Superheterodyne Television Unit

for the "Wireless World" Television Receiver

Three Articles Reprinted from

Wireless World

February, March and August, 1949

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Second Edition

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Introductory Note

The superheterodyne television receiver unit described here is designed for long-range reception of the London or Birmingham transmissions.

The receiver, as described on pp. 3-14, is suitable for reception of the Alexandra Palace transmissions. The alterations needed to suit the Sutton Coldfield transmitter are given in detail on pp. 14-15.

It should be understood that this unit is not a complete television receiver; it is an alternative receiver unit for the *Wireless World* Television Receiver*, and the rest of the equipment described with the latter is still needed. The original straight set is the more suitable for short- and medium-range reception (within the 500-μV area) in the London area because it is the simpler.

Included with the constructional details for ease of reference are maps of the service areas of the television stations. That for London illustrates the field strength normally obtainable in various districts, but considerable local variations may be found. The Birmingham map shows the expected service area of the station.

* Described in the booklet "Television Receiver Construction." Price 2s. 6d., by post 2s. 9d.

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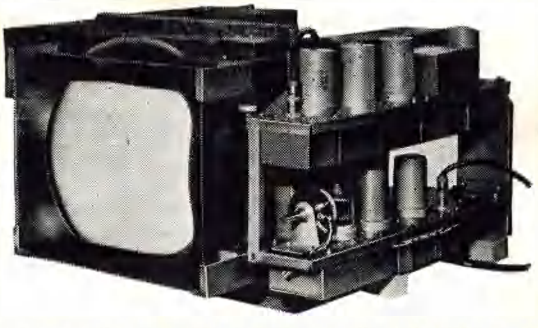
SUPERHETERODYNE TELEVISION UNIT

Long-range Receiver



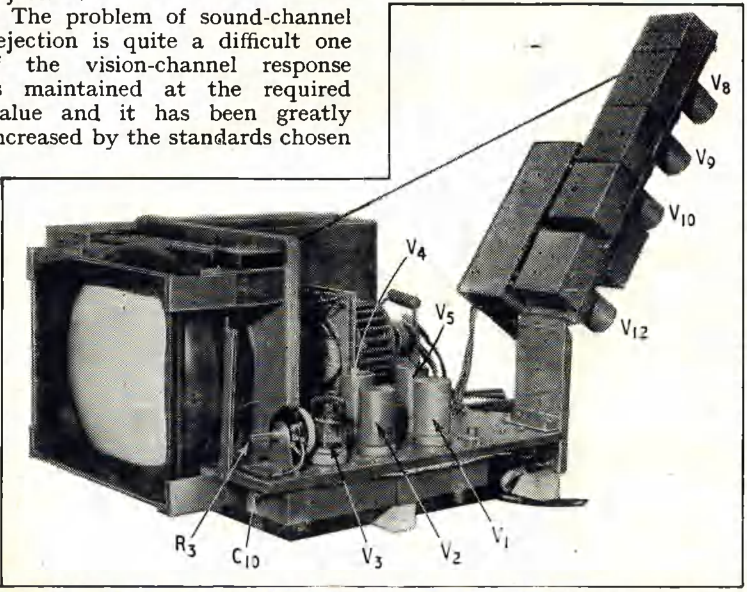
The receiver is shown here in the normal position alongside the cathode-ray tube.

WHEN the WIRELESS WORLD Television Receiver was described*, it was stated that it was suitable only for moderate-range reception and that a more sensitive receiver unit for long-range use would be described later. The original straight set has actually proved adequate for much greater ranges than were originally envisaged, and many reports of good reception at 30 miles and over have been received.

However, it was not intended for really long-distance reception and a great deal of time and effort has been put into the development of a suitable receiver. It is a superheterodyne. It is not the need for high sensitivity which has led to the adoption of this form of receiver, for it is easy to obtain all the gain needed from the straight set; it is the need for sound-channel rejection.

The problem of sound-channel rejection is quite a difficult one if the vision-channel response is maintained at the required value and it has been greatly increased by the standards chosen for the Birmingham station. When the design of the long-range receiver was first considered it was decided that it should be of a type which would be basically suitable for the reception of this station. This decision alone was sufficient to justify the choice of the superheterodyne, for it demands changes to three coils only to make it suitable for Birmingham, whereas a straight set would need changes to at least sixteen.

The design of the set was started before the Birmingham standards were known. From the outset the use of single-sideband reception was decided on, partly because the bandwidth is halved and the stage gain doubled. The main reason, however, was that it enormously helps sound-channel rejection. By picking the sidebands remote from the sound channel the spacing between sound and vision channels is 3.5 Mc/s instead of 0.5 Mc/s. It is then easily possible to obtain 40-db discrimination without using any rejector circuits.



In this photograph the upper deck of the receiver is shown hinged up so that access to the underside can be obtained.

When this receiver had been completed and was awaiting only final testing prior to being described, the Birmingham standards were announced and it was found that single-sideband transmission would be used, the sidebands retained being those *nearer* the sound channel. This is, of course, the natural choice for transmission, just as the alternative is the natural choice for reception.

The result of this choice of transmission standards was to make the receiver as developed useless for the Birmingham area. It also removed most, if not all, the advantage of single-sideband reception in easing the problem of sound-channel rejection, for it brought back the old problem of obtaining some 40-db discrimination for a 0.5-Mc/s change of frequency.

On the announcement of the Birmingham standards, therefore, it was necessary to redesign the i.f. and r.f. amplifier, and it is this which has in large measure been responsible for delaying the publication of this article beyond the date originally fixed for it. The main practical difficulty encountered in design has been that of securing adequate sound-channel rejection with the required bandwidth. In order to secure the necessary performance three rejector circuits have had to be included.

The receiver as now described is suitable for reception from Alexandra Palace. For Sutton

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* *Wireless World*, January–March, May, July, August–December, 1947. Reprinted as "Television Receiver Construction," price 2s. 6d.

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Coldfield changes to three coils—two signal and one oscillator-frequency coils—will be needed. No other changes are expected to be necessary, but as the precise single-sideband standards have not yet been announced there is a remote possibility that a modified. trimming procedure for the i.f amplifier might be required. Details of the three Birmingham coils will be given nearer the opening date of the station.

The receiver has an r.f. stage, mixer and oscillator which are common to both sound and vision signals. These signals are separated in the anode circuit of the mixer. The vision channel comprises three stages followed by a diode detector, v.f. stage, and a diode noise limiter. The sound channel has two i.f. stages followed by a diode detector and diode noise limiter; as in the previous receiver, no a.f. stages are included, since it is assumed that most people already have an a.f. amplifier, or at least a broadcast receiver with pick-up terminals, which can be used with it.

The intermediate frequencies are 9.5 Mc/s for sound and 13 Mc/s for vision. The sound-channel pass-band is about 100 kc/s for — 3 db and the vision-channel pass-band is 3 Mc/s for — 6 db. The latter extends from 10 Mc/s to 13 Mc/s, the vision carrier being at the latter frequency 6 db below the maximum response. This is important if the proper overall characteristic is to be obtained in single-sideband operation.

The oscillator operates at 32 Mc/s (= 45–13). This frequency was chosen instead of the alternative of 58 Mc/s since it was considered that greater oscillator stability could be achieved. The only objection to it is the fact that the second channel interference band is 16–19 Mc/s instead of 68–71Mc/s.

