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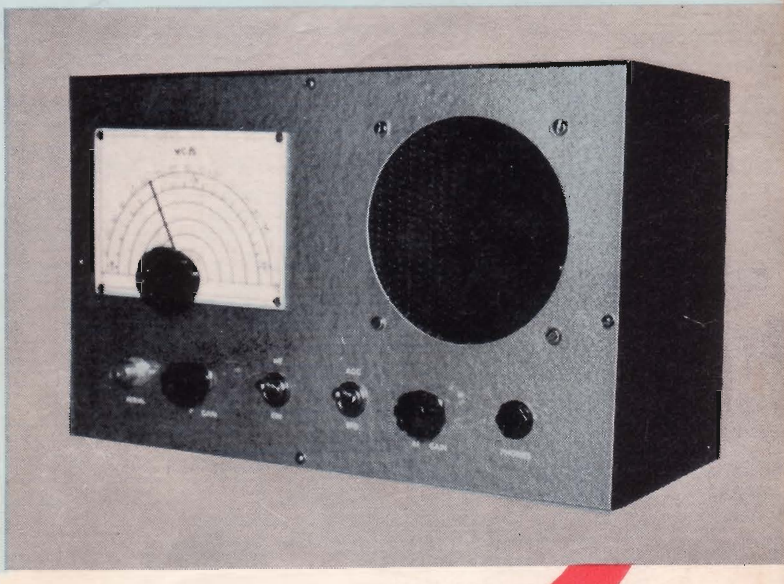
MINIATURE Top-Band Receiver



Simple Audio Generators ■ Portable Oscilloscope ■ Thermo-Electric Sensing Device ■ American VT Valve Equivalents

Cover Feature

Miniature "Top-Band" Receiver

By David Noble, B.A.Hons.(Oxon)
and David M. Pratt, Dip.Tech.(Eng.)

A conventional circuit for 160 metres which may be easily adapted for other Bands

THE RECEIVER TO BE DESCRIBED IN THIS ARTICLE was designed with several purposes in mind. It was mainly made to be lent to young short wave listeners who, having passed the Radio Amateurs' Examination, required a receiver in order to prepare themselves for the Post Office Morse Test. The receiver is, therefore, self-contained and easily transportable. To make the receiver simple to operate, the number of controls is kept to a minimum while still attaining optimum performance. By using multipurpose valves and semiconductor diodes, the number of valves is reduced, and yet the performance is equal to, say, an eight valve receiver. Despite its compactness the sensitivity and selectivity on the range covered seem quite outstanding.

Because the receiver was primarily intended for Morse practice purposes, it was designed for the 160 metre amateur band on which the special Slow Morse Transmissions arranged by the R.S.G.B. are radiated. The circuitry of the receiver, however, lends itself to use on all amateur bands up to 30 Mc/s, and by a simple modification the receiver may be made to cover these other bands. A guide as to how this may be achieved is given later in the text.

Circuit

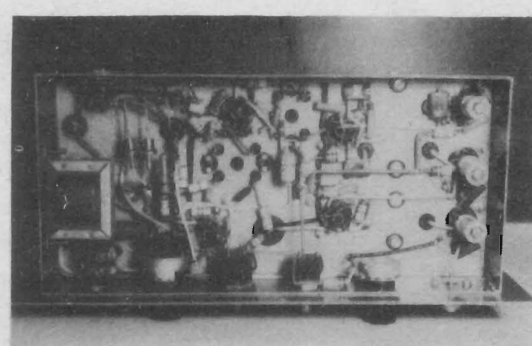
The circuit diagram is shown in Fig. 1. In this, the aerial is fed via the tuned circuit, L_1 and C_1 to C_3, to the control grid of the r.f. amplifier valve, V_1. This stage uses an EF85 and, as this is a variable-mu valve with a high slope, it provides a large amount of gain for small signals. The output from the r.f. amplifier is inductively coupled via L_2 to the control grid of the mixer stage. The triode section of the ECH81 frequency changer valve operates as the local oscillator, providing an output 465 kc/s above signal frequency which is fed to grid 3 of the heptode section. The 465 kc/s output from the mixer stage is taken from the heptode anode by means of the intermediate frequency transformer, IFT_1. The secondary of this i.f. transformer feeds the control grid of the i.f. amplifier valve, V_3. The control in the cathode of this valve is provided to enable the i.f. gain of the receiver to be varied. A limiting resistor, R_{12}, is also included in the cathode circuit, its purpose being to prevent the valve from drawing excessive anode current when the i.f. gain control is at minimum resistance. Output is fed via the i.f. transformer, IFT_2, to the signal and a.g.c. detector consisting of the OA79 germanium diode D_1. This rectifies the i.f. output from the i.f. amplifier, and feeds the audio pre-amplifier via the audio gain control, VR_2. It further provides a negative a.g.c. voltage which is applied to the control grids of the preceding stages, so reducing their gain when a strong signal is received. The i.f. is filtered from both the audio output and the a.g.c. line by the network C_{24}, C_{25}, C_{26}, R_{15} and R_{16}. Further filtering is provided on the a.g.c. line by C_{18} and C_{41}.

