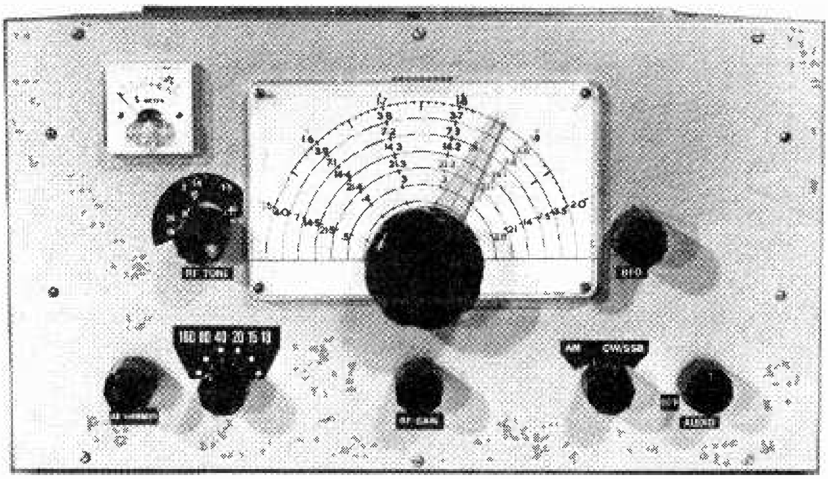
AMATEUR BANDS RECEIVER



1·8-30MHz•AM-CW-SSB•BANDSWITCHED•EASY CALIBRATION

PART 1

F. G. RAYER G3OGR

THIS receiver possesses high stability coupled with excellent sensitivity, selectivity and adequate bandspread covering the Amateur bands from 10 to 160metres. On all bands, except 80m, the receiver employs double conversion with a crystal controlled first oscillator. It is easy to tune and to hold a.m., c.w. or s.s.b. signals on all bands.

Those who may not be familiar with the method of operation of this type of receiver should find the block diagram of Fig. 1 helpful in conjunction with the description that follows.

CIRCUIT

Referring to Fig. 1 stage (1) is an r.f. amplifier followed by the first mixer (2) both working on all bands except 80m. Each Amateur band, except 80m, employs a crystal (3) chosen so that the output of the mixer (2) falls in the range 3·5 to 4MHz whatever the band in use. This tuning range 3·5 to 4MHz is covered by the tunable r.f./i.f. amplifier (4) and is followed by the second mixer and tunable oscillator (5) forming the tunable i.f. part of the receiver on all bands, except 80m. On 80m signals fall in the range 3·5 to 4MHz and are switched to stage (4).

The output frequency of the second mixer (5) is 455kHz which goes to the crystal filter (6) which is a bandpass filter with 2kHz crystal separation. When using a single filter for a.m., c.w. and s.s.b. this is about the highest degree of selectivity which can be tolerated without excessive cutting of the sidebands of a.m. signals.

Stages (7) and (8) are 455kHz i.f. amplifiers followed by the a.m. diode detector (9), its output going to the a.f. amplifier and output stages (10) and (11) and thence to the speaker. For c.w. and s.s.b. reception the beat frequency oscillator (12) and product detector (13) are switched into circuit. Both tunable oscillators (5) and (12) are fed from a voltage regulated source (14).

As the first i.f. is 3·5 to 4MHz the second channel interference, which can be troublesome on the h.f. bands with a lower i.f., is virtually eliminated. The use of a crystal controlled oscillator also gives an enormous improvement in overall stability.

The tuning coverage of each band is a constant 500kHz with fixed 100kHz calibration points which completely eliminates any calibration problems on the h.f. bands. One disadvantage is that because the 10m band is so wide only a small portion of it can be covered but this can be overcome by providing two or more 500kHz sections with very little extra circuitry, as explained later.

CONVERSION FREQUENCIES

As stated the tunable i.f. covers 3·5 to 4MHz and is calibrated at 100kHz intervals. The crystal frequency for the 160m band is 5·5MHz the difference or signal frequency selected by stages (1) and (2) thus extending from 1·5 to 2MHz (5·5-3·5 and 5·5-4). In this case the oscillator frequency is on the high side of the tunable i.f.

Band	Crystal	Calibration MHz					
80	None	3·5	3·6	3·7	3·8	3·9	4·0
160	5·5	2·0	1·9	1·8	1·7	1·6	1·5
40	11	7·5	7·4	7·3	7·2	7·1	7·0
20	10·5	14·0	14·1	14·2	14·3	14·4	14·5
15	17·5	21·0	21·1	21·2	21·3	21·4	21·5
10	24·5	28·0	28·1	28·2	28·3	28·4	28·5

For 40m an 11MHz crystal is used giving coverage of 7 to 7·5MHz the crystal again being on the high side. Crystal frequencies for the remaining bands are shown in the accompanying table and it will be noted that they are all below the signal frequency. Calibration points are shown, the direction being reversed on 160 and 40m because these crystals are above the signal frequency.

Since stages (1) and (2) cover 28 to 30MHz three 500kHz segments can be obtained by simply selecting the appropriate crystal with a three way switch, crystals on 25 and 25·5MHz adding bands 28·5 to 29MHz and 29 to 29·5MHz.

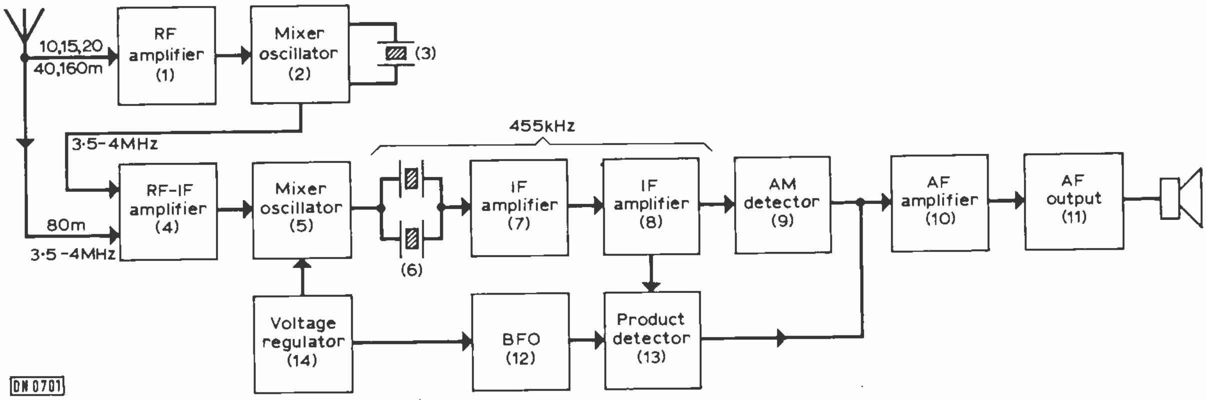


Fig. 1: Block diagram to illustrate the function of each stage in a double conversion communications receiver.

PROGRESSIVE CONSTRUCTION

The constructional work involved is naturally not simple but it can be carried out and tested in sections. This method has much to recommend it as the location of a wiring fault or error is then much easier. The audio stages together with the power supply can be wired and tested with a pick-up or audio oscillator as a signal source. Stages (4) and (5) with one i.f. stage and the a.m. detector can be added thus forming a complete 80m receiver.

