DIRECT CONVERSION RECEIVER

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MOST licensed amateurs began their specialised amateur activities by listening to some of the amateur bands. These bands are frequencies in the short wave range used by amateurs licensed to operate transmitting equipment. Once it was easy for anyone to listen to amateur transmissions, because general purpose all-wave and short wave receivers cover some of the amateur bands.

Due to the very greatly increased use of single sideband (SSB) transmission by amateurs, this is no longer so, since the carrier has been removed and as a result, their transmissions cannot be resolved by general purpose all-wave or short wave receivers. In addition, such receivers cannot be used for CW (Morse). This is a severe limitation to the interested listener who may wish to take advantage of the RSGB Slow Morse transmissions which are available in some areas, or who wish to gain speed in Morse reception.

Such limitations do not apply to a communications type receiver as this will be equipped to deal with AM, SSB and CW signals. On the other hand, such receivers require quite complicated circuits. An answer to the problem of receiving amateur SSB and

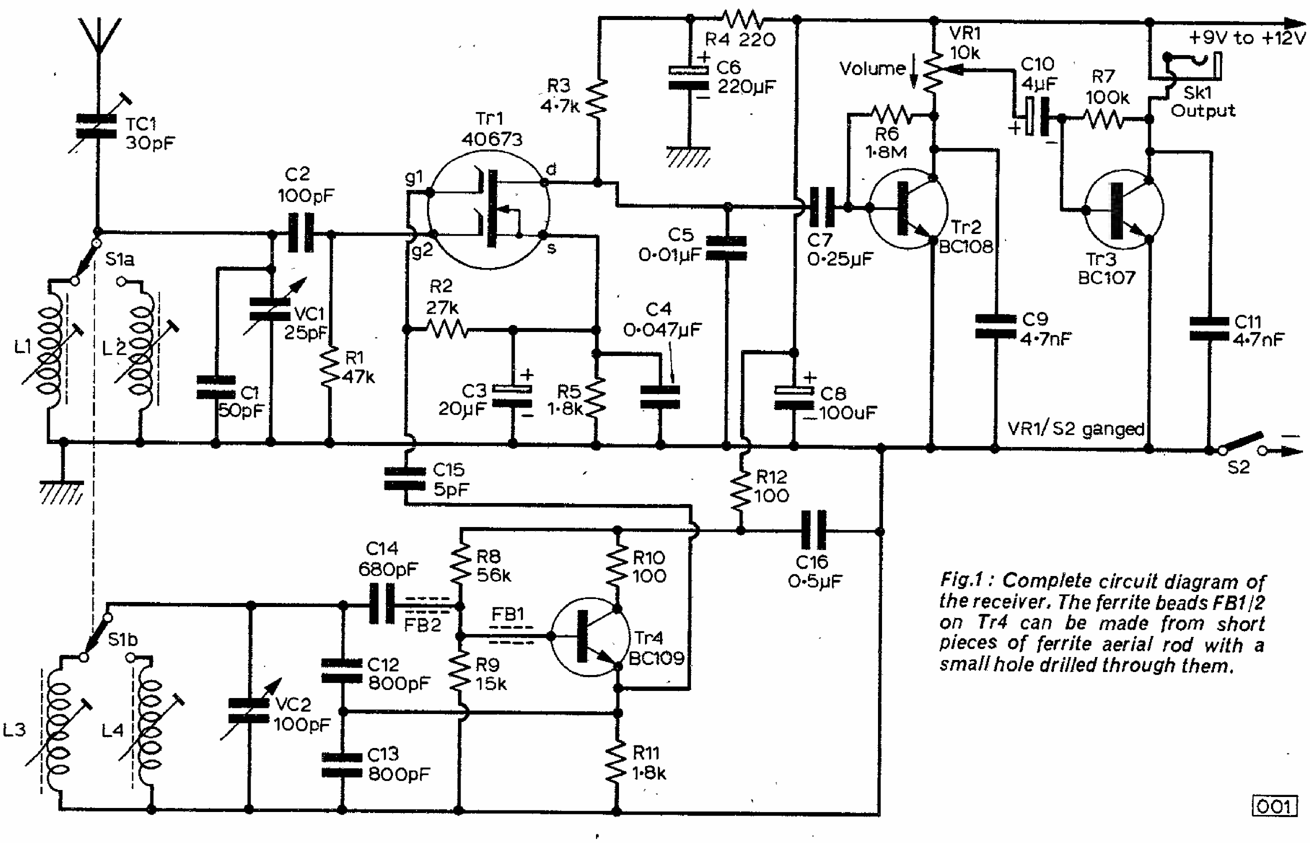
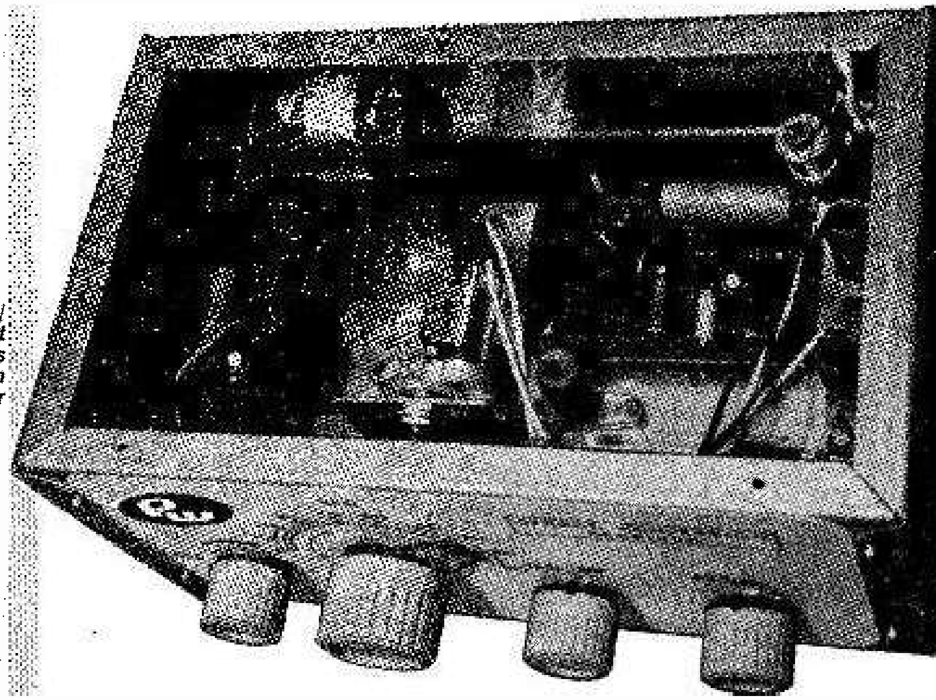