The volume control, VR_2, carries a double-pole switch, S_3, which is used to switch the mains supply to the receiver.

The audio stages utilise an ECL80 triode-pentode, V_5, using the triode section as a pre-amplifier and the pentode as the output stage. The output transformer is a Radiospares miniature type and matches the output valve into the internal 3Ω loudspeaker. A headphone jack is provided on the front panel for high impedance 'phones. The jack socket is arranged to switch off the internal 4in loudspeaker when the 'phones are plugged in.

C.W. Operation

A beat frequency oscillator is included to enable c.w. telegraphy reception to be achieved. This



The clean and tidy layout of the components under the chassis

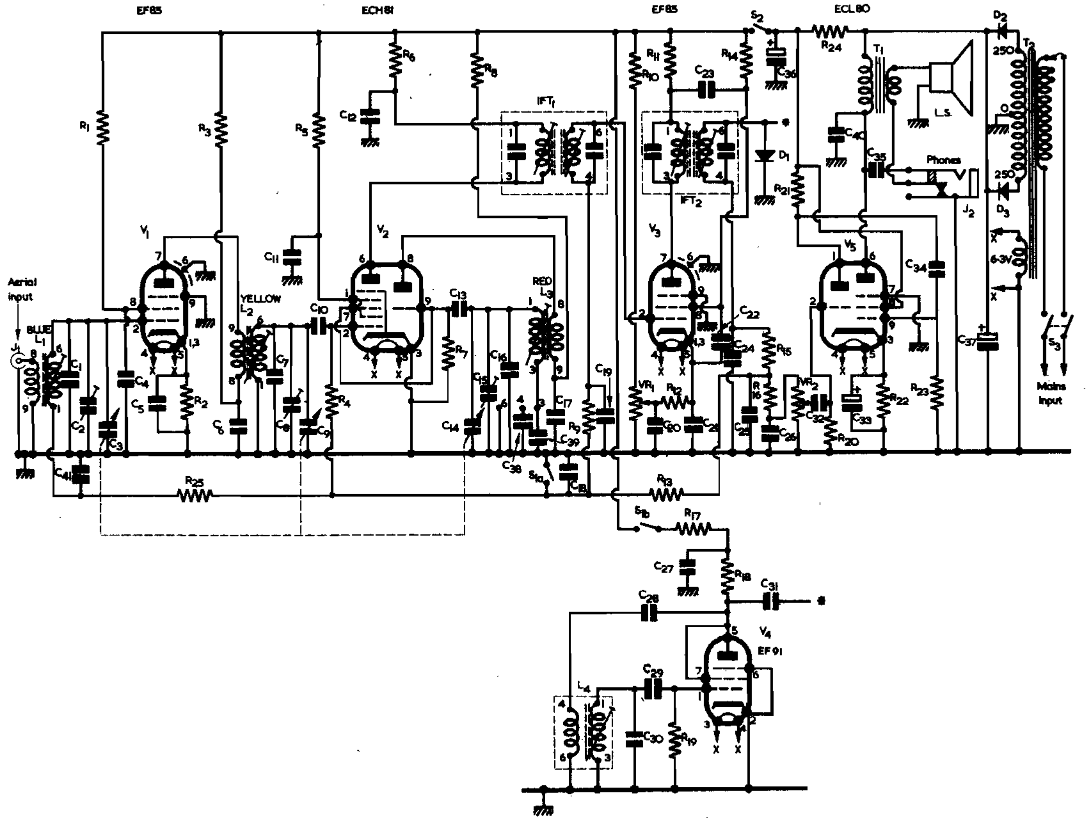


Fig. 1. The circuit diagram of the miniature Top Band receiver, C_{31} connects to the junction of IFT_2 and D_1