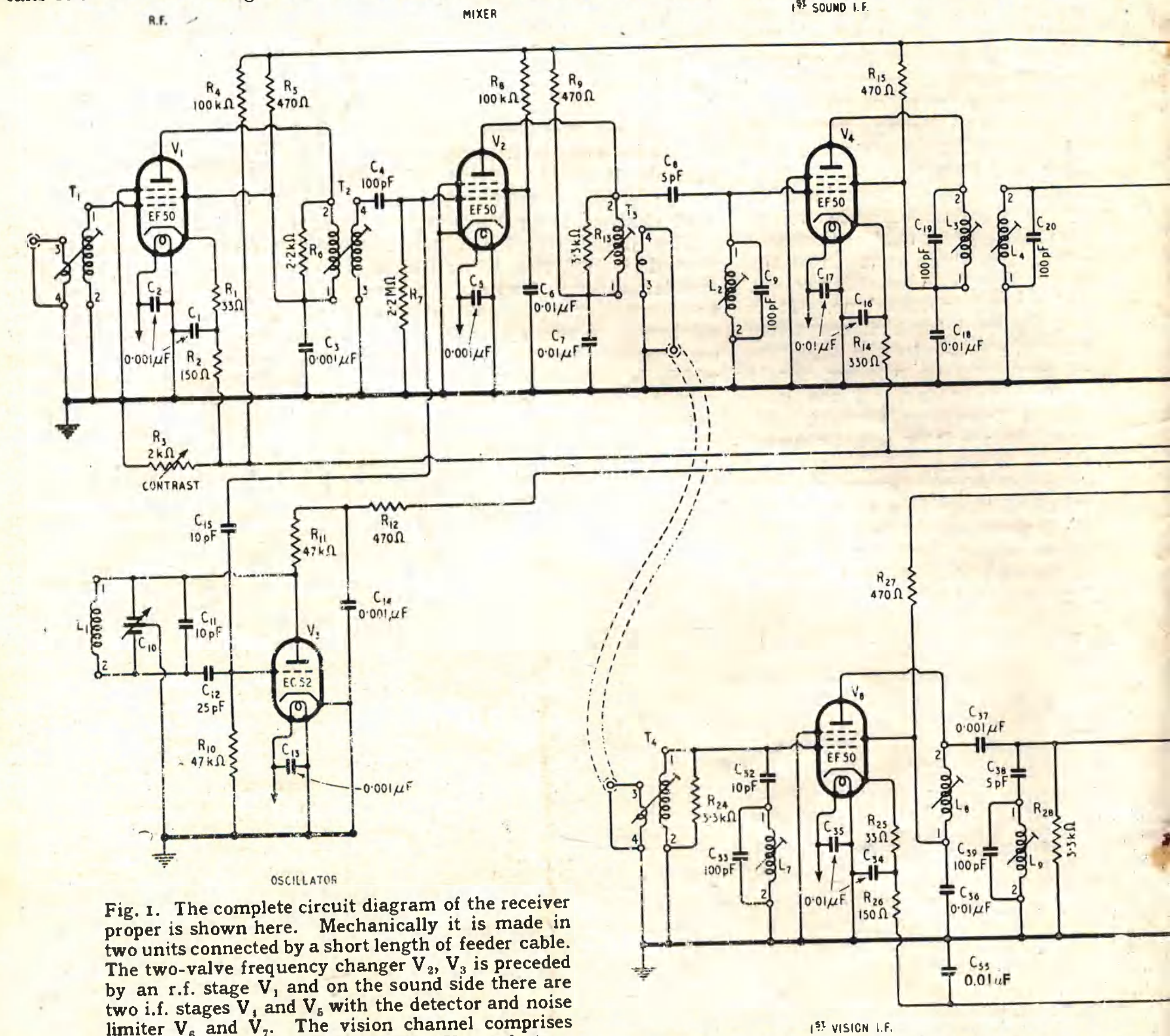
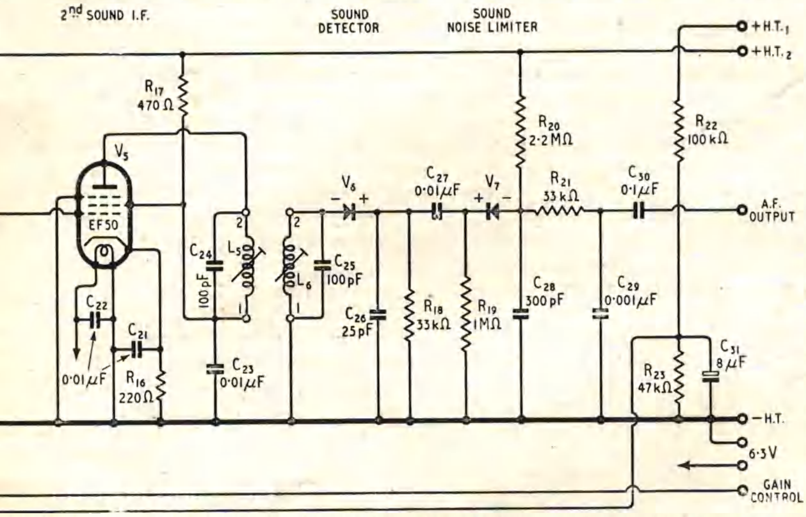
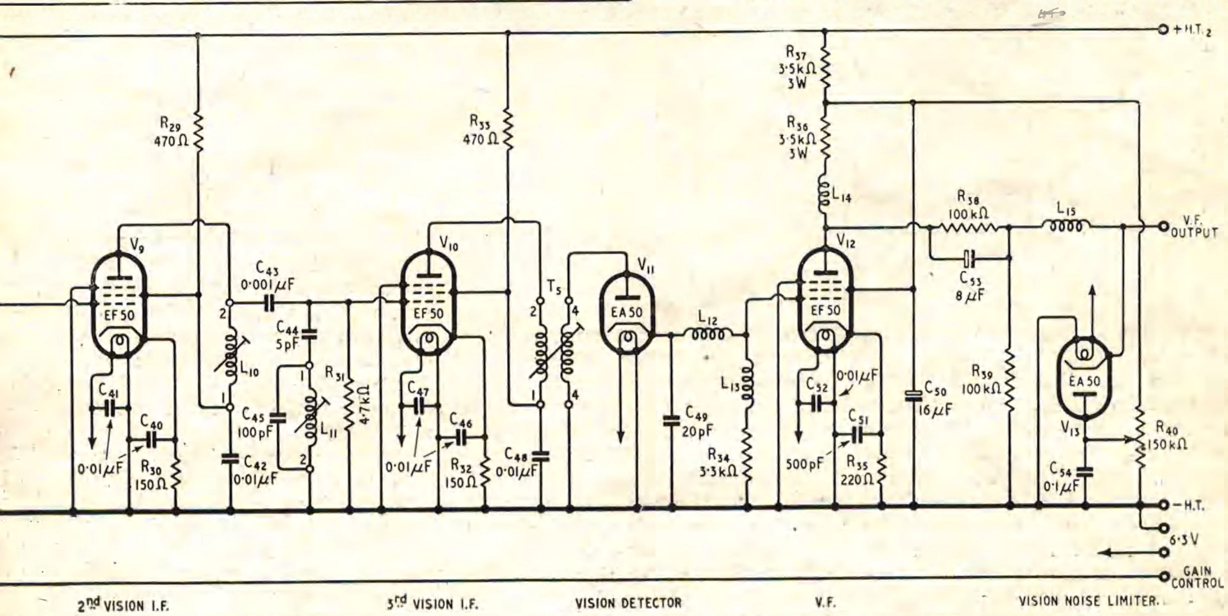


Fig. 1. The complete circuit diagram of the receiver proper is shown here. Mechanically it is made in two units connected by a short length of feeder cable. The two-valve frequency changer V_2, V_3 is preceded by an r.f. stage V_1 and on the sound side there are two i.f. stages V_4 and V_5 with the detector and noise limiter V_6 and V_7. The vision channel comprises three i.f. stages V_8, V_9, V_{10}, detector V_{11}, v.f. stage V_{12} and noise limiter V_{13}.