Fig.1: Complete circuit diagram of the receiver. The ferrite beads FB1/2 on Tr4 can be made from short pieces of ferrite aerial rod with a small hole drilled through them.



Inside the receiver with the oscillator/mixer board to the right with input coils at extreme right. Oscillator coils L3/4 are positioned near the main tuning capacitor. The audio amplifier board is on the left.

CW signals can be found in the direct conversion receiver. This omits the frequency changer, intermediate frequency amplifier, product detector and carrier or heterodyne oscillator of the communications superhet. Instead, conversion of the incoming signal to an audio signal takes place directly.

★ components list

Resistors

R1	47kΩ	R5	1·8kΩ	R9	15kΩ
R2	27kΩ	R6	1·8MΩ	R10	100Ω
R3	4·7kΩ	R7	100kΩ	R11	1·8kΩ
R4	220Ω	R8	56kΩ	R12	100Ω

All 5% ⅓ or ¼W
VR1 10kΩ log-pot with switch S2

Capacitors

C1	50pF SM	C9	4·7nF
C2	100pF SM	C10	4μF 6V
C3	20μF 6V	C11	4·7nF
C4	0·047μF	C12	800pF SM 5%
C5	0·01μF	C13	800 pF SM 5%
C6	220 μF 12V	C14	680pF SM
C7	0·25μF	C15	5pF SM
C8	100μF 12V	C16	0·5μF
TC1	30pF pre-set	VC1	25pF variable (Jackson C804)

VC2 100pF variable (Jackson C804)