Components List

Resistors

(All fixed resistors ¼ watt unless otherwise specified)

R_1 56kΩ
R_2 180Ω
R_3 1.5kΩ
R_4 1MΩ
R_5 33kΩ
R_6 1kΩ
R_7 47kΩ
R_8 33kΩ
R_9 100kΩ
R_{10} 560kΩ
R_{11} 1kΩ
R_{12} 180Ω
R_{13} 1MΩ
R_{14} 68kΩ
$R_{15, 16, 17, 18, 19}$ 47kΩ
R_{20} 1.5MΩ
R_{21} 100kΩ
R_{22} 470Ω
R_{23} 100kΩ
R_{24} 1kΩ, 1 watt
R_{25} 1MΩ
VR_1 25kΩ potentiometer, linear track
VR_2 500kΩ potentiometer, log track, with d.p.s.t. switch (S_3)

Capacitors

C_1 220pF silvered mica
C_2 4–60pF concentric trimmer, Mullard type E7879
C_3 75pF variable, ganged with C_9 and C_{14} (see text)
$C_{4, 5, 6}$ 10,000pF ceramic tubular
C_7 220pF silvered mica
C_8 4–60pF, as C_2
C_9 75pF variable
C_{10} 100pF silvered mica
$C_{11, 12}$ 10,000pF ceramic tubular
C_{13} 100pF silvered mica
C_{14} 75pF variable
C_{15} 4–60pF, as C_2
C_{16} 220pF silvered mica
C_{17} 10,000pF ceramic tubular
C_{18} 0.1μF, 125V wkg., polyester
$C_{19, 20}$ 2,000pF ceramic tubular
C_{21} 10,000pF ceramic tubular
C_{22} 4,000pF ceramic tubular
C_{23} 2,000pF ceramic tubular
$C_{24, 25}$ 500pF ceramic tubular
C_{26} 100pF ceramic tubular
C_{27} 10,000pF ceramic tubular
$C_{28, 29}$ 100pF silvered mica

C_{30} 150pF silvered mica
C_{31} 4.7pF ceramic tubular
C_{32} 10,000pF ceramic tubular
C_{33} 25μF, 25V wkg., electrolytic
$C_{34, 35}$ 10,000pF, ceramic tubular
$C_{36, 37}$ 16+32μF, 350V wkg., single can electrolytic
C_{38} 3,000pF silvered mica, $\pm 2\frac{1}{2}\%$ (see text)
C_{39} 1,100pF silvered mica, $\pm 2\frac{1}{2}\%$
C_{40} 1,000pF ceramic tubular
C_{41} 0.1μF, 125V wkg., polyester

Inductors
L_1 Denco miniature dual purpose coil, Blue, Range 3
L_2 Denco miniature dual purpose coil, Yellow, Range 3
L_3 Denco miniature dual purpose coil, Red, Range 3
L_4 Denco B.F.O. coil type BFO 2/465
$IFT_{1, 2}$ Denco I.F. Transformers type IFT.11/465 (or Radiospares "Standard" I.F's)
T_1 Output Transformer, Radiospares type "Midget"
T_2 Mains Transformer, 250–0–250V, 60mA; 6.3V, 2A, Radio Supply Co. Ltd., 5 County Arcade, Leeds 1

Valves, Diodes
V_1 Mullard EF85
V_2 Mullard ECH81
V_3 Mullard EF85
V_4 Mullard EF91
V_5 Mullard ECL80
D_1 Mullard OA79
$D_{2, 3}$ Mullard BY100

Sockets, etc.
J_1 Coaxial socket type L604/S/Cd (Belling-Lee)
J_2 Jack socket type P.72 (Igranic)
7 B9A valveholders, with centre spigot
1 B7G valveholder, with centre spigot, skirt and screening can
Mains input plug and socket type P360 (Bulgin)

Switches
S_1 d.p.s.t. toggle switch. Type 8370/K7 (N.S.F.) or equivalent
S_2 s.p.s.t. toggle switch. Type 8280/K16 (N.S.F. or equivalent
S_3 d.p.s.t. switch. (On VR_2)

Metalwork
Main chassis type "K", 16 s.w.g., $10\frac{1}{4}$ x 5 x$1\frac{3}{8}$in
B.F.O. chassis type "M", 18 s.w.g., 2 x $1\frac{5}{8}$ x $\frac{3}{4}$in. F=$\frac{1}{4}$in
Case type "W", 18 s.w.g., $11\frac{1}{2}$ x $5\frac{1}{4}$ x 7in, with 16 s.w.g. panel