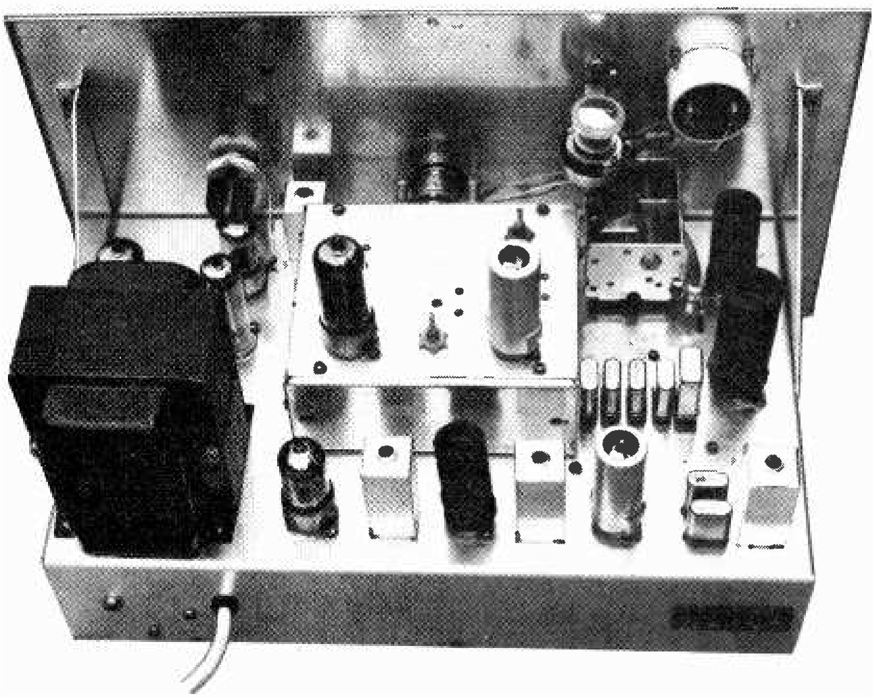
Next the additional i.f. stage and filter together with the b.f.o. and product detector will provide additional selectivity and c.w. and s.s.b. facilities. Stages (1) and (2) should then be wired for one additional band and checked after which the other bands can be added one by one. This general plan will be followed in the articles that follow.

AF/POWER SUPPLY

In Fig. 2D showing this part of the circuit VR1 is the usual audio volume control, followed by a 2-stage amplifier, the output section of the ECL86 providing about 3 watts of audio. An output jack connected to the secondary of the speaker transformer T1 permits the use of phones or an external speaker automatically silencing the phones. This facility can be useful when operating the receiver with a transmitter.

The mains transformer T2 and rectifiers D1 and D2 supply 250V for the triode anode, pentode screen grid and earlier stages of the receiver. The OA2 voltage regulator provides a stabilised 150V supply for the tunable i.f. oscillator and beat frequency oscillator.

If T2 is not as listed, the h.t. voltage may be



Rear view of the completed receiver with the tunable IF amplifier in its own screened box on top of the chassis with the five crystals for the first mixer stage to the right. The two crystals at the bottom right are part of the fixed IF amplifier.

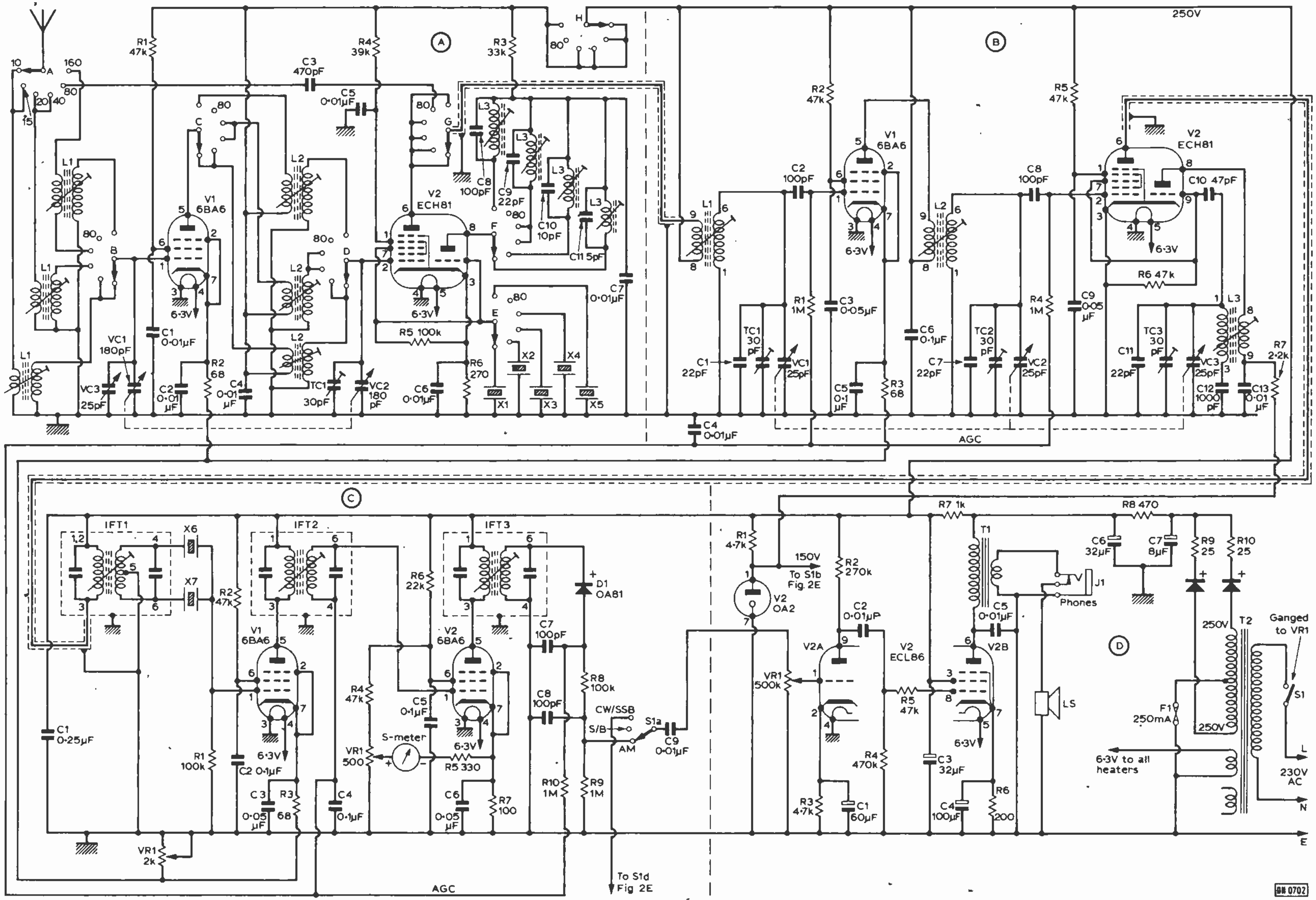


Fig. 2A-B-C-D. Complete circuit diagram of the receiver with the exception of the b.f.o./product detector shown on the next page, Fig. 2E.

different. This has little effect on most stages of the receiver, but if it is found that the OA2 is extinguished or nearly so, with the receiver on any band other than 80m and with no aerial connected and the r.f. gain control at maximum gain, then the h.t. is too low. It is then in order to reduce R7 or R8, or both, to obtain about 250V.

Leads to VR1 run against the chassis and need not be screened but R5 should be soldered directly to pin 8 of the ECL86. A 250mA fuse is placed in a holder on the inside of the chassis, and is in the h.t. circuit from T2 to earth.

The heaters require about 3A and are run from the 6·3V 4A winding of T2. If a transformer is fitted which has two 6·3V windings, rated at less than 3A, use one heater winding to supply some heaters and a separate circuit from the other heater winding to the remaining heaters.

The a.f. amplifier and power supply can be checked by connecting a pick-up, audio signal generator or other source of a.f. to the top of VR1. A 3Ω speaker is connected to or plugged into J1.

IF STAGES

Fig. 2C is the circuit of this section of the receiver which operates at 455kHz. IFT1 is an intermediate frequency transformer with a centre-tapped secondary the centre tap being earthed. Balanced output in opposite phase, from pins 4 and 6, go to the two crystals X6 and X7, which have a frequency separation of about 2kHz. This pass-band can readily be modified, as described later. It is, however, a reasonable degree of fixed selectivity for all general amateur band purposes and avoids the need for an adjustable phasing capacitor.

Valves V1 and V2 are the two i.f. stages at 455kHz both receiving bias from the a.g.c. line (which also passes to some earlier stages). The manual gain control VR1 adjusts the cathode bias of the first i.f. stage.

Diode D1 provides bias for the a.g.c. line and also operates as the a.m. detector.

Switch S1a is one pole of a 3-way switch, and when in the "AM" position feeds audio via C9 to the volume control.

When S1a is in the "CW/SSB" position, audio signals are fed from the product detector, Fig. 2E. The central position of S1 is for "Standby" when h.t. is removed from several stages.

