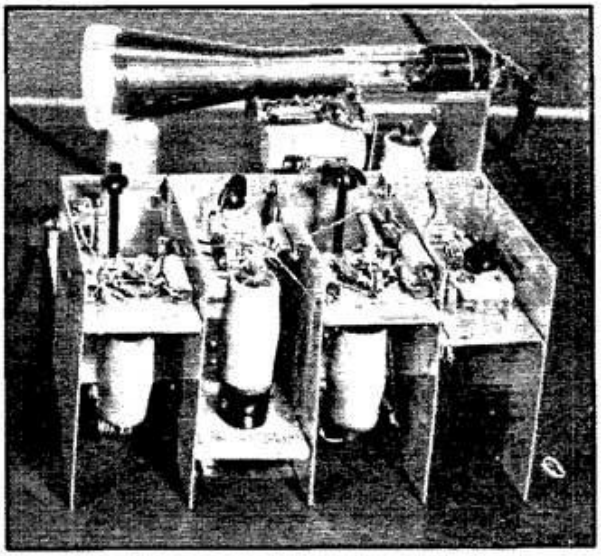


FIG. 2—THE DETECTOR, VIDEO AMPLIFIER AND SYNCHRONIZING IMPULSE SEPARATOR OF THE T.R.F. RECEIVER
For constants see under Fig. 1.

sweeps for the t.r.f. receiver, we find that the general arrangement is quite similar to that already described in previous articles. As is normal practice with cathode-ray tubes using electrostatic deflection, the positive of the high-voltage supplies is grounded. This means, of course, that the focusing and grid-bias control, together with the grid itself, are "hot" with respect to ground. It will be noted that the coupling condenser from the output of the video amplifier to the cathode-ray tube control grid has a rating of 1000 volts for this reason. The 300-volt supply for the remainder of the receiver follows conventional practice. The sweep circuits are very similar to those described in the February issue of *QST*, except that, in the actual receiver, the double-triode 6F8G is used in place of the pair of 76's.

The r.f. portion of the receiver uses three Type 1851 tubes as straight r.f. amplifiers. The circuit arrangement is quite similar to that commonly used in the usual r.f. amplifier for an ultra-high-frequency receiver. The most important difference is in the use of loading resistors across the four tuned circuits to permit the amplifier to pass a sufficiently wide band of frequencies. The circuit comprising the detector, the video amplifier and the synchronizing impulse separator follows very closely the arrangement described in the January issue. One minor difference is that instead of using a triode phase inverter to feed the synchronizing impulse separator, the input to that section is derived from the plate circuit of the first video tube.



SHOWING THE R.F. SECTION OF THE SIMPLE RECEIVER

The somewhat unusual arrangement of the tubes permits very short plate-to-grid wiring. Each stage is tuned separately in order to avoid mechanical complications.

Since it is impractical to present at this time the complete description of the assembly and, more particularly, the adjustment of the various sections of the receiver, we shall pass to a review

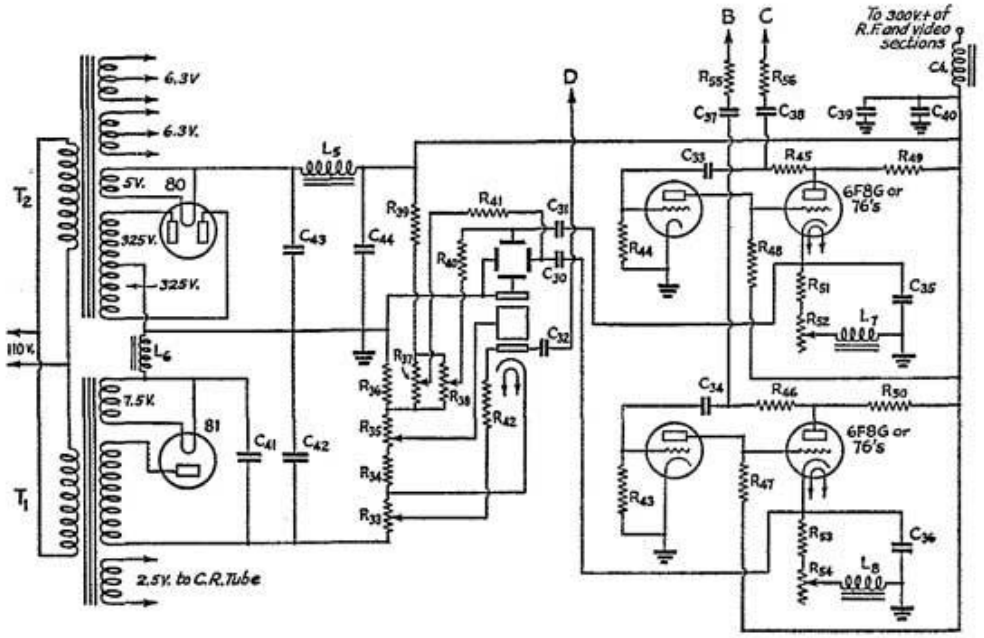


FIG. 3—THE SWEEP, POWER SUPPLY AND CATHODE-RAY TUBE CIRCUITS OF THE T.R.F. RECEIVER

For constants see under Fig. 1.