Loudspeaker
4in loudspeaker, 3Ω impedance

Miscellaneous
1 Epicyclic slow motion drive. Cat No. 4511 (Jackson Bros.)
2 Tagstrips type T19 (Bulgin)
2 Tagstrips type T20 (Bulgin)
Speaker grille
Knobs, grommets, screws, etc.

employs an EF91, V_4, in a simple anode feedback circuit oscillating at 465 kc/s. The output is loosely coupled by C_{31} to the second i.f. transformer, and the h.t. to the stage is switched on by means of $S_{1(b)}$. S_1 is a double-pole toggle switch, and $S_{1(a)}$ short-circuits the a.g.c. line to chassis when the b.f.o. is switched on. This is necessary to prevent the output from the b.f.o. from generating an a.g.c. voltage, and so limiting the reception of weak c.w. signals.

A miniature 250–0–250V., 60mA transformer is used for the power supply. Two silicon h.t. rectifiers are employed in order to save space and heater current. A smoothing choke is obviated by taking the h.t. for the output stage anode circuit from the reservoir capacitor, and using a wirewound resistor to provide the smoothing for the rest of the circuit.[1] Switch S_2 mutes the receiver by breaking the h.t. supply for V_1, to V_4 where it is opened.

[1] It will be noted in Fig. 1 that a common cathode resistor, R_{22}, provides bias for both the triode and pentode sections of V_1. Although this arrangement might appear to offer excessive bias for the triode it functions satisfactorily in practice at the h.t. voltage of 250 employed in the receiver. The relatively low value of 100kΩ for R_{23} is intentional; higher values may result in instability. Care should be taken to ensure that the correct mains tapping into T_2 primary is employed. If, for instance, a 250 volt mains supply is applied to the 200–210 volt tapping, the maximum p.i.v. for D_2 and D_3 might be exceeded.—EDITOR.

Components

Wherever possible, standard components are used throughout. The coils, L_1, L_2 and L_3 are Denco dual purpose coils. These coils are colour coded according to their purpose, and plug into B9A valveholders. A blue coil is used for the r.f. amplifier, while the heptode of the frequency changer uses a yellow coil, and the local oscillator a red one.

Denco miniature i.f. transformers may be used for IFT_1 and IFT_2, and the chassis drawing, Fig. 3 shows drilling details for these. In the prototype, however, Radiospares "Standard i.f. Transformers" were used, but these are slightly larger and require different drilling arrangements.

The b.f.o. coil is also manufactured by Denco, and the circuit employed for the b.f.o. is that recommended by the makers.

The tuning capacitor, C_3, C_9, C_{14}, is taken from the ex-Government RF27 unit and is chosen for its low-loss insulation and robustness of construction. In order to fit the capacitor on the chassis, the spindles will require shortening slightly. A small bush type coupler is recommended in place of the original flexible type. So as to avoid the consequences of mechanical misalignment, rubber grommets are used to provide a resilient mounting. An epicyclic slow motion drive is used, with a suitable pointer made from brass wire.

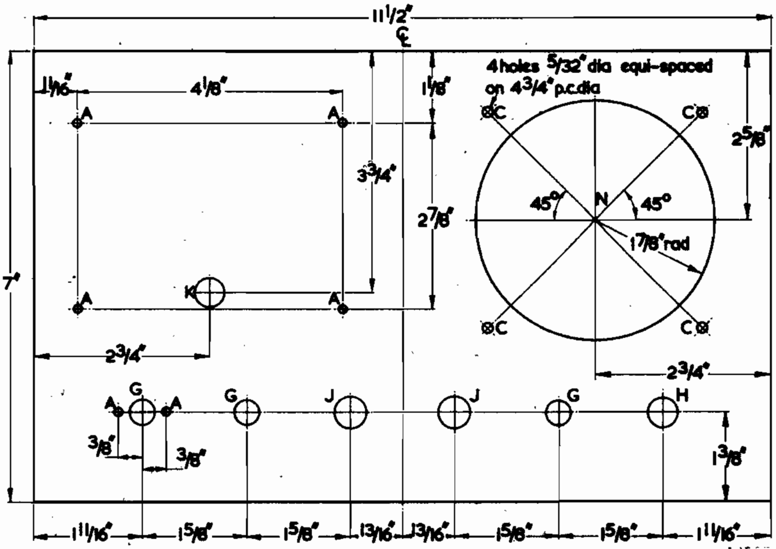


Fig. 2. Drilling dimensions for the front panel. Hole diameters are indicated in the Table. The material is 16 s.w.g. aluminium. The mounting holes for the speaker may vary in position from those indicated here