S-METER

Incoming i.f. signals produce negative bias at diode D1, Fig. 2C, fed through R10 and the secondary of i.f.t.2 to V2 control grid. This moves negative with increased signal strength, the current through R7 and R6 falls, so that the screen of V2 becomes more positive, and the cathode more negative. With no signal, potentiometer VR2 allows the circuit to be balanced so that no voltage is present across the S-Meter. Incoming signals cause the meter reading to rise in proportion to the signal strength. R5 reduces the meter sensitivity to a suitable level.

If a steady signal is present, from a transmission or a signal generator, all i.f.t. or other adjustments can be directed towards obtaining the best meter reading. This also applies to any external adjustments, such as to an aerial tuner or to the aerial-earth system.

CRYSTAL FILTER

With the i.f.t.'s aligned at 455kHz, crystal X6 was 454kHz and X7 was 456kHz but it is not necessary that X6 and X7 have exactly 2kHz separation. The specified i.f.t.'s are 465kHz types but they tune easily to 455kHz.

If one crystal only is used, and the other replaced by a 15pF variable phasing capacitor, a sharply resonant peak can be obtained together with a rejection notch which can be moved across the i.f. pass-band. A filter of this type was described in the December 1971 issue of *Practical Wireless* and is excellent for c.w. in particular.

The lead from the mixer pin 6, Fig. 2B, to pin 3 of i.f.t.1 is screened right up to the i.f.t., otherwise stray coupling round the filter will degrade results.

If an accurately calibrated signal generator is available, set it midway between the crystal frequencies and inject at pin 1 of V2, Fig. 2C, adjusting the

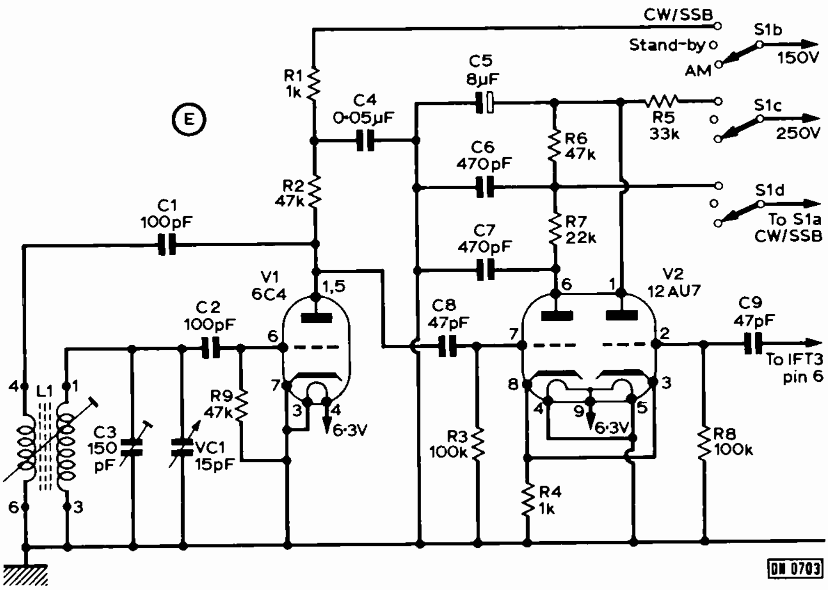


Fig. 2E: Circuit of the b.f.o./product detector, the addition of this unit to the receiver permitting the reception of c.w. and s.s.b. signals. The frequency of the b.f.o. is variable from the front panel to accommodate upper or lower sideband signals.

★ components list

1ST. RF, MIXER/OSCILLATOR (FIG. 2A)

Resistors

R1 47kΩ 1W   R3 33kΩ 1W   R5 100kΩ ¼W
R2 68Ω ¼W   R4 39kΩ 1W   R6 270Ω ¼W

Capacitors

C1 0·01μF Disc 350VW   C7 0·01μF Disc 350VW
C2 0·01μF Disc 350VW   C8 100pF SM
C3 470pF Mica   C9 22pF SM
C4 0·01μF Disc 350VW   C10 10pF SM
C5 0·01μF Disc 350VW   C11 5pF SM
C6 0·01μF Disc 350VW   TC1 30pF trimmer
VC1-2 2 x 180pF (Jackson L2)
VC3 25pF midget variable (Jackson C804)

Valves

V1 6BA6   V2 ECH81

Miscellaneous

Valveholders B7G (1) skirted, B9A (1) skirted. Formers (7) see text. Crystals X1-5 Type HC6U (see text) with holders. Bandswitch sections A-H, comprising 4 wafers each 2 pole 6 way. Universal chassis flanged members, 6 x 2in. (1), 5 x 2in. (2) (Home Radio).

TUNABLE IF AMPLIFIER (FIG. 2B)

Resistors

R1 1MΩ ¼W   R4 1MΩ ¼W   R7 2·2kΩ 1W
R2 47kΩ ¼W   R5 47kΩ 1W
R3 68Ω ¼W   R6 47kΩ ¼W

Capacitors

C1 22pF SM   C8 100pF SM
C2 100pF SM   C9 0·05μF 350VW
C3 0·05μF 350VW   C10 47pF SM
C4 0·01μF 350VW   C11 22pF SM
C5 0·1μF 350VW   C12 1000pF SM
C6 0·1μF 350VW   C13 0·01μF 350VW
C7 22pF SM   TC1-2-3 30pF trimmer
VC1-2-3 3 x 25pF (Jackson 003)

Valves

V1 6BA6   V2 ECH81

Inductors

L1 Blue Range 3 L2 Yellow Range 3 L3 Red Range 3 (All Denco, miniature, valve type)

Miscellaneous

Universal chassis flanged members, 5 x 2in. (2), 4 x 2in. (2), flat plate 5 x 4in. (1) (Home Radio). Cabinet 15 x 9 x 8in. Type W, chassis 13 x 8 x 2½in. Type K, brackets 4 x 4in. Type C (2) (H. L. Smith). Dial and drive, Type DL6 and ball drive Type 4511 (Home Radio). If not available use combined Jackson dial and drive Type 4103/A.

FIXED IF AMPLIFIER (FIG. 2C)

Resistors

R1 100kΩ ¼W   R5 330Ω ¼W   R9 1MΩ ¼W
R2 47kΩ 1W   R6 22kΩ 1W   R10 1MΩ ¼W
R3 68Ω ¼W   R7 100Ω ¼W   VR1 2kΩ linear WW
R4 47kΩ 1W   R8 100kΩ ¼W   VR2 500Ω WW pre-set

Capacitors

C1 0·25μF 350VW   C6 0·05μF
C2 0·1μF 350 VW   C7 100pF mica
C3 0·05μF 350VW   C8 100pF mica
C4 0·1μF 350VW   C9 0·01μF 350VW
C5 0·1μF 350VW

Valves

V1 6BA6   V2 6BA6

Inductors

IFT1 IFT/11/465CT   IFT2 IFT/11/465
IFT3 IFT/11/465 (All Denco)

Miscellaneous

Crystals X6/7 Type HC6U with holders (see text). Valveholders B7G (2) skirted. Diode D1, OA81. Switch S1a-d, 4 pole 3 way wafer switch. S meter, 1mA f.s.d.

AUDIO AMPLIFIER/POWER SUPPLY (FIG. 2D)

Resistors

R1 4·7kΩ 3W   R4 470kΩ ¼W   R7 1kΩ 3W
R2 270kΩ ¼W   R5 47kΩ ¼W   R8 470Ω 5W
R3 4·7kΩ ¼W   R6 180Ω ¼W   R9 25Ω ¼W
R10 25Ω ¼W
VR1 500kΩ log. pot. with switch, S1

Capacitors

C1 60μF 6VW   C5 0·01μF 350VW
C2 0·01μF 350VW   C6 32μF 450VW
C3 32μF 350VW   C7 8μF 450VW
C4 100μF 15VW

Valves

V1 ECL86   V2 OA2 (150V)

Miscellaneous

Valveholders B7G (1), B9A (1). D1-2 silicon rectifiers 800 p.i.v. 1A. Closed circuit jack. Fuse 250mA and holder. T1, output transformer Type TO46 (Home Radio). T2, mains transformer Parmeko P2931 or similar (Home Radio) see text.