Because stations in this band are generally stronger there is a greater probability of interference for the same image rejection in the receiver. However, the selectivity of tuned circuits naturally tends to be greater below than above resonance, and this, at least partially, offsets it. In practice no trouble at all from second-channel interference has been found.





Very thorough screening of all parts of the receiver has been adopted. There is far more screening than is necessary for receiver stability, but it is needed to prevent the direct pick-up of signals in the i.f. band. It must be remembered that in a television superheterodyne the intermediate frequency lies in the crowded s.w. band, and at high gain complete screening is necessary if the direct pick-up of signals is to be avoided.

There is also the question of avoiding i.f. harmonic interference. In the superheterodyne, harmonics of the intermediate frequency are inevitably produced in the detector. If they are fed back to the signal-frequency circuits they may beat with the signal to produce a pattern on the picture. The correct choice of the intermediate frequency enables this to be overcome for any given signal frequency, but it is impracticable to secure freedom from it in this way over the whole of the television band. For this it is necessary to use thorough screening and to include an adequate filter after the detector.

The receiver is so arranged in its mechanical form that it will fit into the space allocated to it in the original design. This has necessitated building it in two units mounted one above the other. The lower unit includes the r.f. stage, mixer and sound channel and the upper the vision channel.

The circuit diagram is shown in Fig. 1. The received signal picked up by the aerial is passed through a coaxial feeder of 72 ohms nominal impedance to the input transformer T_1. This is resonant at 45 Mc/s with the stray capacitance, namely the input capacitance of V_1. Damping is provided mainly by the feeder.

This valve is coupled to the mixer V_2 by T_2, damped by R_6. The two signal circuits give a bandwidth adequate to embrace the sound and vision channels.

A separate oscillator valve V_3 is used in the interests of stability. The coil L_1 is wound with heavy gauge wire on a polystyrene former and the turns are cemented

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in place. All the oscillator components are mounted on the lower chassis well away from anything hot and the H.T. supply is taken from the 480-V line via the potentiometer R_{22}, R_{23}. This is done because the direct load on this line is a stable one—the line and frame time-base valves, whereas the 250-V line varies to some degree with the gain- and focus-control settings.

The mixer output at 13-10 Mc/s for vision and 9.5 Mc/s for sound appears in the network T_3, R_{13}, C_8, L_2, C_9. T_3 is the vision coupling transformer tuned by the stray capacitance and damped by R_{13}. The coupling coil is connected to a short length of 72-ohm cable which conveys the vision signals to the upper chassis. The circuit L_2C_9 is tuned to 9.5 Mc/s and applies the sound signal to the first sound i.f. stage V_4.

Coupled pairs L_3C_{19}, L_4C_{20}, and L_5C_{24}, L_6C_{25} are used between the two sound i.f. stages and for the 2nd i.f.-detector coupling respectively. The five circuits give a bandwidth of about 100 kc/s. This is adequate to prevent minor instability in the oscillator from affecting the performance and also to permit the peakiness of ignition interference to be retained so that the noise limiter can function. The selectivity is amply sufficient to avoid any trace of interference from the vision signals.

The detector is a diode V_6. A germanium crystal is actually used, largely because of its small physical size, but there is no objection to the thermonic diode and the EA50 is an equally good alternative. The load resistor and by-pass capacitor R_{18} and C_{26} are made smaller than usual because it is imperative that the frequency response be good enough for the peaky waveform of ignition interference to be retained.

Another diode V_7—again a crystal, but again the EA50 can be used—acts as a noise limiter. It is normally conductive and is maintained so by R_{20} returned to + h.t. If the voltage across R_{19} changes at an audio-frequency rate it appears with negligible drop across C_{28} and is passed through the filter R_{21} C_{29} to the output. If the voltage changes very rapidly in the positive direction, however, as it does on an interference peak, the voltage across C_{28} cannot change rapidly enough to follow it and V_7 becomes non-conductive. V_7 virtually disconnects the output from the detector while the interference peak lasts.

The circuit is very simple and quite effective in dealing with ignition interference. It should be understood, however, that it will do little or nothing to reduce other kinds of interference. On the vision side, the inter-unit cable feeds into T_4 which is tuned in the 10-13 Mc/s band and damped by R_{24}. T_3 and T_4 together form a coupled pair of tuned circuits. Normally each circuit of such a system is tuned to the same frequency—to about mid-band which in this case would be 11.5 Mc/s—and the coupling and damping adjusted to give the required bandwidth. With the type of coil used, however, it has been found impracticable to obtain sufficiently tight coupling between the two windings of T_3 and T_4 for adequate overall coupling.

About 1 ft of cable is used and its main influence is its capacitance of about 25 pF. It is necessary to step-down at each end sufficiently to make this capacitance of negligible importance and with this step-down the coupling in the transformers is inadequate for the required bandwidth. T_3 and T_4, therefore, have their resonance frequencies staggered somewhat. The bandwidth is obtained but the mixer—1st i.f. stage gain is reduced somewhat.

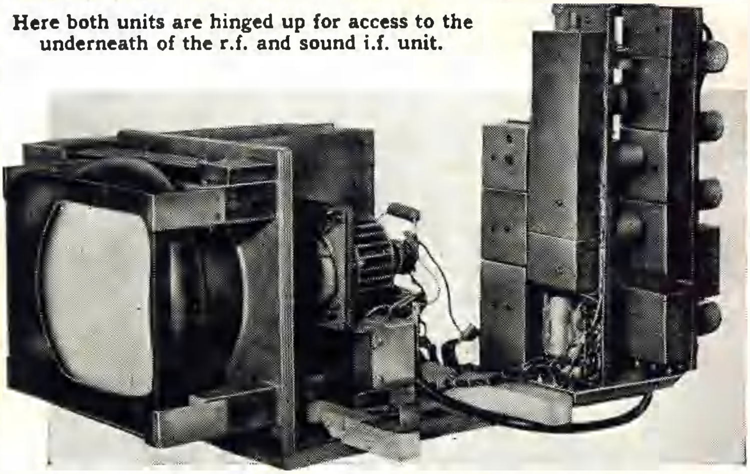
A trap circuit L_7 and C_{33} is coupled to T_4 by C_{32}. It is a sound-channel rejector and gives about 20-db attenuation when adjusted so that C_{32} resonates with the combination of L_7 and C_{33} at 9.5 Mc/s. L_7 and C_{33} then exhibit parallel resonance at about 10 Mc/s and at this frequency they have negligible effect. The cut-off is thus very sharp. At higher frequencies the trap has the effect of loading the coupling capacitively so that R_{24} and T_4 must be lower than would otherwise be necessary.

The first and second and second and third i.f. stages are coupled by L_8 and L_{10} respectively, the circuits being tuned by stray capacitance and the resonance frequencies staggered. Traps comprising C_{38}, C_{39}, L_9 and C_{44}, C_{45}, L_{11} are connected across the couplings. They are similar to the first trap already described but are more loosely coupled and give about 10-12-db rejection apiece. The overall sound-channel attenuation is then about 40-45 db, all provided by the three traps.

A double-wound coupling T_5 is used between the last i.f. valve and the detector V_{11}. This valve has a filter choke L_{12} which is wound to be self-resonant at the intermediate frequency and the load resistor R_{34} has a compensating inductance L_{13} in series with it.