Use on Other Bands

The Denco Range 3 plug-in coils used in the r.f. circuitry are designed to tune from 1.67 to 5.3 Mc/s with a 300pF tuning capacitor. In order to achieve adequate bandspread a tuning capacitor of only about 65pF swing is used in the receiver, and fixed capacitors, C_1, C_7, C_{16}, are provided in parallel to bring the coverage to the 1.8–2.0 Mc/s amateur band. By the choice of a suitable value for the parallel capacitors, the receiver may also be made to tune the 3.5–3.8 Mc/s (80 metre) band. Similarly, Range 4 coils may be used for the 7 and 14 Mc/s bands, while Range 5 coils will cover the 14, 21 and 28 Mc/s bands.

For the constructor wishing to make this receiver for several amateur bands, it is recommended that the parallel capacitors, C_1, C_7 and C_{16}, be connected across the appropriate solder tags on the coils themselves, a complete set of coils being used for each amateur band. With this form of construction the use of band-switching, which may prove complicated and inefficient, is not necessary.[2]

Chassis Construction

The receiver is built on a conventional 16 s.w.g.

[2] C_{39}, connecting to pin 3 of L_3 in Fig. 1, is the oscillator padding capacitor for Range 3. C_{38}, connecting to pin 4, is the padding capacitor for Range 4, and may be deleted if this range is not required. No padding capacitor is required for Range 5, the lower end of the tuned winding connecting direct to chassis via pin 6. If coils for other bands are fitted, it will be necessary to retrim C_2, C_8 and, perhaps, C_{15}.—EDITOR.

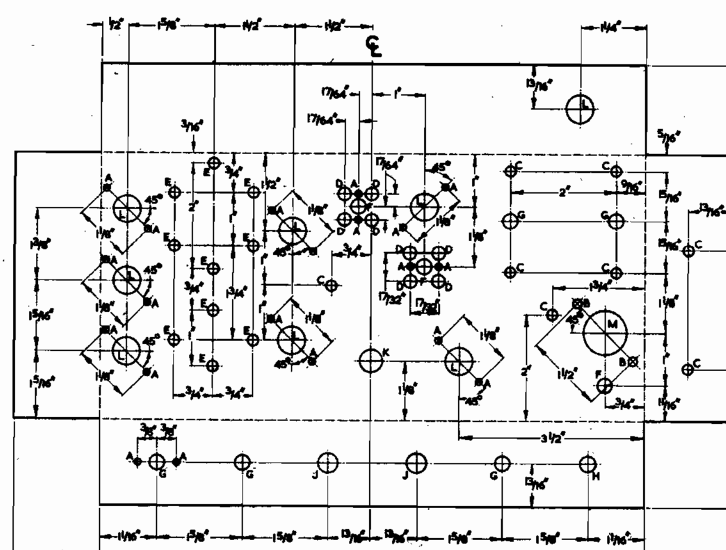


Fig. 3. Chassis drilling details. The material is 16 s.w.g. aluminium, and the sides are bent down along the dotted lines. The holes for C_{36}, C_{37} may vary in position and diameter for different versions of this component