BFO/PRODUCT DETECTOR (FIG. 2E)

Resistors

R1 1kΩ ¼W   R4 1kΩ ¼W   R7 22kΩ ¼W
R2 47kΩ ¼W   R5 33kΩ ¼W   R8 100kΩ ¼W
R3 100kΩ ¼W   R6 47kΩ ¼W   R9 47kΩ ¼W

Capacitors

C1 100pF SM   C6 470pF mica
C2 100pF SM   C7 470pF mica
C3 150pF SM   C8 47pF SM
C4 0·05μF 350VW   C9 47pF SM
C5 8μF 350VW   VC1 15pF variable

Valves

V1 6C4   V2 12AU7

Miscellaneous

L1, b.f.o. coil (Denco BFO2/465).
Valveholders B7G (1), B9A (1).

cores of i.f.t.3 for best output. Repeat with i.f.t.2, with the signal applied at pin 1 of V1 The signal can then be taken to the second mixer grid and i.f.t.1 aligned.

Assuming no generator is available, tune in any strong, stable signal. It will probably be found that there are two responses, one is relatively broad and arises from the i.f.t.'s while the other is sharper and may be much weaker if the i.f.t.'s are not tuned near to the crystal frequencies. Tune the signal in at the sharper response position which places it in the

continued on page 738

Let's suppose we want to use the virtual earth pre-amplifier as an input stage for a mixer, where there are several odd sources that may be used separately or simultaneously, and where the action of one must not interfere with that of another. As any amateur disc-jockey will tell you, a very practical problem. In Fig. 65(c) we get the inputs from the sources taken to low value potentiometers and from there we can feed up to three R3 resistors to the virtual earth point, this time using our coupling capacitor to follow the resistors, for effective isolation. By juggling resistor values, with a little experiment, we can again get our levels somewhere the same, and use a master gain control later in the circuit, where its operation at a higher signal level will not introduce unwanted noise, etc.

Of course, there is always the microphone pre-amplifier, as in (d), where we want a bit more gain prior to a mixer stage. The transformer is a low/high or medium/high type and is best mounted in the overall screened box that houses the virtual earth amplifier.

Power supply

Finally, this month, having again not kept my promise to lead us on to tone controls, although a careful perusal of the foregoing will have seen the trend our thoughts are taking, we have a brief look at the proposed power supply for this and other projects. This was knocked up easily in an hour and needs no particular layout finesse, nor screening. It uses any convenient transformer that can give between 24 and 33 volts—not really safe to exceed 33·6V—and the rectifiers are easily obtained types with minimum requirements of peak-inverse voltage

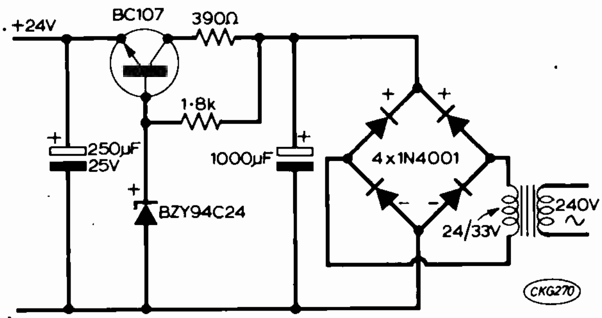


Fig. 66. A practical power supply, suitable for use with the circuits described.

50V and handling capacity 200mA. We used a REC 60 because it happened to be there, but four 1N4001's would have done. The particular requirement is the zener diode, which must be a 24 volt type, such as shown, and components can be half-watt types, with the biggest problem the mounting of the two large capacitors. Note that this zener operates in the reverse to the breakdown mode, i.e., it is set to regulate, with cathode to positive. This 24 volt output, with the 2kΩ resistor (or 2·2kΩ, if you have no 2kΩ version available) drops to the needed 20 volts for our amplifier.

TO BE CONTINUED

AMATEUR BANDS RECEIVER

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crystal pass-band. Adjustment of any of the i.f.t. cores should then bring about a great increase in signal strength as they are shifted into the crystal pass-band. The i.f.t.'s are all finally peaked in this way, signal strength being reduced by VR1 as necessary.

When the i.f. amplifier is aligned in this way, a very steep sided response should be obtained. If X6 and X7 are removed and a 100pF capacitor plugged into one holder, general selectivity will still be very good, but there should be a very noticeable reduction in sharpness of tuning and noise will increase due to the broader pass-band.

MODIFICATIONS

As the idea of construction in stages is to obtain fully working circuits as quickly and easily as possible, the i.f. section can be simplified initially then modified to the full circuit.

The S-Meter circuit can be omitted completely at first and fitted later.

IFT1 and V1, Fig. 2C may be omitted and mixer pin 6 taken to pin 3 on i.f.t.2 or V1 and i.f.t.2 may be omitted and the crystals or secondary of i.f.t.1 may be temporarily connected to pin 1 of V2.

When the tunable first i.f. section is constructed, the receiver can be employed for the 3·5-4MHz band only. The receiver cannot be used on other bands until the crystal controlled first conversion section is completed.

With some valves i.f. instability occurred with VR1 at maximum gain. This was cured by placing a 2·2kΩ resistor between pin 2 of i.f.t.1 and h.t., with a 0·25µF capacitor from pin 2 to chassis.

TUNABLE FIRST IF AMPLIFIER

This has two stages, Fig. 2B, and is constructed in a screened box to minimise pick-up of unwanted signals. Coverage is 3·5MHz to 4MHz, with a little to spare at the extreme positions of the 3-gang capacitor VC1, VC2 and VC3.

V1 operates as an r.f. amplifier on the 3·5-3·8MHz band and as first i.f. on the other ranges. The gain of this stage is also controlled by VR1. AGC bias is applied to both stages via R1 and R4 (*it is not good practice to apply a.g.c. to a frequency changer of this type—Ed*).

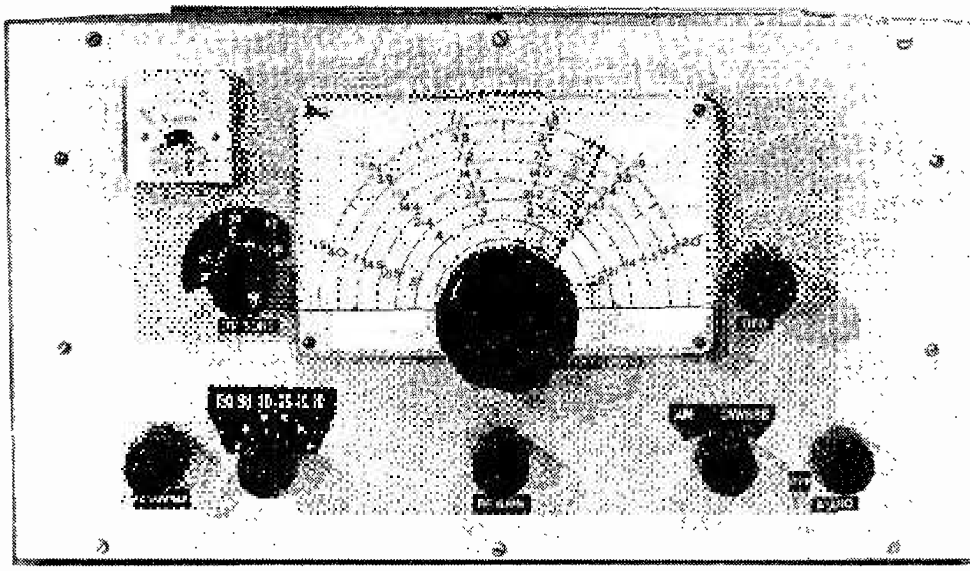
The oscillator section of the mixer-oscillator V2 is run from the 150V stabilised h.t. supply. Input to L1 is via a screened lead and a similar screened lead runs from V2 to the 455kHz i.f. amplifier.

The box is 5×4×2in. deep, with the valves on top and all other parts, including VC1/2/3, inside. This box is made from a 5×4in. flat plate, to which are bolted two 4×2in. and two 5×2in. "universal chassis" flanged members. It is easier to leave the sides and back off the box until wiring is completed.