Semiconductors

Tr1	40673	Tr3	BC107
Tr2	BC108	Tr4	BC109

Miscellaneous

Coilformers 10mm (7/16in.) diameter, with cores (4). Ferrite beads FX115 (2). Ball slow motion drive (Jackson 4511/DRF). Knobs (4). S1 2-pole 2-way wafer switch. Jack socket, insulated. Case, flanged members 203 x 101mm (8 x 4in.) (2), 127 x 101mm (5 x 4in.) (2), 203 x 76 (8 x 3in.) (1), flat plates 203 x 127 (8 x 5in.) (2) (Home Radio). Aerial and earth sockets. Rubber feet

BANDS USED

Of the amateur bands available, the 80 metre band (3·5 to 3·8MHz), will probably be of most interest for general reception of amateur signals, likely to be available at any time, while at weekends and evenings there is usually a great deal of activity. So the receiver is primarily intended for this band. However, Top Band, 160m (1·8 to 2MHz) coverage is also included, as this band carries Slow Morse, local and other transmissions.

Both these bands are influenced by seasonal, daily and other propagation changes, but it is unusual for 80m, in particular, to lack all amateur signals as this band is much used for regular Nets and other contacts.

RECEIVER CIRCUITS

In the circuit in Fig. 1. L1 tunes 160m and L2 tunes 80m, VC1 with C1 in parallel providing suitable coverage. VC1 is panel operated and is peaked for best reception. Aerial coupling is via TC1, which can be set to suit long or short aerials. Pole S1a of the switch selects either L1 or L2 as required. Tr1 is the converter stage signal passing to gate 1 of the 40673 which is internally diode protected, and thus much less liable to damage than an unprotected insulated gate transistor. For the reception of CW, Tr4 acts as a heterodyne oscillator, with injection to gate 2 of Tr1 via C15. When receiving CW, the pitch of the audio tone depends on the difference in frequency between the received signal and osillator Tr4.

During SSB reception, Tr4 performs as the conversion oscillator, resulting in an audio signal appearing at the drain of Tr1. This audio is resolved into intelligible speech when Tr4 is so tuned that it is able to replace the carrier suppressed during transmission. If Tr4 is tuned to the wrong side of the SSB signal, the speech is inverted and unintelligible.