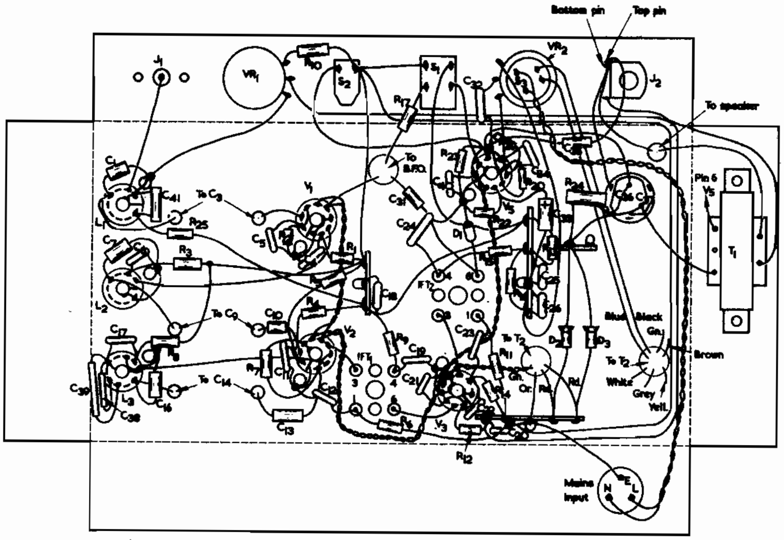


Fig. 4. How the receiver is wired up. The concentric trimmers C_2, C_8 and C_{15} are connected across pins 1 and 6 of L_1, L_2 and L_3, and they are omitted here to show the wiring underneath. The heater wiring is earthed at pin 4 of V_3

aluminium, 4-sided chassis measuring $10\frac{1}{4}$ x 5 x $1\frac{5}{8}$in. It is housed in a cabinet $11\frac{1}{2}$ x 7 x $5\frac{1}{4}$in with a front panel $11\frac{1}{2}$ x 7in. The metalwork may be obtained ready drilled from H. L. Smith and Co. Ltd. For readers who prefer to drill their own metalwork, the material can also be supplied blank.

Drilling details of the front panel and main chassis are given in Fig. 2 and Fig. 3 respectively, and the Table gives the various hole sizes. To give a neat appearance, the metalwork for the prototype was silver-hammer sprayed at a local cycle shop.

Assembly

The components are assembled as shown in Fig. 4. The space between pins 1 and 9 on the valveholders is indicated, and the recommended orientation of the valveholders should be followed in order to keep the various leads as short as possible. It will be found necessary to leave fitting the output transformer to the chassis until after the wiring associated with the smoothing capacitor has been completed.

In order to support several components four Bulgin tagstrips are used in the assembly of the receiver. Two of these are modified by removing one tag with a pair of wire cutters.

Wiring up of the receiver should not cause difficulty provided normal constructional techniques are used and leads are kept as short as possible. Work should be commenced with the heater wiring and power supply. It is then suggested that the rest of the wiring be carried out in order, commencing with the r.f. amplifier and ending with the a.f. amplifier.

Beat Frequency Oscillator

The b.f.o. is built on a small sub-chassis which is centrally positioned towards the front of the main receiver chassis. The fixing holes for the b.f.o. are not shown on the main chassis drawing as these are best drilled after assembly of the b.f.o. chassis. The sub-chassis is made from 18 s.w.g. aluminium, and the dimensions and drilling information are

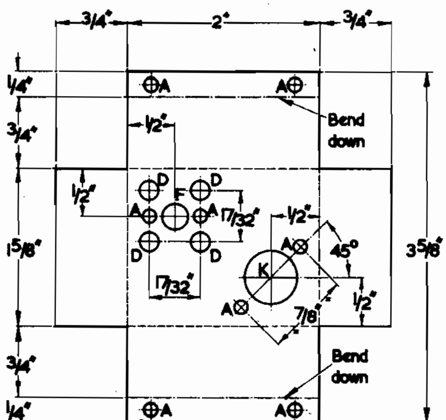


Fig. 5. Details of the b.f.o. chassis. The sides are bent up along the dotted lines (see Fig. 6). The material is 18 s.w.g. aluminium

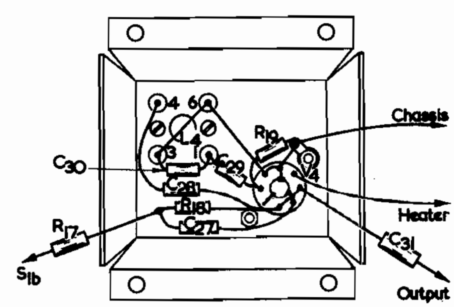


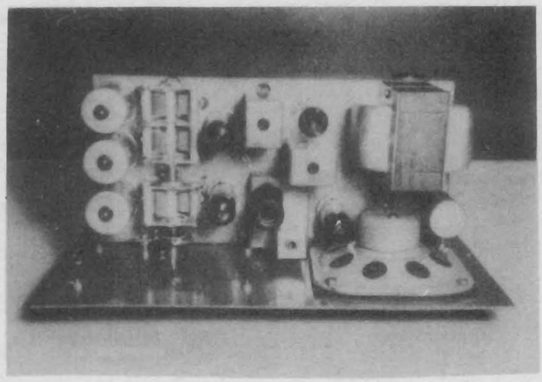
Fig. 6. Wiring diagram for the b.f.o. unit. C_{31} and R_{17} finally take up the positions indicated in Fig. 4