TO BE CONTINUED

Next month we shall cover the construction and alignment of the tunable IF amplifier and give full information on the BFO/Product Detector and RF/1st Mixer stages to enable the receiver to be completed.

AMATEUR BANDS RECEIVER



1·8-30MHz • AM-CW-SSB • BANDSWITCHED • EASY CALIBRATION

PART 2

F. G. RAYER G3OGR

TUNABLE IF AMPLIFIER (Cont)

Fig. 3 shows the underside of the box. The "Blue" coil L1 is placed inside the screening can supplied with it, holes being drilled in advance through the can sides, for the leads shown. L2 is the "Yellow" coil, and L3 the "Red" type.

The ganged capacitor is attached to the front of the box by three bolts. Solder a lead to the frame or rotor tag near the back, and run this to MC (chassis).

Trimmers TC1, TC2 and TC3 are of the ceramic type, each mounted with two 8BA bolts a little clear of the box top, so that they may be adjusted through holes in the box. Jackson air-spaced trimmers Type C801 (3·8-50pF) or concentric trimmers are also suitable.

Construction and wiring should be rigid. For easy identification of circuits, coloured leads are soldered on to pass down through the chassis. Solder a length of 75 ohm co-ax to L1 as in Fig. 3, and the white lead from pin 8. These run through a single hole immediately under L1.

Yellow (VR1), Brown (a.g.c.), Grey (150V), Blue (heaters) and Red (h.t. positive) leads run together through a single hole. R7 is actually on the voltage regulator holder, V2 of Fig. 2D.

The co-axial lead from V2 runs inside the box towards the first 455kHz i.f. transformer, and through the chassis. It is screened because stray coupling round the band-pass crystal filter will cause a reduction in selectivity.

All leads are left long enough for the box to be turned at right angles to the main chassis should any tests be needed. The box is mounted by self-tapping screws passing up through the chassis and into the flanges of the box sides, front and back.

TUNABLE IF ADJUSTMENT

When the 455kHz, a.f. and power circuits are completed, the tunable i.f. can be aligned, and its coverage adjusted. This is the only calibration work required, as other receiver ranges are automatically obtained on the same scale, as explained.

With the ganged capacitor almost fully closed, adjust the core of L3 for 3·5MHz, and roughly peak the cores of L1 and L2 for best results. The ganged capacitor is then set nearly fully open, and TC3 is adjusted for 4MHz. Trimmers TC1 and TC2 are set for best results. Adjusting TC3 at the h.f. end of the band will to some extent change the core setting of L3 at the l.f. end of the band, so L3 and TC3 are checked several times. Remember to adjust L3 at the l.f. band and, and TC3 at the h.f. band end. In this way coverage is eventually brought to the desired range.

The cores of L1 and L2 can then be adjusted at about 3·55MHz, and the trimmers at about 3·9MHz, until no further improvement is possible, and the cores are locked with 6BA nuts.

For these adjustments, the signal is taken to the co-axial lead to L1. A harmonic crystal marker using a 100kHz crystal and giving calibration points at 3·5, 3·6, 3·7, 3·8, 3·9 and 4MHz is most suitable. A tunable signal generator should if possible be checked with a crystal or other reference source. Output indication can at this stage be estimated by ear. When construction is finished, cores and trimmers can if necessary be touched up while observing the receiver S-meter, to secure the best reading.

CHASSIS

Fig. 4 shows the top of the chassis and drilling dimensions. It is best to complete as much drilling and other metal work as possible before fixing any components, and to clear away metal fragments. Tags are bolted on tightly for chassis connections. Metal fragments between the i.f.t. pins and chassis can cause h.t. or other shorts, so sleeving can be put on the pins in advance. Each i.f.t. needs a central hole to reach the lower core.

The panel is supported by two brackets, bolted to chassis and panel. Fit the panel so that it projects about ½in. below the edge of the chassis, as the

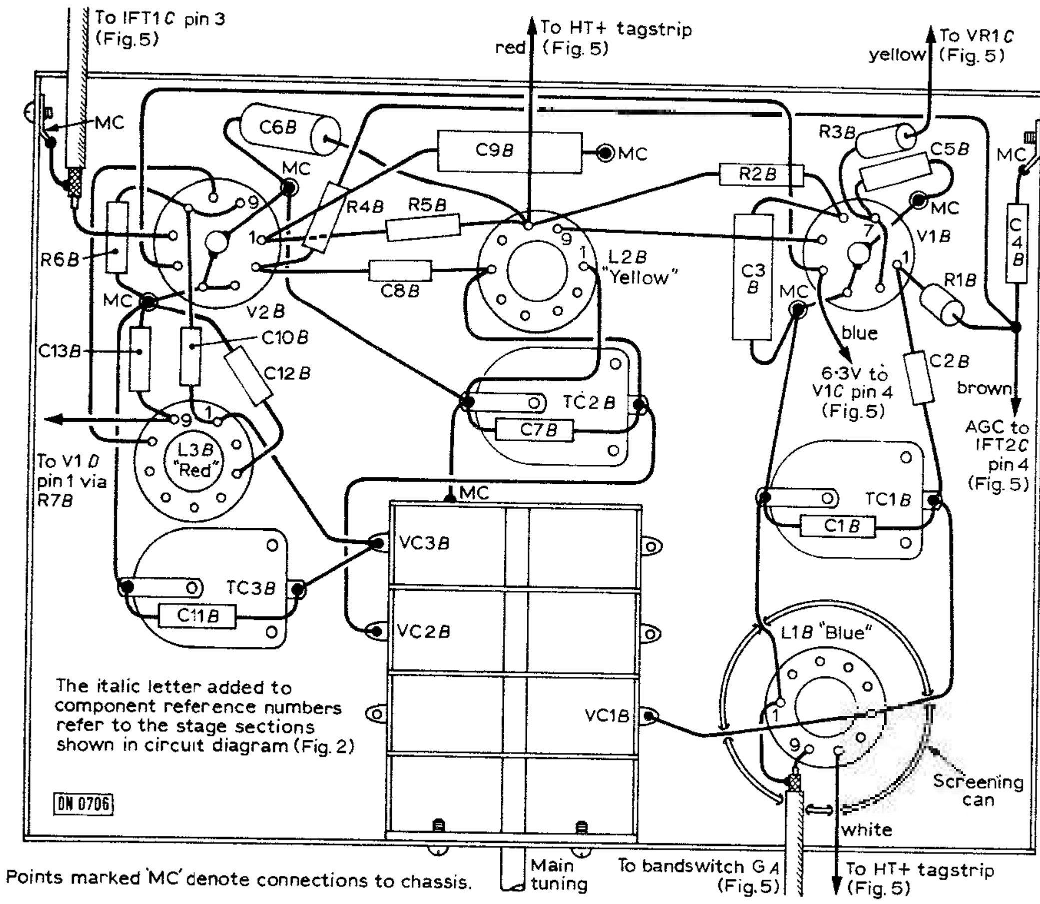


Fig. 3: Component placement and constructional details of the tunable i.f. amplifier unit.