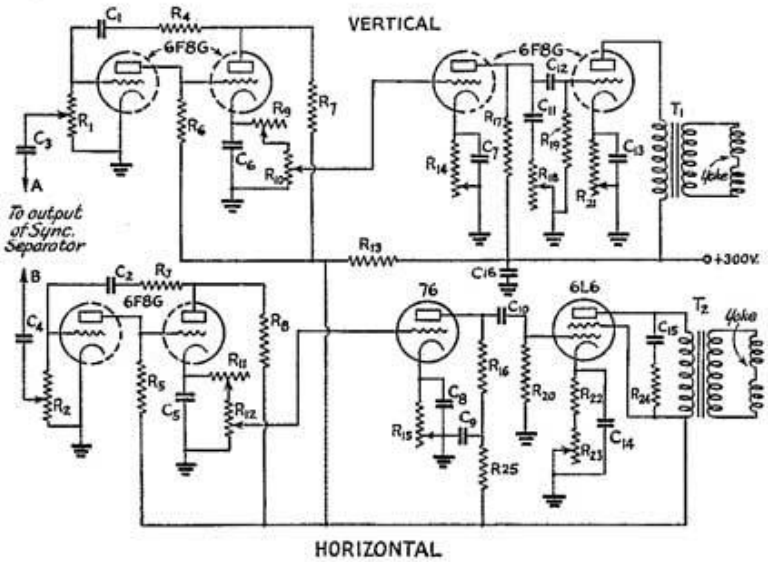
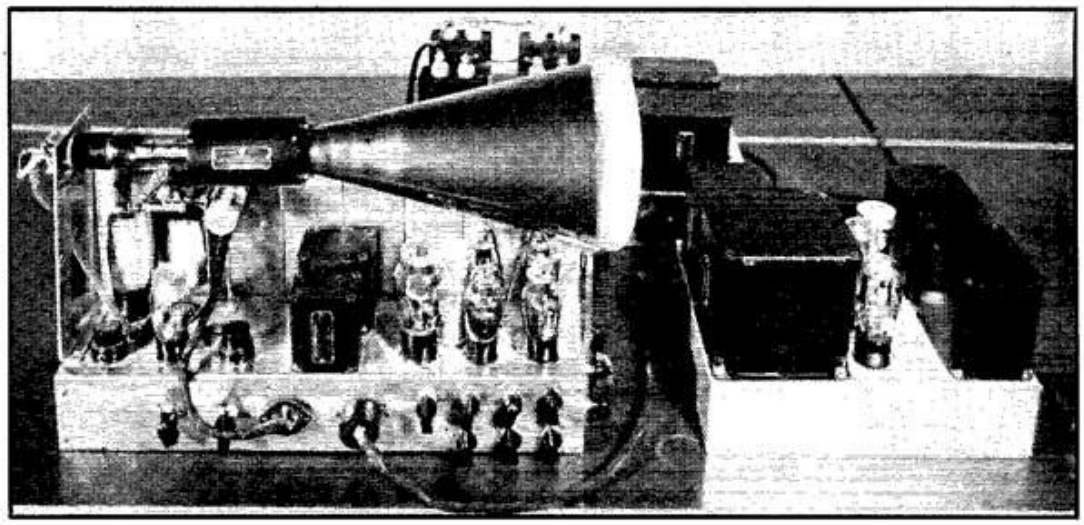


FIG. 4—THE SWEEP CIRCUITS FOR THE SUPERHET RECEIVER

R_1, R_2—1-megohm variable.
R_3, R_4—4000-ohm, 1-watt.
R_5, R_6—100,000-ohm, 1-watt.
R_7, R_8—2000-ohm, 5-watt.
R_9—250,000-ohm variable.
R_{10}—25,000-ohm variable.
R_{11}—100,000-ohm variable.
R_{12}—10,000-ohm variable.
R_{13}—35,000-ohm, 1-watt.
R_{14}—50,000-ohm variable.
R_{15}—10,000-ohm variable.
R_{16}—50,000-ohm, 1-watt.
R_{17}—.5-megohm, 1-watt.
R_{18}—100,000-ohm variable.
R_{19}, R_{20}—.5-megohm, half-watt.
R_{21}—10,000-ohm variable.
R_{22}—250-ohm, 1-watt.
R_{23}—1000-ohm variable.
R_{24}—35,000-ohm, 1-watt.
R_{25}—25,000-ohm, 1-watt.
C_1, C_2—.002-μfd. mica.
C_3—.1-μfd. paper.
C_4—.005-μfd. mica.
C_5—.001-μfd. mica.
C_6—.01-μfd. paper.
C_7—.25-μfd. 50-volt electrolytic.
C_8—.25-μfd. paper.
C_9—.8-μfd. 450-volt electrolytic.
C_{10}—.005-μfd. mica.
C_{11}—.5-μfd. paper.
C_{12}—.1-μfd. paper.
C_{13}, C_{14}—25-μfd. 50-volt electrolytic.
C_{15}—.0005-μfd. mica.
C_{16}—8-μfd. 450-volt electrolytic.
T_1—Low frequency deflection coupling transformer—Kenyon T112.
T_2—High-frequency deflection transformer—Kenyon T111 or R.C.A. No. 9836.
Yoke—Kenyon T700 or R.C.A. No. 9831.

of the basic elements of the superheterodyne receiver. It is suggested that the reader should study all these circuits very closely in conjunction with the explanation given in previous articles. Absolute familiarity with the circuit arrangement and the function of its components is an essential before successful construction or adjustment can be hoped for.

To provide a preliminary description of the superheterodyne receiver, two photographs are given together with the circuits of the power supplies and sweeps. In the first photograph of this receiver the video amplifier and sweep circuits are on the left-hand chassis. The five tubes on the right-hand side with the two output transformers are the magnetic sweep generator tubes and coupling transformers. Along the top of the receiver is the cathode-ray tube with the magnetic deflection yoke in position on the neck of the tube. This mounting is convenient for applying sweeps and modulation but the equipment must be treated with considerable respect because



THE ADVANCED SUPERHET-TYPE TELEVISION RECEIVER

A magnetically-deflected viewing tube is used. Below it are to be seen the sweep circuits and video amplifier. The low-voltage power supply is at the right.