TABLE

Key to Holes on Chassis Drawings

A	$\frac{1}{8}$in dia. (6BA clearance)
B	$\frac{9}{64}$in dia. (5BA clearance)
C	$\frac{5}{32}$in dia. (4BA clearance)
D	$\frac{3}{16}$in dia.
E	$\frac{1}{4}$in dia.
F	$\frac{5}{16}$in dia.
G	$\frac{3}{8}$in dia.
H	$\frac{7}{16}$in dia.
J	$\frac{15}{32}$in dia
K	$\frac{5}{8}$in dia.
L	$\frac{3}{4}$in dia.
M	$1\frac{1}{8}$in dia.
N	$3\frac{3}{4}$in dia.

given in Fig. 5. Fig 6 shows the assembly of the unit using the recommended Denco b.f.o. coil. The four leads to the b.f.o. feed through a $\frac{5}{8}$in diameter rubber grommet in the main chassis.



Looking down at the top of the chassis. The b.f.o. sub-chassis may be seen immediately behind the front panel

Alignment

As with any superheterodyne receiver, optimum performance can only be obtained if a signal generator covering the i.f. and r.f. ranges is available for the alignment. The writers are not suggesting that it would be impossible to get the receiver working without a signal generator, but in order to obtain full benefit from a receiver of this kind, the use of an accurate signal generator is essential.

For those not familiar with superheterodyne alignment a suggested procedure is given for guidance, the i.f. circuits being lined up first.

A power output meter or a.c. ammeter is connected across the secondary of the output transformer, T_1. The i.f. and a.f. gain controls, VR_1 and VR_2 are set at maximum and the switch S_1, to the b.f.o. position. The b.f.o. valve, V_4, is removed from its holder.

A modulated signal on 465 kc/s is then injected at pin 2 of the frequency changer valve, V_2, and its output increased until a signal is obtained on the output meter. Working back through the receiver, beginning with the secondary of IFT_2 and ending with the primary of IFT_1, the cores of the i.f. transformers are then adjusted for maximum. The output from the signal generator is reduced as necessary, keeping the output level as low as practicable. As the tuning of one coil may affect the tuning of another, the procedure is then repeated. The b.f.o. valve, V_4, is then placed in its holder and allowed to warm up. L_4 is then adjusted to give a comfortable beat note with the signal generator.

The r.f. circuits are next aligned. With the controls as they were for i.f. alignment. With the b.f.o. valve removed, the signal generator is now fed into the aerial socket, J_1. With the tuning capacitor set at 10° (vanes almost fully in mesh), and the signal generator set at 1.8 Mc/s, the core of L_3 is adjusted until the signal is heard. Now, with the vanes almost fully open at 170°, and the signal generator set at 2.0 Mc/s, the trimming capacitor, C_{15}, is adjusted until the signal is heard. This procedure is repeated until no further adjustment of either the core or the trimmer is required.

The core of L_2 is adjusted for maximum output

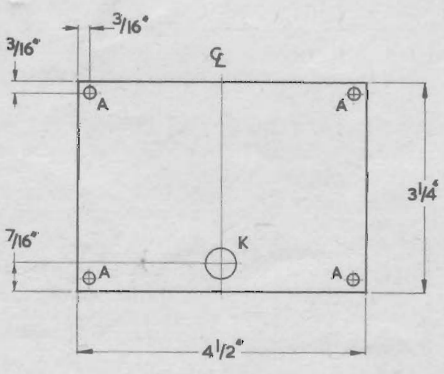
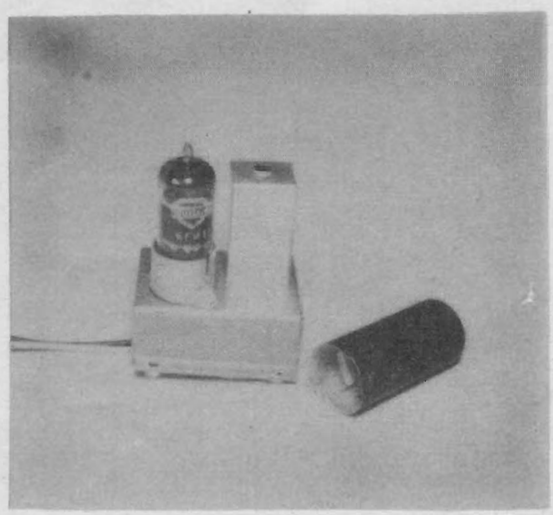


Fig. 7. The transparent dial cover. The material is $\frac{1}{16}$ in Perspex



The appearance of the b.f.o. chassis

of the 1.8 Mc/s signal at 10°, and the trimmer, C_8, is adjusted to peak the 2 Mc/s signal at 170°. These should be adjusted alternately until no improvement can be obtained.