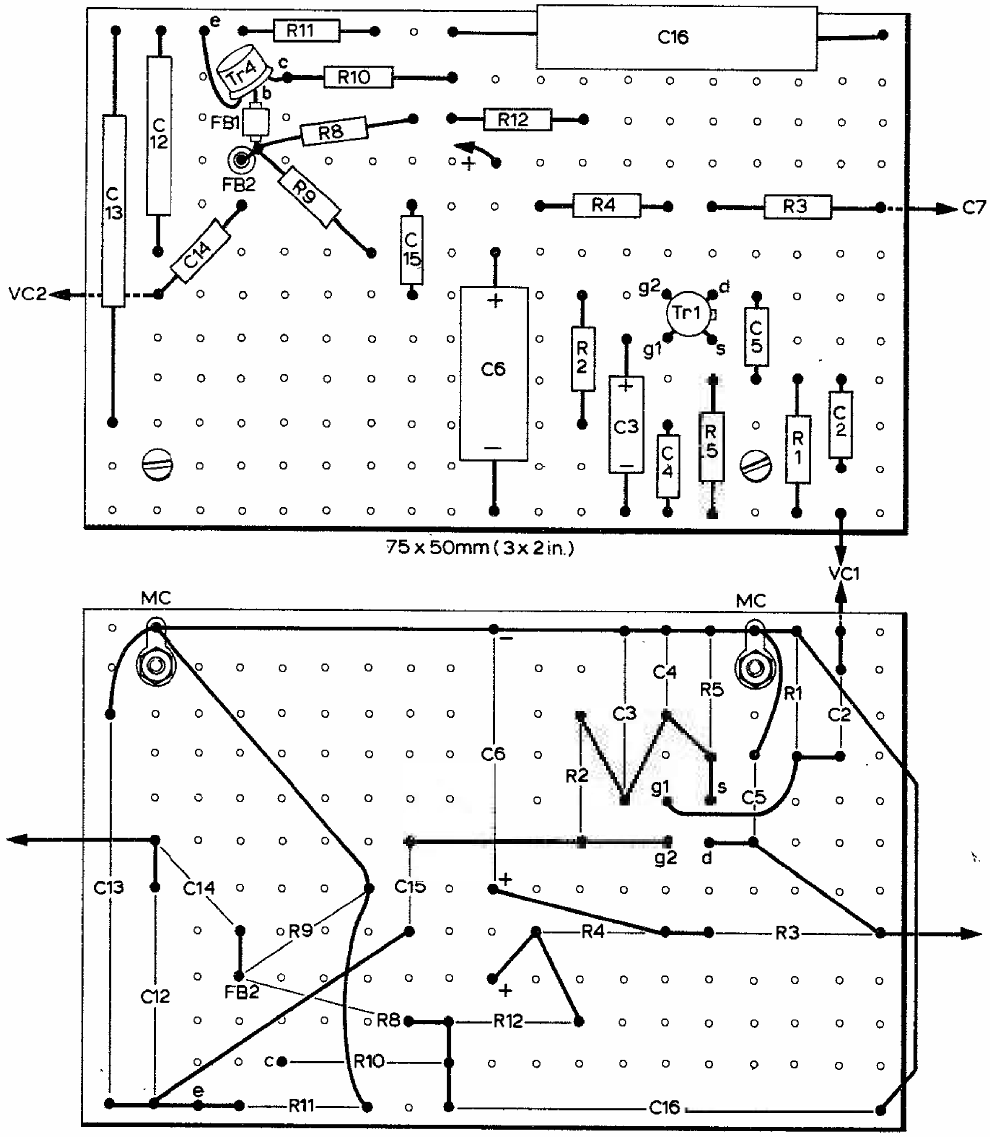
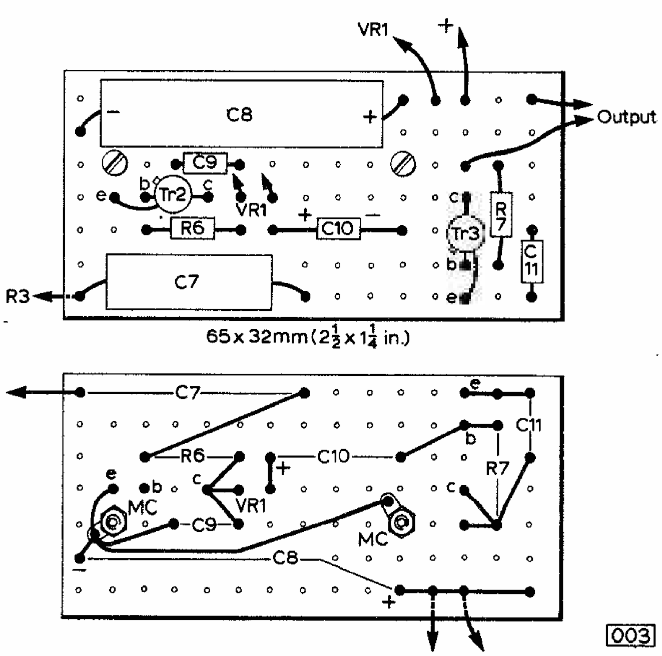


Fig.2: above, gives details of the construction of the oscillator/mixer board. Fig.3, below, shows the audio amplifier board. Both boards are 0·15in. matrix.



The second section of the switch, S1b, selects L3 for 160m, and L4 for 80m with VC2 giving approximately correct coverage. C12 and C13 are 1% or 2% silver mica capacitors and no adjustment is required, except to the coil cores, to bring the oscillator into the band.