The v.f. stage is V_{12} and this part of the circuit is identical with that of the straight set

Here both units are hinged up for access to the underneath of the r.f. and sound i.f. unit.



previously described. A noise limiter V_{13} has been added, however. This comprises V_{13}, C_{54} and R_{40}. The output signal is negative going and the control R_{40} is set so that over the whole range of normal output voltages the diode is non-conductive and does nothing. A peak of ignition interference, however, which makes the output voltage drop below the peak-white level brings the diode cathode below its anode potential. It then conducts and prevents the output voltage from falling appreciably further.

Its main function is to prevent the worst effect of ignition interference, the defocusing of the scanning spot. The normal white blotches of interference are replaced by white pin-points which are much less noticeable. The circuit is effective, but it requires careful adjustment of R_{40}; of this, more later.

COMPONENTS

The parts in this list are the ones employed in the original model. Any components of the same electrical specification and suitable physical dimensions can be used.

RESISTORS

($\frac{1}{4}$ watt unless otherwise stated)

R_1, R_{25}	33 Ω	Erie
R_2, R_{26}, R_{30}, R_{32}	150 Ω	Erie
R_3	2 kΩ, 3 W, variable wire-wound	Reliance Type T.W.
R_4, R_8, R_{38}, R_{39}	100 kΩ	Erie
R_5, R_9, R_{12}, R_{15}, R_{17}, R_{27}, R_{29}, R_{33}	470 Ω	Erie
R_6	2.2 kΩ	Erie
R_7, R_{20}	2.2 MΩ	Erie
R_{10}, R_{11}, R_{23}	47 kΩ	Erie
R_{13}, R_{24}, R_{28}, R_{34}	3.3 kΩ	Erie
R_{14}	330 Ω	Erie
R_{16}, R_{35}	220 Ω	Erie
R_{18}, R_{21}	33 kΩ	Erie
R_{19}	1 MΩ	Erie
R_{22}	100 kΩ, 1 W	Erie
R_{31}	4.7 kΩ	Erie
R_{36}, R_{37}	3.5 kΩ, 3 W	Erie
R_{40}	150 kΩ, 1 W, variable	Reliance Type S.G.

CAPACITORS

C_1, C_2, C_3, C_5, C_{13}, C_{14}, C_{29}, C_{37}, C_{43}	0.001 μF, mica	Dubilier Type 635
C_4, C_9, C_{19}, C_{20}, C_{24}, C_{25}, C_{33}, C_{39}, C_{45}	100 pF, silvered-mica	Dubilier Type 5811W
C_8, C_{36}, C_{44}	5 pF, ceramic	T.C.C. Type CC31a
C_{10}	25 + 25 pF, split stator	Eddystone Type 583
C_{11}, C_{15}, C_{32}	10 pF, ceramic	Dubilier Type CTD310
C_{12}, C_{26}	25 pF, silvered-mica	Dubilier Type 5811W
C_6, C_7, C_{16}, C_{17}, C_{18}, C_{21}, C_{22}, C_{23}, C_{27}, C_{34}, C_{35}, C_{38}, C_{40}, C_{41}, C_{42}, C_{46}, C_{47}, C_{48}, C_{52}, C_{55}	0.01 μF, 500 V, tubular paper	Dubilier Minicap T.C.C Type 543
C_{28}	300 pF	Dubilier Type 635
C_{30}, C_{54}	0.1 μF, tubular paper	T.C.C. Type 343
C_{31}	8 μF, electrolytic	T.C.C. Micropack, Type CE19P
C_{49}	20 pF, ceramic	Dubilier Type CTS310
C_{50}	16 μF, electrolytic	Dubilier Type CT1650
C_{51}	500 pF, mica	Dubilier Type 635
C_{53}	8 μF, electrolytic	Dubilier Drilitic BR850

VALVES

V_1, V_2, V_4, V_5, V_8, V_9, V_{10}, V_{12}	Mullard EF50
V_3	Mullard EC52
V_6, V_7, Germanium crystal-valves	B.T.H. CG1
V_{11}, V_{13}	Mullard EA50

MISCELLANEOUS

Coaxial-cable plugs	Belling-Lee Type L604/P
Coaxial-cable sockets	Belling-Lee Type L604/S
Polystyrene tube, $\frac{3}{8}$-in outside diameter	Denco
$\frac{1}{4}$-in inside diameter	Denco
Polystyrene varnish	Denco
Coaxial cable (for aerial feeder and inter-unit connection)	T.M.C. Type P.T.1.M

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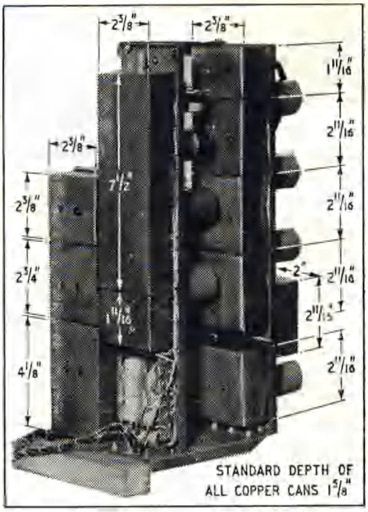
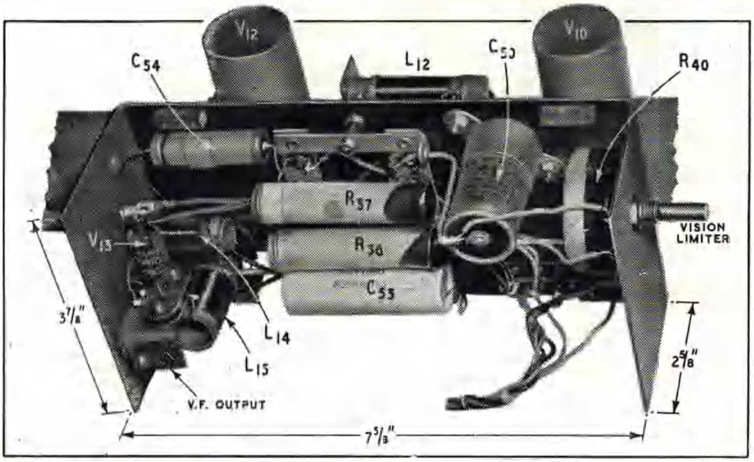
Mechanical Details and Alignment

THE vision i.f. amplifier is built on a chassis consisting of a flat copper plate with the edges turned down to form a ¼-in lip all round for stiffening. It measures 14 in by 2¾ in when completed. All parts are mounted on the underside except for L_{12} and C_{49}. The detector V_{11} passes through a hole in the chassis and is partly enclosed by the can under the chassis which screens T_5, and partly by the can above the chassis which screens L_{12}.

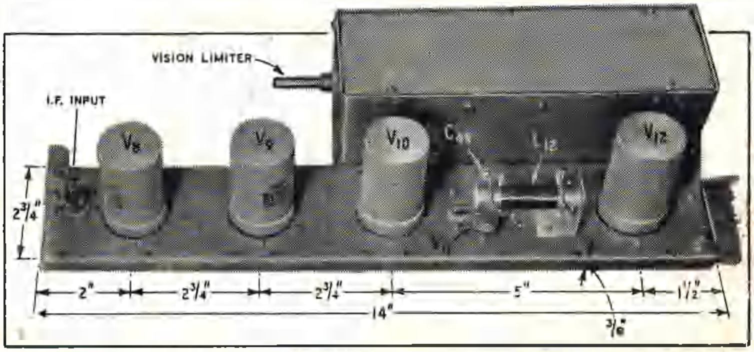
Small tubular-paper capacitors are used for bypassing and are connected directly between the appropriate valveholder contacts and the chassis with very short leads. All earth leads are soldered to the chassis. In the i.f. stages one heater lead, the suppressor-grid connection and the two 'internal-screen' connections are soldered directly to the chassis.



Dimensions of all screening boxes are marked on this photograph.