Similarly, the core of L_1 and the trimmer, C_2, are adjusted for optimum output of the 1.8 and 2 Mc/s signals respectively.

While carrying out the alignment of the various circuits, the output from the signal generator should be kept as low as possible so as to prevent any stage from being overloaded.

The alignment is now completed and the b.f.o. valve may be replaced in its holder.

Conclusion

When receiving c.w. signals, the audio gain control should be set at maximum and the volume adjusted with the i.f. gain control. On telephony, however, the reverse applies, the volume being adjusted with the a.f. gain control.

With only a very short aerial connected to the input socket, stations in the 1.8–2.0 Mc/s amateur band will be heard very strongly. The performance of this receiver will be found to be superior to that of many commercial communications receivers. The receiver will be found ideal for the short wave listener wishing to build his own equipment, or for the licensed amateur who wishes to confine his activity to one band.

THE NEW DUAL-STANDARD TV SETS

By Gordon J. King, Assoc. Brit. I.R.E., M.T.S., M.I.P.R.E. **PART 3**

This third article in our series on 405–625 line receivers deals with the tuner circuits and techniques employed for dual standard reception

LAST MONTH WE INVESTIGATED THE VISION I.F. channel response requirements for the 405 and 625 signals. It was shown that a passband of 8 Mc/s is required in the i.f. channel on the 625 standard owing to the fact that both the sound and vision signals are carried through it. On the 405 standard the passband is little more than 3 Mc/s, since rejectors are employed in the vision i.f. channel to put a deep trough into the response at the sound frequency.

It was intimated that dual standard receivers are designed essentially to give the correct 625 response characteristics and that the 405 response characteristics are provided by the switching in of suitably tuned rejector circuits. In that way, the response is narrowed and shaped so that it matches that of 405-line-only models.

Before we go on to look at the tuner units and the i.f. channels, it is worth noting that in some dual standard models, particularly those which were designed specifically to be later converted to "switchable" models, two i.f. strips are featured. One is the normal 405-line-only strip with its associated sound channel and the other (which was sometimes fitted afterwards, whne conversion was required) a suitably tailored 625-line-only strip complete with intercarrier sound section and (sometimes) its own detector and video amplifier. The "conversion unit" may also contain a flywheel controlled line oscillator section for 625 line use, as the higher velocity of the scanning spot coupled with the negative vision modulation of the 625 standard can influence the line synchronising if direct sync is used. We shall have more to say about that later.

V.H.F. Tuner

For the time being let us look at the tuner units themselves. In Fig. 10 is shown the circuit of a v.h.f. tuner used in some dual standard models. This is very similar to the v.h.f. tuner of 405-line-only models. We have a double-triode cascode r.f. amplifier at V_1 and a triode-pentode frequency changer at V_2, with the pentode as the mixer and the triode as the local oscillator.

The tuner shown has thirteen v.h.f. channel positions *plus* a "u.h.f." position.

The aerial signal is applied, via the isolating capacitor C_1, the static discharge resistors R_1 and R_2 and various i.f. and image rejectors, to the grid of the first triode section, the tuned circuit being selected by S_1 and S_2. The anode of the first triode is "loaded" by the cathode of the second triode in the conventional cascode manner. Bandpass coupling tuned circuits, selected by switches S_3 S_4 and S_5 S_6, feed the signal from the cascode anode to the mixer control grid.

The oscillator coil for the required channel is selected by switches S_7 S_8, with fine tuning provided by the variable element of C_{318}.

U.H.F. Tuner

In Fig. 11 is given the circuit of the u.h.f. tuner. This employs two triode valves, V_{16} and V_{17}, with the former serving as the r.f. amplifier, in the earthed-grid mode, and the latter as a self-oscillating mixer, also in the earthed-grid mode.

Owing to the nature of the signals ordinary coils cannot be used for tuning and in place are used resonant lines, called trough lines or lecher wires.