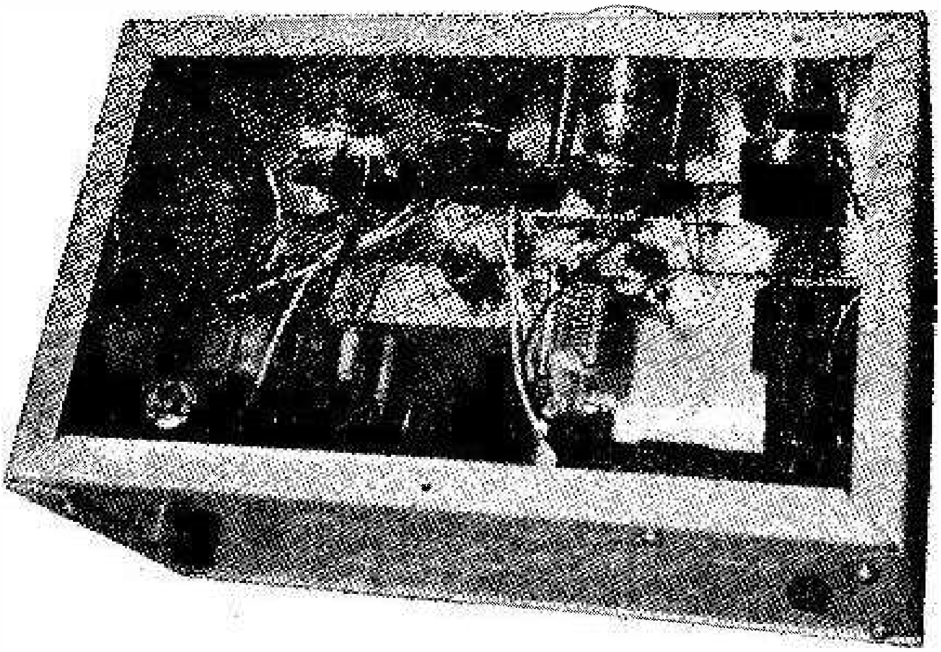
Ferrite beads FB1 and FB2 are to avoid VHF parasitics, although this oscillator circuit was found to be very stable and reliable.

Audio signals from Tr1 are taken to a simple two-stage audio amplifier Tr2/3. Capacitors C3 and C4 by-pass the source of Tr1 at audio frequencies. VR1 is the audio volume control the output from the final audio amplifier Tr3 going to a jack socket.

INDUCTORS

The coils are all wound on 10mm ($\frac{7}{16}$in.) diameter formers with adjustable cores. L1, L2 and L3 are wound with 32SWG enamelled wire, L4 is wound with 24SWG enamelled wire.

L1 has 70 turns, wound in a compact pile. L2 has 40 turns, L3 has 32 turns and L4 has 20 turns, all close wound.



View from the rear of the completed receiver. If the potentiometer VR1 has a metal spindle it is important to check that it is isolated from the track, see Fig.1. If not, insulating panel bushes must be used. Leads between the coils and their respective tuning capacitors should be rigid and as short as possible.

Each winding is begun as near to the top of the coil former as possible. The wire can be secured with a little quick-setting adhesive, or with a turn or two of cotton or thread to which a little adhesive has been applied. After winding, the end of the coil is secured in the same way. A few touches of an adhesive, such as Bostick 1, can be applied to keep turns in place, but the whole windings should not be painted, varnished or waxed.

The bottom end of each winding is soldered to a tag. This will be held by one of the fixing bolts in contact with the metal chassis. The top end of each winding is cut to a suitable length to reach S1.

The cores of L3 and L4, in particular, should be fixed against further movement after adjusting them, by wax or thin elastic placed between core and former.

OSCILLATOR MIXER BOARD

The board is approximately 75 x 50mm (3 x 2in) and components are positioned as in Fig. 2. Begin by drilling holes for two 6BA bolts, which secure the tags MC. Later, additional nuts on these bolts will allow the board to be secured to the metal chassis, with a little clearance for underside wiring.

In most places the wire ends of components will be long enough to reach the various connecting points. Elsewhere, 22SWG tinned copper or other connecting wire can be used, with insulated sleeving where necessary.

No special care is necessary when fitting Tr1, except to avoid lengthy heating of the leads, as with any transistor. Other dual-gate FET's may be used in this circuit, but if they are not gate-protected it is