The interior of the v.f. compartment is shown here; R_{38} and R_{39} are on the tag board but hidden from view by C_{53}. The photograph on the right shows the top of the i.f. chassis.



The wiring is very simple because the absence of permanent screens makes everything very accessible. Dimensions of the screening cans are given in one of the photographs; they drop over the appropriate parts of the chassis and are held in place by eyebolts. It is necessary to provide suitably placed slots in the edges of the cans to clear leading out wires and, of course, the adjacent sides are cut away sufficiently to clear the valveholders. The can covering L_{12} has tabs left on its ends which are bent over to form feet by which it can be secured by 6BA screws to tapped holes in the chassis.

Although the v.f. valve is on this chassis, most of the components associated with it are mounted in a separate unit mounted alongside it, and bolted to it. This separate unit need not be of copper. Any convenient metal can be used; brass was employed in the original model. The top and bottom are filled with a sheet of metal gauze to provide screening while permitting adequate ventilation.

The potentiometer R_{40} for the vision noise limiter is mounted on the front end of this unit. It is intended as a pre-set control, but if it is required to bring it to the panel it can be mounted elsewhere.

The r.f. unit is similarly made from a copper plate with the edges turned down. However, there is a cut-out in one corner to clear the c.r. tube mounting. The form of construction is similar to that of the other unit and needs little comment. The components associated with the noise limiter V_7 are mounted on two tag-boards which in turn are mounted one on each side of a *metal* bracket. Components prior to V_7 are mounted on one side and com-

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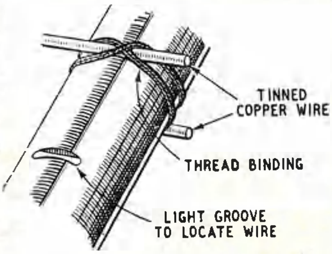
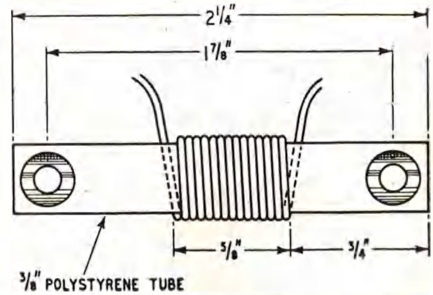
ponents following V_7 on the other. The bracket thus provides screening between the pre- and post-limiter circuits and is necessary to prevent stray capacitance from passing interference when V_7 is cut-off.

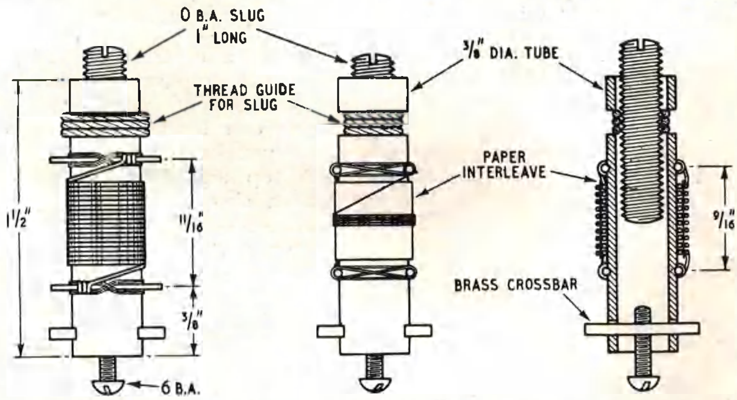
All the r.f. and i.f. coils used are of the same mechanical form and comprise a tube of $\frac{3}{8}$-in outside diameter and $\frac{1}{4}$-in inside diameter with slots in the walls at one end to carry a flat brass cross-piece for mounting. Slots at the other end permit a few turns of twine to be wound so as to engage in the thread of the o.B.A. tuning slug. Although all the coils utilize formers of the same mechanical type and are identical with those used in the straight set previously described, two different materials are used.

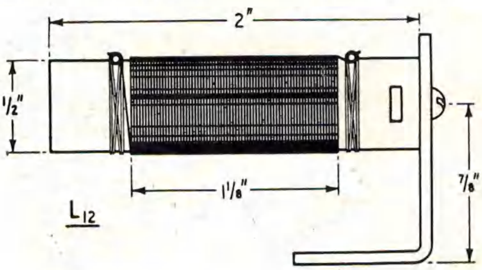
All coils tuned to the sound channel—L_2, L_3, L_4, L_5, L_6, L_7, L_9 and L_{11}—have polystyrene formers and copper slugs, whereas all coils in wideband circuits,—T_1, T_2, T_3, T_4, T_5, L_8, L_{10},—have paxolin formers and brass slugs. The losses with paxolin and brass are heavier than with polystyrene and copper and their use is only permissible in circuits which require high losses for their proper operation. If it is desired for uniformity, polystyrene formers and copper slugs can be used throughout, but the reverse is not permissible. If any difficulty is found in obtaining o.B.A. copper rod, it should be noted that $\frac{1}{4}$-in copper rod can easily be threaded with a o.B.A. die. Polystyrene is also used for the oscillator-coil former L_1, but paxolin for the coils L_{12}, L_{13}, L_{14}, and L_{15}.

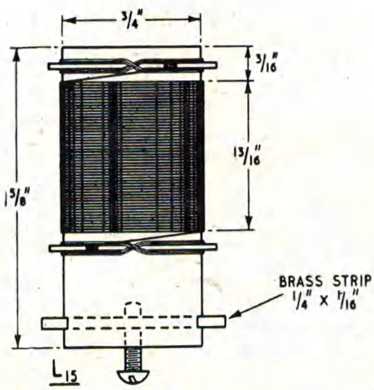
Except for T_1 and T_2 all coils are close wound. In T_1 and T_2

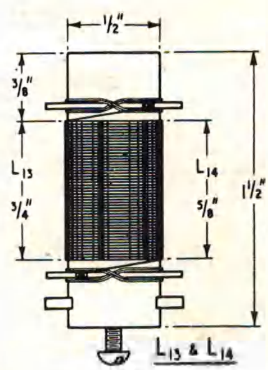












Details of the r.f., i.f. and oscillator coils are given above. On the left the drawings show the form of the filter and correction coils. The winding data appears in the Table on page 12.

the turns are spaced out to fill the winding space uniformly. After winding, the coils should be doped with shellac, in the case of those with paxolin formers, or polystyrene varnish, for the others. T_2, T_3, T_4 and T_5 are double-wound and should have a layer of shellacked paper between the windings to provide insulation. Primary and secondary are identical in T_2 and T_5 but in T_3 and T_4 the coupling windings have only a few turns, which should be placed in the centres of the main windings. Details of the windings are given in the table.