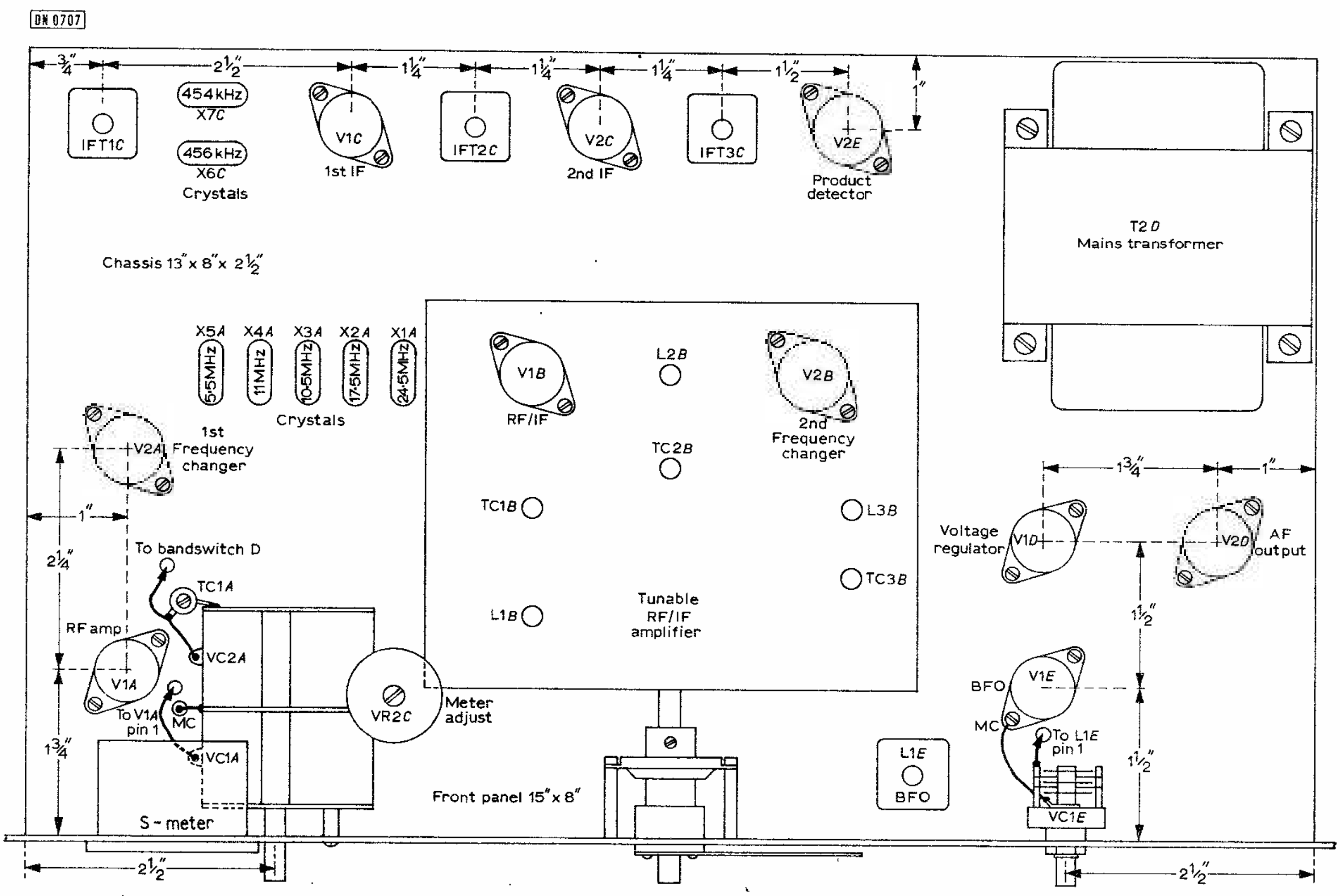


Fig. 4: Top of the chassis with drilling information. The photograph on p. 695, Part 1, will assist in identifying components.

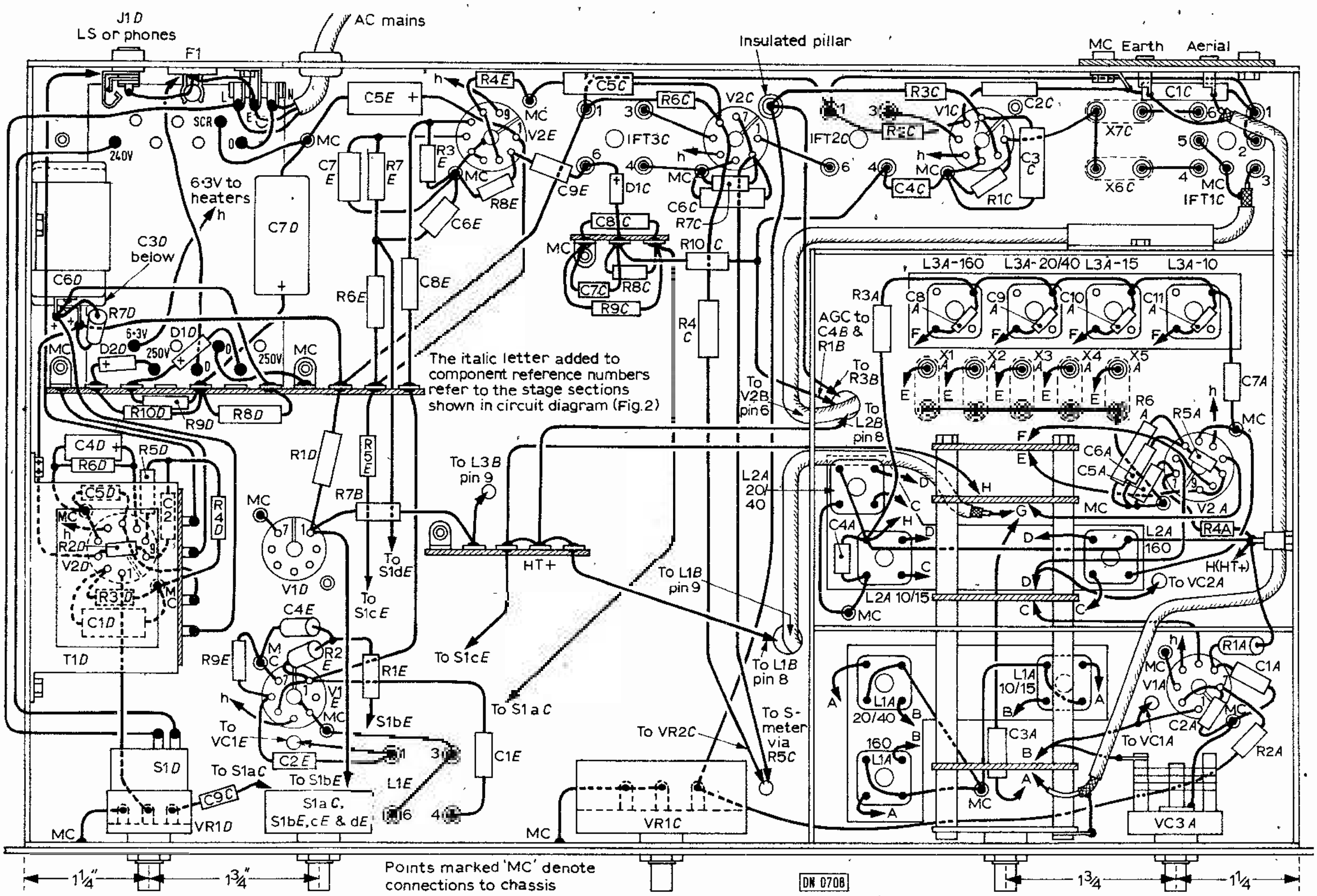


Fig. 5: Location of components underneath the chassis. Note that the wiring of the ECL86 output stage should be completed before fitting the output transformer.

cabinet requires this. Mark through the chassis control bush holes on to the panel, and drill or punch the latter to match.

The panel is marked centrally, level with the ganged capacitor spindle, then drilled and punched to take the ball drive. The dial can then be fitted and holes marked for it.

The b.f.o. pitch capacitor and ganged first r.f. and mixer tuning capacitor are also above the chassis and operated directly by knobs.

Fig. 5 shows the underside of the main chassis and where needed components can be identified by reference to the circuit diagrams.

The mains cord is anchored to a tag strip. The mains transformer tags project through the chassis and a long tag strip near this supports the h.t. rectifiers and other components.

The a.f. and output stage is wired complete and then the speaker transformer T1 is bolted to the side runner and thus lies over this valveholder. The audio section can be tested as described by feeding a signal in at VR1.

The a.m. diode D1 and associated resistors and capacitors are mounted on a tag strip as shown.

Fig. 5 shows all wiring to the crystal filter and following i.f. stage. It is easy to check that this section operates, by temporarily taking D1 positive to pin 6 of the 2nd i.f.t., or by wiring the i.f. amplifier anode to pin 3 of the last i.f.t. The signal is taken by the screened lead to pin 3 of the i.f.t., either from the tunable i.f. described, or from a signal generator. The i.f.t.'s may then be aligned in the way described. The few extra connections etc, for the second i.f. amplifier can then be added, to complete the circuit, the meter being included or omitted as wished.