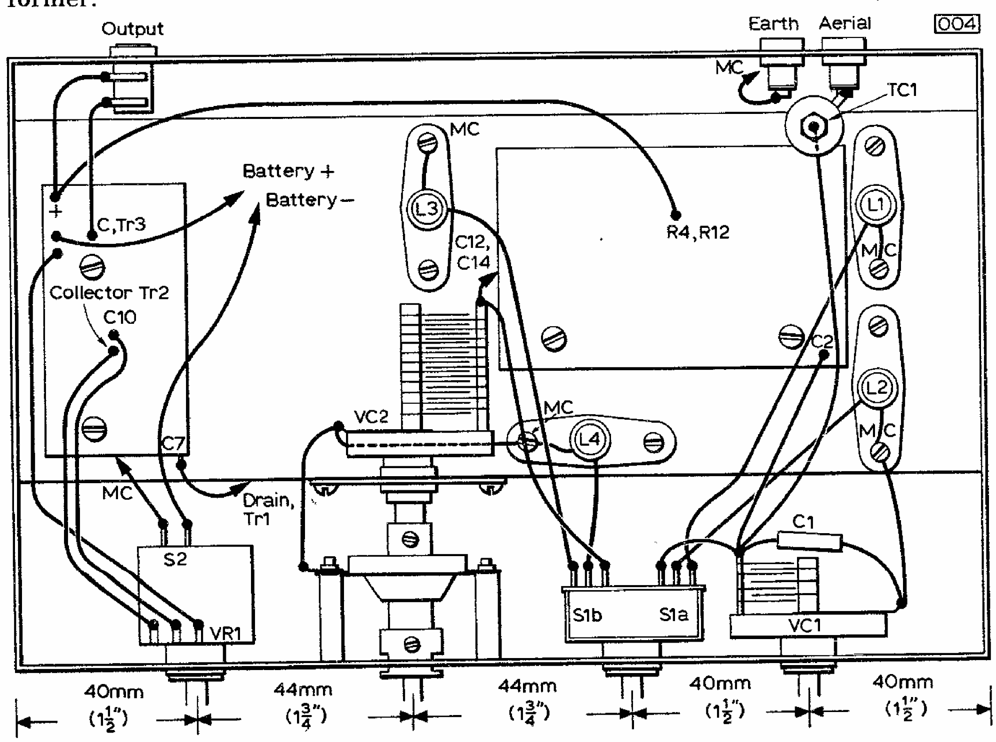


Fig.4: Layout of components on sub-chassis and panel. The aerial and earth sockets are shown displaced for clarity but their actual positions are not important. Both circuit boards are raised off the sub-chassis to avoid short-circuits.

absolutely essential that the shorting wire supplied round the leads is **not removed** until R1, R2 and R5 are connected, at least.

When fitting Tr4, take the collector lead to R10 and the emitter lead to R11, as in Fig. 2. A piece of insulated sleeving slightly longer than the ferrite bead is put on the base lead, and bead FB1 is added. R8 and R9 are then soldered in place, with very short leads at the base. Bead FB2 is then fitted in the same way, and the base lead is taken through the board to C14.

Some flying leads are provided, for connecting later. One runs from C2, to C1, VC1 and S1a. A short projecting wire passes from the junction of C12 and C14, for VC2 and S1b. A connection is also provided from the drain of Tr1, R3 and C5, to go through the chassis to the audio amplifier. A red lead from R4 and R12 is the positive connection. The negative circuit is completed by the bolts MC.

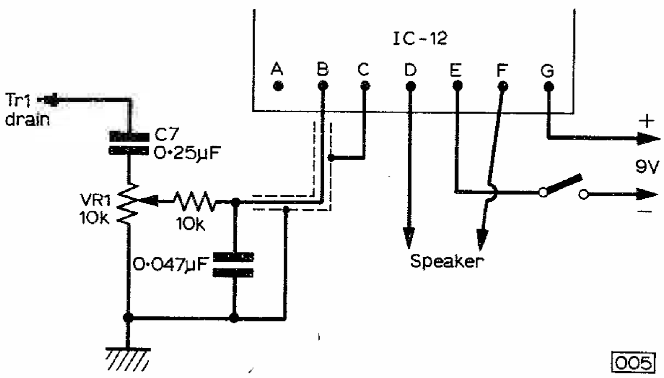


Fig.5: If a separate audio module is available stages Tr2 and Tr3 can be omitted. Connections for the Sinclair IC2 are shown here.

AUDIO AMPLIFIER

The board 65 x 32mm (2½ x 1¼in.) is assembled in a similar way, as in Fig. 3, with bolts MC again providing a connection to the metal chassis. The wire end of C7 can be taken through the board, then bent up to provide a connecting point for the lead from Tr1 drain circuit. A pin is inserted for the positive connecting point. Leads from here run to R4/R12, output jack and battery positive, the latter going through a hole in the board, with a clip soldered to the end of the flex.