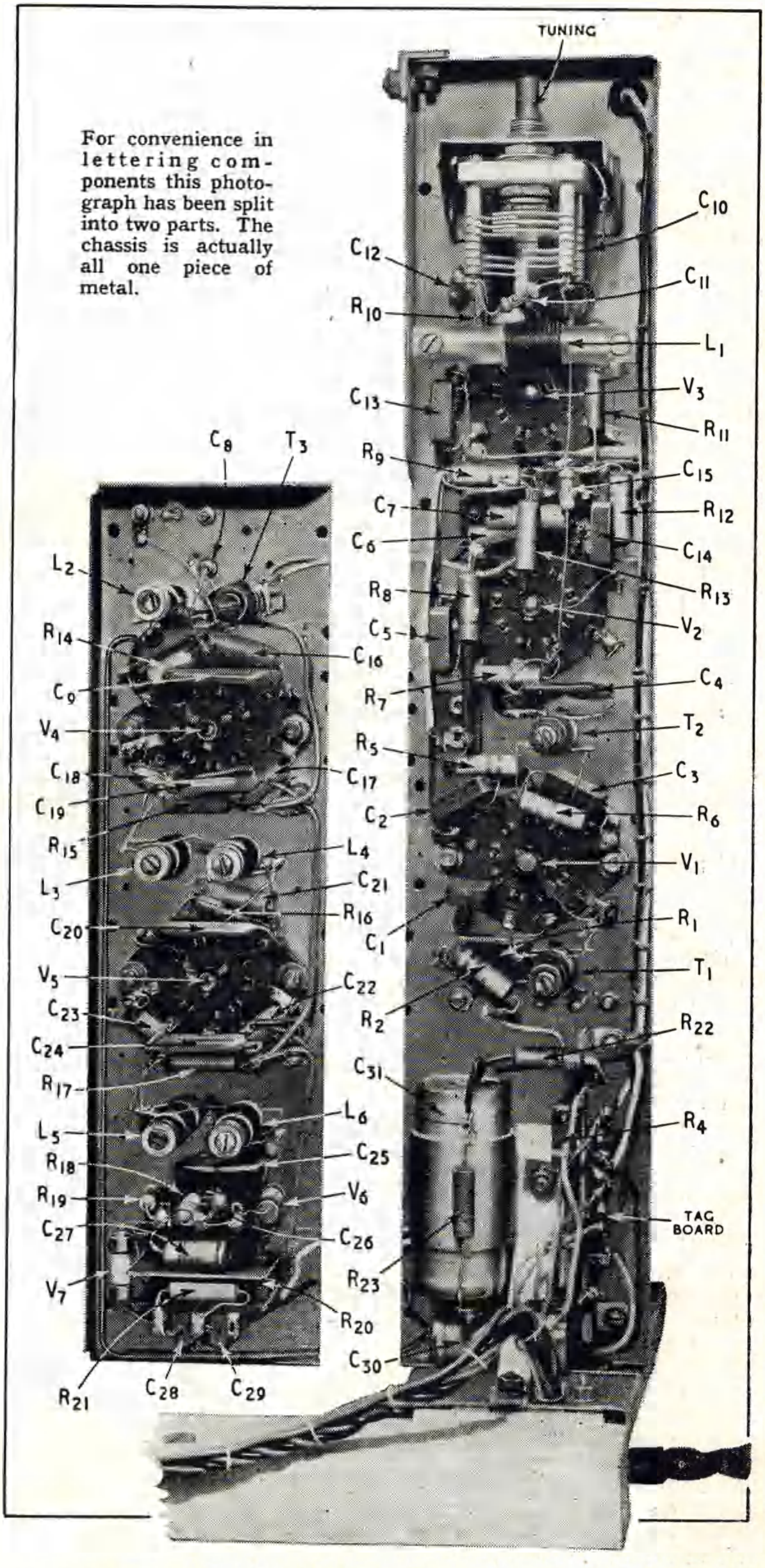
The set requires careful alignment and a calibrated test oscillator must be regarded as *essential.* The sound channel should be aligned first. Remove V_3; set the signal generator to 9.5 Mc/s and connect it between the chassis and the grid of V_5. Then adjust L_5 and L_6 for maximum output; L_6 will normally be flatter than L_5. Transfer the signal generator to the grid of V_4 and adjust L_3 and L_4. Disconnect C_4 from the secondary of T_2 and connect it to the signal generator; adjust L_2. Then readjust all sound-channel trimmers with the gain control (contrast) at maximum starting with L_6 and finishing with L_2.

It will be necessary progressively to reduce the signal-generator output as more circuits are brought into operation, and as they come into tune. The coupling between L_3 and L_4 and between L_5 and L_6 is adjustable by their spacing. This is normally $\frac{3}{4}$-in between centres but is not critical. It should be slightly sub-optimum. Now connect the signal generator to the grid of V_{10} and set it to 11.5 Mc/s. Adjust T_5 for maximum response. The tuning is very flat and it is advisable to use a meter as an indicator; this should be an 0-1 milliammeter connected in series with R_{34} and by-passed with an 0.001-μF capacitor.

Transfer the signal generator to the grid of V_9 and with it set to 9.5 Mc/s adjust L_{11} for *minimum* output. This circuit is sharp and must be set precisely. Alter frequency to 10 Mc/s and adjust L_{10} for maximum output. Then connect the signal generator to the grid of V_8 and with it set to 9.5 Mc/s adjust L_9 for *minimum* output; then adjust L_8 for maximum output with the generator at 12.5 Mc/s.

Now connect the generator to C_4 just as in the case of the sound-channel adjustments, and connect a 470-ohm resistor in series with each end of the inter-unit cable. Disconnect R_{24}, set the generator to 9.5 Mc/s and adjust L_7 for *minimum* output. Then adjust T_4 for maximum output with the generator at 10.3 Mc/s. Reconnect R_{24}, disconnect R_{13}, set the generator to 12 Mc/s and adjust T_3. Reconnect R_{13} and remove the 470-ohm resistors. The overall response curve should now be of the form shown in Fig. 2.

Connect the signal generator to the grid of V_1, set it to 41.5 Mc/s,



For convenience in lettering components this photograph has been split into two parts. The chassis is actually all one piece of metal.

R.F., Oscillator and Sound I.F. Chassis.

Superheterodyne Television Unit—
insert V_3 and adjust C_{10} for maximum output on the sound channel. Swing the generator to a higher frequency. All output

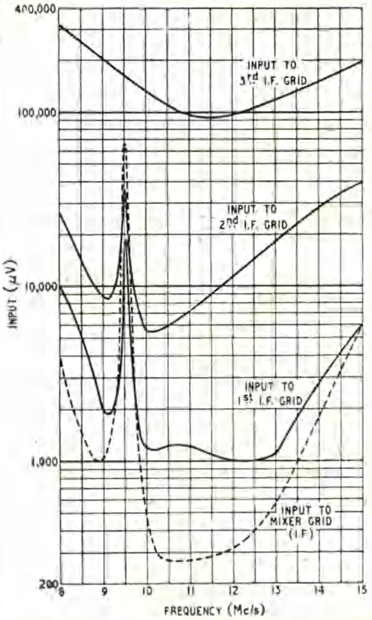


Fig. 2. These curves show the unmodulated r.m.s. signal input needed at various stages to produce a change of detector current of 0.5 mA ; i.e., a change of 1.65 V across the diode load.

from the sound channel should rapidly vanish and should appear in the vision channel. There should be a maximum around 44 Mc/s and the response should be about one-half of this at 45 Mc/s.

When satisfied that the oscillator is properly set connect the signal generator to the input socket. With it set to 43 Mc/s, adjust T_2 for maximum vision-channel output, and T_1 with it set to 45 Mc/s.

The adjustments on a signal are the same as with any other receiver, but tuning with C_{10} must be carried out on the sound signal only. If C_{10} is adjusted for maximum sound output, the picture signal will automatically be tuned right provided, of course, that the i.f. circuits have been properly aligned. This correct setting of C_{10} is not one giving maximum vision signal, it is one giving one-half of the maximum. Initially put the noise suppressor out of action by tuning the control so that the slider of R_{40} is at earth. Set Brightness and Contrast for the best picture, re-adjusting Focus as necessary. If there is ignition interference adjust R_{40} until its setting just has no effect on the picture.

As this control is turned it will be found that it has no effect at all until a certain point is reached at which it suddenly takes out the brightness of the whitest parts of the picture. It should then be turned back a little so that it just has no effect on the picture quality. Any alteration to Contrast will require a re-adjustment of the noise limiter but Brightness does not affect it.