This completes construction up to the point where the receiver can be used for a.m. reception in the 3·5-4MHz range.

BFO

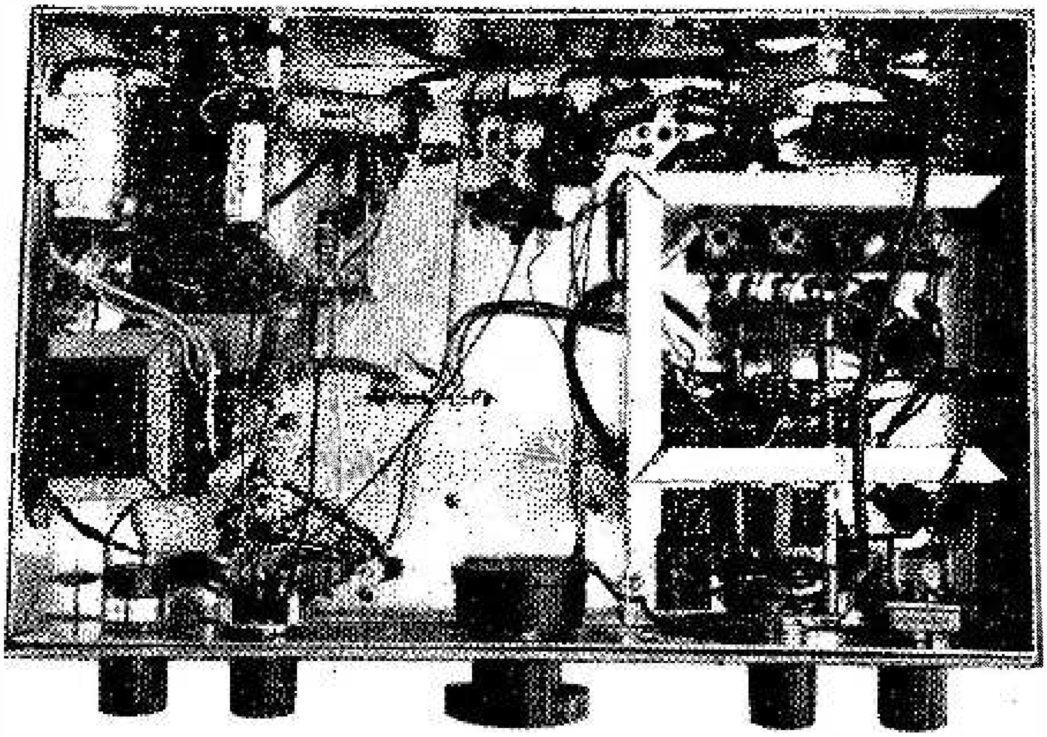
V1 in Fig. 2E is the beat frequency oscillator for c.w. and "carrier oscillator" for s.s.b., and receives h.t. from the regulated supply when section S1b of the 3-way switch is in the CW/SSB position.

The voltage regulated supply is not absolutely essential, but will be found to give a worthwhile improvement in frequency stability. It is possible to use a switched crystal controlled oscillator for selection of upper and lower sidebands but the tunable oscillator is simpler and gives satisfactory results.

PRODUCT DETECTOR

This is V2 in Fig. 2E and it operates on both c.w. and s.s.b., giving an audio output which is selected by section S1a of the 3-way switch. Section S1c applies h.t. to V2, when in the c.w./s.s.b. position. This double-triode circuit is very reliable and trouble-free, and capable of very good results on s.s.b.

In some designs a.g.c. is removed for c.w. and s.s.b. reception and an extra pole on the 3-way switch could accomplish this. However, for strong signals the r.f. gain control has to be turned back anyway, which greatly reduces a.g.c. action so it was decided to leave the a.g.c. circuit in operation at all times.



This view of the chassis will be useful when wiring up the receiver from Fig. 5.

ADJUSTMENT OF BFO

Initially VC1 is half closed and a steady a.m. transmission is tuned in as precisely as possible. The function switch is then turned to "c.w./s.s.b.", and the core of the b.f.o. coil adjusted with a trimming tool for zero beat. If the core is adjusted a little either side of this setting, a strong heterodyne note will be heard, which rises in pitch as the core is moved from its correct position. Opening or closing VC1 from its central or zero position has the same result.

To receive CW, set VC1 above or below the central position, as required to produce the most suitable tone.

For s.s.b. reception, slowly rotate VC1 one way or the other, as required, to produce intelligible speech. Lower sideband is generally used on 1·8, 3·5MHz and 7MHz bands and upper sideband on 14MHz and above, but the effect of adjusting VC1 will soon become clear. Speech cannot be resolved if VC1 is the wrong side of the s.s.b. signal. When VC1 is set for s.s.b. reception, it need not be further adjusted, unless the receiver is switched from l.f. to h.f. bands or vice versa.

Many very strong s.s.b. signals are often heard so for general s.s.b. reception it is better to keep the a.f. gain fairly high, and turn back the r.f. gain as necessary.

The centre pole of the 3-way switch takes h.t. off all but the tunable oscillator and output stages, muting the receiver transmission.

FIRST RF/MIXER OSCILLATOR

This part of the receiver operates on 10, 15, 20, 40 and 160m bands, and the circuit is shown in Fig. 2A. V1 is the r.f. amplifier while the triode section of V2 functions as a crystal controlled oscillator and the heptode section as a mixer.

The 6-way bandswitch has eight poles. For 80m sections A and G take the aerial circuit directly to the 3·5-4MHz tunable i.f., which operates as r.f. and mixer on this band. For all other bands, section A takes the aerial to the primaries of the aerial coils L1, while section G takes output of the mixer to the tunable i.f.

Section B selects the appropriate coils L1 but three coils only are required for the five bands covered by this section: one coil for 10m and 15m, a second for 20m and 40m, and the third coil for 160m. This reduces the number of coils needed while giving a satisfactory L/C ratio. Switch sections C and D select similar coils L2, for the mixer grid circuit.

Coils L1 and L2 are tuned by the ganged capacitor VC1/VC2. In use, this capacitor is peaked up in the selected band and need only be re-adjusted slightly when receiving weak signals, or when moving well across the band, except in the case of 160m, where it requires more frequent adjustment. The panel aerial trimmer VC3 allows further alignment with almost any aerial. AGC is not applied to either of these stages, but the gain of V1 is controlled by VR1, which also adjusts the cathode bias of some later stages.

The r.f. coils L1 are wound to give an input impedance of around 75Ω. Transmitting equipment will often be operated into a dipole or other aerial with a matching device to provide about this load, so the same system can generally be used for reception. For reception only, any simple end-connected wire may be taken to the aerial socket, with good results. For maximum signal strength with weak signals it is customary to employ some improved form of aerial, such as an end-connected wire with matching unit, or a single-band or multi-band dipole with 75Ω co-axial feeder.

Switch section E selects the appropriate crystal and section F the triode anode oscillator coils. The crystal frequencies are chosen so that incoming signals on the wanted band are converted into the 3·5-4MHz range. The latter thus covers a 500kHz band which includes the wanted h.f. band, or 160m.

It will be seen that it is not essential to use the crystal frequencies listed, though these allow dial markings to match up easily. For example, the 11MHz crystal for 40m results in a range of 7·0-7·5MHz being tuned. If the band 7·0-7·1MHz only is required, as permitted for transmission in this country, any crystal which converts 7·0-7·1MHz to a part of the 3·5-4MHz range can be used. In the same way, the 5·5MHz Top band crystal results in coverage of 1·5-2·0MHz but any crystal which results in 1·8-2MHz being covered would do. "Round number" crystals will give dial readings which match up with the 3·5-4MHz range at 100kHz points, such as an actual range of 1·6-2·1MHz, for example, for 160m.

Crystal frequencies which are not "rounded off" to 100kHz will result in the band being off-set one way or the other, according to the actual crystal frequency. The listed crystals can be easily obtained, but it will be seen that it may be possible to use surplus or other crystals to hand, provided band calibration is adjusted to suit.