Three leads run to VR1. That from C10 positive goes to the centre tag of VR1, while the outer tags go to Tr2 collector and positive line. Switch S2 is connected to the chassis and to a flexible lead with a negative battery connector.

Leads from Tr3 collector and positive run to the output jack. This must be an insulated type, giving complete isolation from the metal.

CONSTRUCTION

The flanged members form a rigid assembly and make a good case for the receiver when top and bottom are closed with flat plates. The general layout of items will be seen from Fig. 4.

The internal 205 x 75mm (8 x 3in.) member is raised about 32mm (1¼in.), and is set back about 40mm (1½in.) to clear the drive, VR1 and other panel controls. It is necessary to place the member forming the panel **inside** the flanges of the sides. Front, back and sides are secured together with the 4BA bolts provided, using the holes already punched for this purpose. Holes are drilled to take bolts to secure the internal member.

Fit VC1, S1 and VC1 about 40mm (1½in.) from the bottom of the panel. The drive for VC2 is 50mm (2in.) from the bottom edge, so that VC2 clears the chassis. A clearance hole is punched for the drive, which is fixed with spacing sleeves and long bolts. VC2 is attached to a bracket, or to a piece of scrap metal which is bolted to the front flange of the chassis. The drive and VC2 should be lined up correctly, so that tuning is smooth and easy. If needed, large or elongated holes can be provided on the bracket, to allow a little adjustment for this purpose.

If a different drive is employed, it should have a fairly high ratio, or tuning will be rather critical. The cursor is attached by two small screws.

Fix the two circuit boards in the way described, taking care that no short circuits can arise to the metal. Leads can then be taken to the two sections of the bandswitch, etc., as shown in Fig. 4. C1 is soldered directly across VC1. Insulated sockets provide for aerial and earth connections, the earth socket being connected to the metal.

ALIGNMENT

The cores can be provisionally located with each about 4 or 5 turns down from the top of the former, but this will have to be adjusted to secure band coverage.

If no other means of adjustment is available, each band can probably be located fairly readily at a time when there is plenty of amateur activity, such as on a Sunday morning. With the receiver switched to 80m, set the core of L4 so that amateur signals are heard throughout almost the whole swing of VC2. Tuning from the maximum capacitance position for VC2, CW signals should be heard for about the first one-third of rotation, and SSB signals for about the other two-thirds.

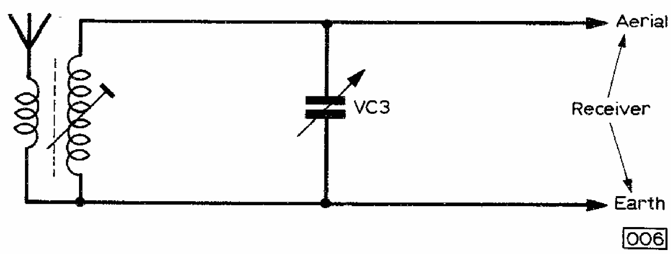


Fig.6: A bandpass input can be formed by adding the above circuit but TC1 must be reduced in value, see text.

Should it be possible to borrow a communications-type receiver, place a temporary wire from its aerial socket to near VC2 and adjust L4 so that the carrier picked up by the receiver can be tuned from about 3·5 to 3·8MHz. In the same way, adjust L3 for about 1·8-2·0MHz. Otherwise adjust L3 to bring amateur activity within the range tuned by VC2.

Subsequently, it is only necessary to adjust L1 on the 160m band, and L2 on the 80m band, so that VC1 can be peaked for best volume, throughout both bands. Here, TC1 will have some influence on tuning. With other than short aerials, TC1 should be unscrewed to quite a low value.

Should a signal generator be available, it can of course provide a means of adjusting the circuits for correct coverage.

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DIRECT CONVERSION RECEIVER—*contd from page 118*

IN USE

When receiving SSB signals, accurate tuning is absolutely necessary, since small errors will influence the quality of the signal. No resolution of speech is possible if the oscillator is on the wrong side of the signal. This will soon become apparent in use.

For CW reception, the oscillator may be either side the signal, as is found to give best reception. Tuning slightly either way will change the pitch or audio tone.