Care in the setting of this control is necessary. The aim is to adjust it so that the anode potential of V_{13} is very close to the instantaneous anode potential of V_{12} with a peak-white signal. If it is more negative than this, the limiter will not reduce interference fully ; if it is more positive, the diode will conduct on the signal and all detail in the white region will be lost.

The receiver draws a somewhat higher current than the earlier straight set and in consequence one change is desirable elsewhere. The resistor R_2 of Fig. 1, Part 6 (the limiting resistor in series with the focus control), should be changed to 200 Ω, 3 W. The resistor R_1, of Fig. 1, Part 9, (+ H.T.3 feed resistor) need not be altered, however.

It is not possible to give much indication of the range of the receiver for it depends to a very large extent on local conditions. The set has been designed on the

COIL WINDING DATA.

Note—In all multi-winding assemblies, all windings are in the same direction, and grid windings are overwound on anode windings with one turn of shellacked paper between for insulation ; adjacent ends are grid and anode on the one hand and earth and + H.T. on the other.

Component	Wire (S.W.G.)	Winding 1—2 (turns)	Winding 3—4 (turns)	Trimming Frequency (Mc/s)	Remarks
T_1	36 D.S.C.	12	1½	45	3-4 interwound with 1-2 at earthy end.
T_2	36 D.S.C.	9	9	43	1-2 overwound on 3-4 with one turn of shellacked paper between.
T_3	38 enam.	45	4	12	3-4 overwound in centre of 1-2 with one turn of shellacked paper between.
T_4	38 enam.	50	4	10.3	
T_5	38 enam.	51	51	11.5	1-2 overwound on 3-4 with one turn of shellacked paper between.
L_1	20 enam.	15	—	32	Polystyrene former, air core.
L_2, L_3, L_4, L_5, L_6, L_7, L_9, L_{11}	26 enam.	22	—	9.5	Polystyrene formers and copper slugs.
L_8	36 enam.	30	—	12.5	
L_{10} ...	36 enam.	45	—	10	
L_{12} ...	40 enam.	200	—	—	
L_{13} ...	38 enam.	108	—	—	
L_{14} ...	38 enam.	90	—	—	
L_{15} ...	40 enam.	142	—	—	

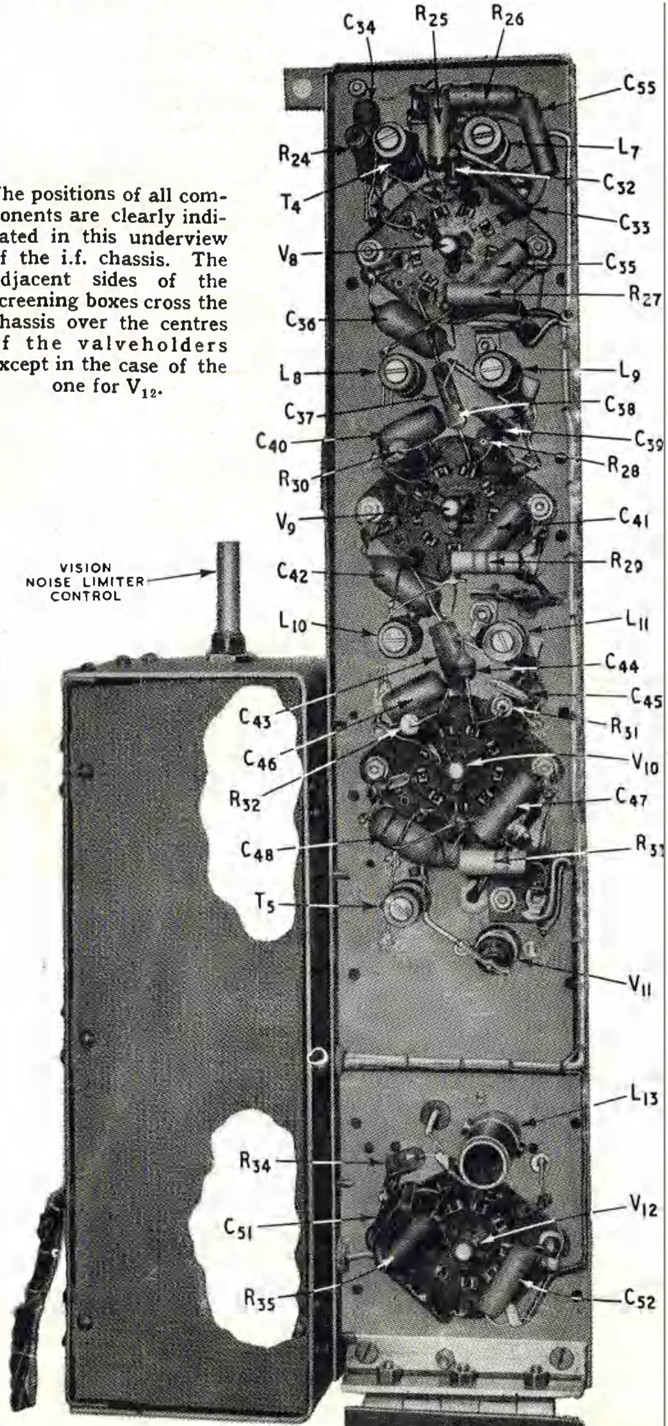
basis that a signal-noise ratio of 20 db is the minimum acceptable. This being so it has not been thought worth while to go to extremes in reducing set noise. A triode first stage, for instance, would theoretically be an improvement, but would at most be 6 db better. In practice, probably no more than 3 db would be gained. In either case the improvement is small considering the overall requirement of at least 20 db. Matters are very different in radar where signals equal to the noise can be useful ; an improvement of only 1 or 2 db may then justify considerable receiver complication.

When receiving a weak signal, receiver and external noise may well be appreciable and may affect the line synchronizing as well as produce a pattern on the picture. It has been found that the 'tearing of lines' is more disturbing than the direct noise. This can be greatly reduced, if not completely eliminated, by connecting a resistor in series with C_1, Fig. 1, Part 6.

The effect of this is to form with the input capacitance of the sync separator an integrator which largely smooths out noise peaks and prevents them from tripping the timebase. If the resistor has too high a value pulling on whites may occur, but it should be made as high as possible as long as much pulling does not occur. Usually, 20 kΩ is a suitable value.

At extreme ranges when receiver noise becomes important it has been found that considerable improvement can be effected by the careful adjustment of the limiter. If it is set so that it does operate on the picture signal to some degree it removes quite a lot of the noise and although it degrades the picture to some extent the net result is an improvement. At such ranges the aerial becomes extremely important and is the place to which one must look for any major gain.

The receiver has been tested in a country district some 40 miles north-east of Alexandra Palace, but with rather a poor aerial. The aerial itself was a standard dipole and reflector but during the tests it was impracticable to mount it high enough above the roof of the house on which it was erected. The lower ends of the dipole rods



The positions of all components are clearly indicated in this underview of the i.f. chassis. The adjacent sides of the screening boxes cross the chassis over the centres of the valveholders except in the case of the one for V_{12}.

I.F. and V.F. Chassis

Superheterodyne Television Unit— were only a couple of inches from the tiles of the sloping roof and the centre of the aerial was no more than a couple of feet above the peak of the roof. It was estimated that at least 10 db more signal would have been obtained with a properly erected aerial.

Nevertheless, the picture obtained was indistinguishable from a local one, except of course, from ignition interference from passing vehicles. On sound, such interference could be heard but was never obtrusive. On vision it was more noticeable, but only in the case of one or two particularly bad cars was it sufficient to mar one's enjoyment of the picture.

BIRMINGHAM TELEVISION RECEPTION

Modifying the "Wireless World" Superheterodyne Unit

WHEN describing the Superheterodyne Television Unit for the *Wireless World* Television Receiver it was said that the changes needed to make it suitable for the reception of the Birmingham station would be described later. It was expected that the changes would be to three coils only.