The receiver is not intended for conventional AM reception as AM signals produce a continuous heterodyne except when tuning of the oscillator agrees exactly with the carrier frequency.

The output stage is suitable for headphones of medium or high impedance type with a resistance of about 100Ω to 1·5kΩ. Battery current is about 7mA with 1·5kΩ phones and 20mA with 100Ω phones, the latter providing greater volume.

MODIFICATIONS

Other audio amplifiers could be used, omitting Tr2 and Tr3. An example is the Sinclair IC-2, which can be connected as in Fig. 5.

C7 and VR1 are already present. The additional resistor and capacitor are a high frequency filter, to help produce a frequency response more suitable for the purpose. The amplifier is operated from its own 9V battery and a 3 to 15Ω speaker can be used.

When using this or other Class B amplifiers it is essential to prevent frequency modulation of Tr4 at syllabic rate from a common battery supply. The simplest method is to use separate batteries, as mentioned. The alternative is a decoupled and regulated supply for Tr1 and Tr4. The amplifier in Fig. 1 gives excellent headphone volume with many signals, but it is not really intended for a loudspeaker.

BANDPASS INPUT

If a resonant aerial or tuning unit is not available, the coil and capacitor in Fig. 6 may be added near the receiver aerial socket.

VC3 can be 100pF or larger, if one coil is to cover both bands. The tuned winding resembling L1 or L2 in the receiver. For the aerial coupling winding, use about one-third as many turns as the tuned winding. TC1 is almost fully opened providing top-capacitance coupling between the tuned circuits. PW

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TELEVISION

IN THE JUNE ISSUE

THYRISTOR TESTER
Thyristors are now commonly used in solid-state receiver stabilised power supplies. Unfortunately they are inclined to be troublesome. Other applications are in the line output stage of many imported colour receivers and as over-voltage protection crowbar trips. So there is increasing need to be able to test them. Simple checks are not reliable: the only satisfactory method of testing involves the use of high voltages and currents. This is the basis of Alan Willcox's useful tester, which complements his recent transistor tester.

FAULT-FINDING: GEC SERIES 1 AND 2
John Law's latest fault-finding guide deals with the timebase sections of the GEC Series 1 and 2 chassis.

RANK'S REMOTE CONTROL SYSTEM
Channel changing techniques have altered a great deal in recent times. The latest approach is to use touch tuning in conjunction with a varicap tuner unit, with an integrated circuit to switch between the tuning potentiometers. This arrangement lends itself readily to remote control and Rank have exploited the possibilities to produce an ingenious low-cost cordless remote control system which is a standard feature of the latest range of Bush colour receivers. A detailed description of the system will be given.

APOLLO—*continued from page 139*

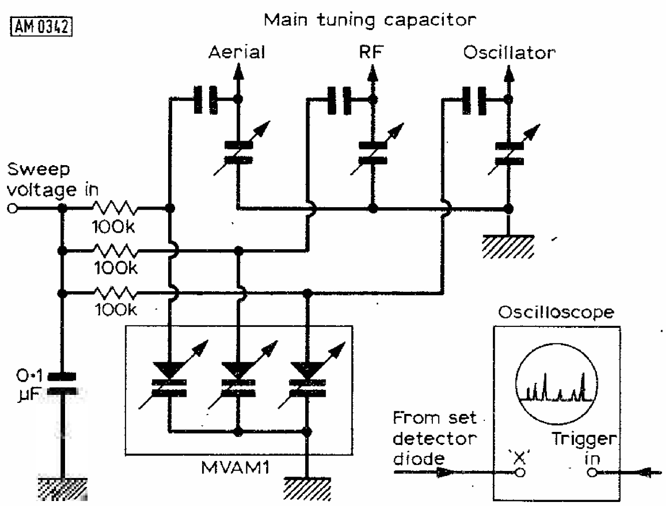

Fig. 2.7: Using this set-up one may obtain a visible display o signals present within the swept part of the band.

If in any doubt about one's proficiency to undertake such a modification to an existing set, take great care to become accustomed to using the varicaps, and the techniques necessary to avoid damaging them through over-voltage when coupling to an existing circuit.

NEXT MONTH: A VARICAP AM/FM STEREO TUNER