As the Birmingham station is not yet in operation it is obviously impossible to test the modified receiver on the actual television reception, but signal-generator tests indicate that it should behave correctly. As single-sideband transmission will be used, there is always the possibility that some further minor changes might be needed, but this is considered unlikely.

The alterations needed to the Superheterodyne Unit are confined

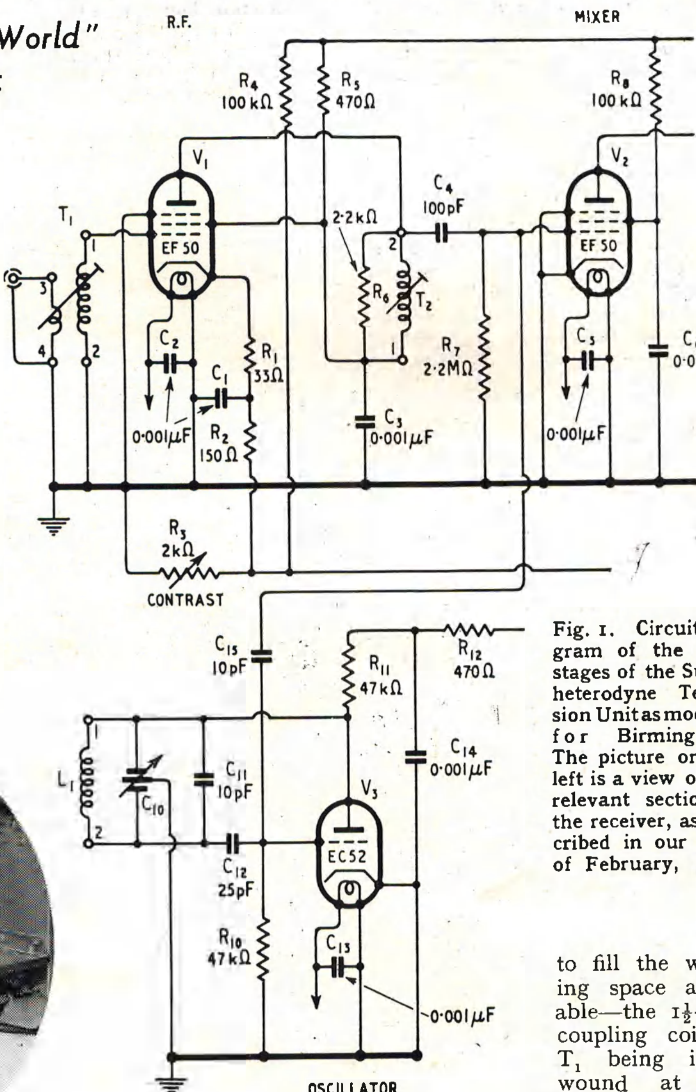
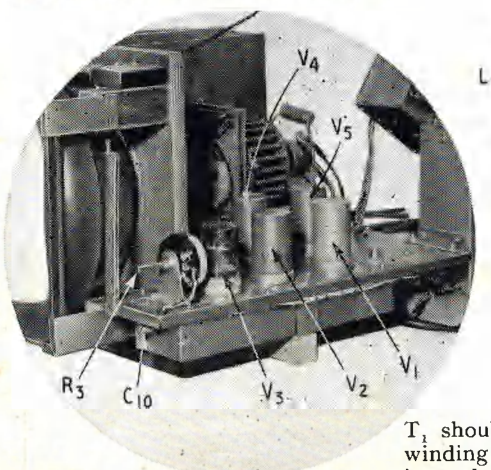


Fig. 1. Circuit diagram of the early stages of the Superheterodyne Television Unit as modified for Birmingham. The picture on the left is a view of the relevant section of the receiver, as described in our issue of February, 1949.



to the three coils T_1, T_2, and L_1 of the original circuit diagram and to one minor circuit alteration. The coil formers are unchanged; T_1 should have 10 turns for the winding 1-2 and $1\frac{1}{2}$ turns for 3-4, instead of the $12 + 1\frac{1}{2}$ turns used for Alexandra Palace. T_2 should have one winding of 6 turns instead of the double winding of 9 turns. The turns are spaced out to fill the winding space available—the $1\frac{1}{2}$-turn coupling coil in T_1 being interwound at the earthy end—and No. 36 d.s.c. wire is used. The oscillator coil L_1 has 8 turns of No. 20 enamelled wire close wound instead of the original 15 turns.

The circuit change consists of the use of a tuned-anode coupling

Birmingham Television Reception— for T_2 instead of a double-wound transformer. The latter is generally to be preferred, since it permits the complete isolation of the return leads to the cathodes of the two valves and so reduces chassis currents. In this instance, however, it was found to be unsatisfactory because it proved impracticable to secure sufficiently tight coupling between the two windings with so few turns in each. The tuned-anode form of intervalve coupling has been adopted, therefore, and is satisfactory in the single-stage amplifier used in this set.

The circuit of the early part of the unit has been re-drawn in Fig. 1 to show this modification. If it is compared with the original diagram, the change can be seen to be a very minor one.

Since the sound and vision carriers are at 58.25 and 61.75 Mc/s respectively the oscillator must operate at 48.75 Mc/s, while the signal circuits should be tuned to 59 Mc/s and 61.5 Mc/s for T_2 and T_1 respectively.

The alignment procedure described in the original article is unchanged except for the frequencies to which the signal-generator must be set while adjusting the signal and oscillator circuits. Frequencies for adjustments in the i.f. amplifiers remain unaltered.

This original procedure should, therefore, be followed exactly, but wherever 41.5 Mc/s occurs in the description substitute 58.25 Mc/s. Similarly, for 44 Mc/s substitute 60.75 Mc/s and 61.75 Mc/s for 45 Mc/s. T_2 is to be adjusted with the signal-generator at 59 Mc/s instead of 45 Mc/s and T_1 with it at 61.5 Mc/s instead of 45 Mc/s.

Of course, the aerial must be modified for the higher frequency. The dipole length should be about 7 ft 6 in instead of 10 ft 6 in.

B.B.C. TELEVISION MAPS

THE map reproduced on cover ii shows the results of a survey carried out by the B.B.C. Research Department. The survey was extended well beyond the boundary of the nominal Alexandra Palace service area.

The field-strength measurements, from which the contours plotted on the map have been derived, were made at several places along eight routes, radiating from Alexandra Palace, up to distances of about sixty miles. Whenever possible, places in open country were chosen, where there were no nearby hills or buildings that might produce reflected components of field strength, which could give misleading results. In order to take account of the substantial variations in field strength that occur at these frequencies between points which are almost contiguous, a continuous record of the field strength at each place was made as the vehicle in which the measuring equipment was installed moved slowly along. The average value of field strength at each place was then determined from these records. The aerial on the vehicle was twenty feet above the ground, and as the average height of television receiving aerials is nearer thirty than twenty feet, the measured values were subsequently corrected to get the field strength at thirty feet above ground, these corrections being made on the assumption that the gain of the aerial increased linearly with height. All the measurements were made while the transmitter was radiating either normal programme or the "artificial-bars" signal, and the results were then multiplied by a factor to obtain the peak field strength, which corresponds to the white elements in the picture.

Some additional measurements were made at each of the principal towns within the area. The field strength there was usually less than in the surrounding country by between three and six decibels, and this reduction should be remembered when using the contour map, since, to avoid undue complication, closed contour loops have not been drawn around the towns.

The stippling on the map indicates the area within which considerable fading may be experienced.

The second map on cover iii shows only the anticipated service area of the Midland television transmitter.