A crystal should not put its own harmonic in the wanted band. A 3·5MHz crystal would, for example, give 3·5MHz from V2 with the receiver tuned to 7MHz, but the 3·5MHz 2nd harmonic and fundamental pick-up at 3·5MHz by the tunable i.f. would block reception.

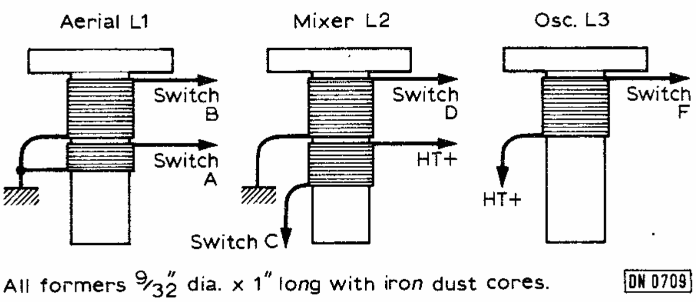
Only four anode coils L3 are necessary for the five crystals because 40m uses a 11MHz crystal and 20m a 10·5MHz crystal so a single coil is satisfactory for both ranges.

Should there be no interest in Top band, L1, L2, L3 and the crystal for this band can be omitted.

One crystal provides coverage of one 500kHz sector of 10m, any additional 500kHz sector requiring another crystal. If 160m is omitted, the 6th position could introduce a 25MHz crystal, for 28·5-29MHz. Alternatively, 8 and 9-way switches are available, so that coverage of 10m may be extended that way. Another method is to extend section E to a 3-way rotary switch for the 10m crystals.

RF/MIXER COILS

Each coil is begun right against the tagged end, as in Fig. 6, no space being left between the tuned section and the primary. The wire ends can be



Band MHz	RF Pri.	RF Sec.	Mixer Pri.	Mixer Sec.	Wire
1·8	10	*	40	*	32g. enam.
7/14	4	24	12	24	32g. enam.
21/28	2	10	10	7	26g. enam.

* MW coil (Osmor Range 5) with 20 turns removed.
All windings close wound. No space between windings.

Fig. 6: Showing the method of constructing the r.f./mixer coils.

soldered to tags, taken through small holes, or run directly to wiring points, the ends of the windings being held with a touch of polystyrene adhesive.

A strip of 3/16in. plywood or similar material is drilled to be a push fit for the ends of r.f. coils, with a similar strip for the mixer coils. The strips are bolted to the chassis.

CRYSTAL OSCILLATOR COILS

The four coils, see table, are a push fit in holes in a strip of plywood, which is bolted to the chassis near the switch.

Crystal (MHz)	Turns	Wire	Parallel C
5·5	30	32g. enam.	100pF
10·5	24	32g. enam.	22pF
17·5	19	32g. enam.	10pF
24·5	16	26g. enam.	5pF

Close wound at end of former as in Fig. 6.

Winding information for the crystal oscillator stage coils.

If a meter is clipped from chassis to the h.t. end of the coils, oscillation is shown by a *rise* in voltage. Adjust each core for maximum voltage then, if necessary, set it slightly off this peak so that each crystal starts reliably. One setting is suitable for both 10·5 and 11MHz crystals. Readings were approximately 50V when not oscillating, rising to about 100V with oscillation, but a little lower on the highest frequency range.

SWITCH AND COILS

The bandswitch is positioned as in Fig. 5, and arranged so that the 10/15m coil L1 can be placed as shown to allow short wiring to the wafers. A 5x2in. flanged universal chassis member is placed inside the chassis, and marked to agree with the switch bush hole. This hole is punched, and holes are drilled for the switch screwed rods. The rear wafers and spacers are taken off, and the switch re-assembled with the flanged member, which gives extra support and also provides a screen between r.f. and mixer sections. Holes are drilled in the flanged member in advance, so that a lead can run directly through from r.f. anode (pin 5) to section C, and so that the heater circuit can be wired. C3 (used to isolate h.t. on 80m) is near section A and a lead runs through to section G.

Leads from sections B and D run up through the chassis to VC1 and VC2. Short, direct chassis returns are necessary, especially for the h.f. bands coils. Connections to the 10/15m coils and leads to the crystals are kept very short.

To avoid possible errors in wiring the switch, first check that normal results are obtained on 80m. The coils and crystal for 40m may then be added and the circuit tested. The other ranges can then be fitted in turn.

The remaining flanged members listed can be bolted to the chassis to enclose this section of the receiver.

ALIGNMENT

With TC1 and VC3 nearly fully open and with the band switch on 10m, check that 29·5MHz can be tuned with VC1/2 fullly open. If not, screw the cores of L1 and L2 further out of the windings (towards the chassis) VC3 should also peak signals but if it is fully open, screw down TC1 a little.

Switch to 15m and peak signals by closing VC1/2. If VC3 now needs considerable adjustment move the core of L1 or L2 (10/15m range) to correct this.

Switch to 20m, and with VC1/2 fully open, set the cores of L1 and L2 for 14·5MHz. Check that 7MHz can be reached with VC1/2 nearly fully closed, after switching to this range. If not, adjust the cores until this is possible to minimise the need for re-adjustment of VC3.

On 160m, adjust L1 and L2 (160m range) to allow peaking with VC1/2 and to minimise the need for altering the setting of VC3 when tuning from the h.f. end of the band towards the l.f. end.

The crystal oscillator coils are adjusted as previously described. No reception is possible on a range where the crystal is not oscillating. VC1/2 should peak quite sharply on each amateur band, but should not be too critical. The dial or control knob should be marked with approximate band positions and with frequencies for 1·8, 1·9 and 2MHz.

With an i.f. of 3·5 to 4MHz a second channel signal arises at 7 to 8MHz from the wanted amateur band so that in normal use, interference is unlikely. But on the highest frequency bands the wide coverage of VC1/2 allows these circuits to be tuned accidentally to the second channel frequency. This tuning position must not be used for amateur band reception.

With the tunable i.f. of 3·5-4MHz the oscillator covers 3955-4455kHz the 5th harmonic of which falls in the 15m band and is heard as a weak carrier. This is unavoidable with this type of circuit and similar considerations apply to 10m.

Should the S-meter potentiometer be at the limit of its adjustment without the meter being at zero, add a resistor of some 100 to 330Ω or so between potentiometer and chassis. This value depends on individual valves, h.t. voltage, etc.

CABINET

Holes or slots are required in the back of the cabinet for the mains lead, aerial, etc. Slots can be made by drilling holes and sawing between them or by sawing between holes made with a chassis punch. For additional ventilation six ½in. holes were punched in the bottom and a row of similar holes in the back near the top. The case is raised on four ¾in. rubber feet.

An opening lid is made to reach the S-meter potentiometer, etc. Lines are drawn about 1½in. from front, back and sides, to make a lid about 12x6in. Sufficient 1/16in. holes are drilled at the corners to start a small metal saw. The 12x6in. piece is cut out, and edges smoothed with a file. Strips of metal about 7x1in. are bolted inside the cabinet for the lid to rest upon when closed. ■

Note: Part 1. Fig. 2A, bottom of L1(160m) primary should go to chassis, 40 and 20m switch sections (B) should be linked. In Fig. 2E, C3 is a fixed capacitor.

GOING BACK—*continued from page 829*

Arthur L. Kongshaug, Schouterrassen 22, Oslo 5, Norway has some more information on Dr. Loewe and his Loewe receiver mentioned in a previous Going Back article.

This type of receiver was based on a patent by Dr. Sigmund Loewe, and was manufactured in his own factory, Radiofrequenz G.m.b.H., in Berlin, starting in 1926.

The receiver was made in two versions, a two-valver and a three-valver. Both versions were intended to operate a vibrating reed type of loudspeaker—a type which was very popular at the time (before the Dane, Mr. Jensen, came along with the dynamic types).

The basic idea behind the "Loewe" receivers, was that all resistors, all capacitors and the elements of the valves, in fact everything outside the tuning arrangement, were enclosed in one big glass tube under vacuum. Resistors and capacitors not being as stable as they are today, this was a real improvement.

One may also assume that this first attempt to make an "integrated" receiver, made them cheaper to manufacture than the standard versions of the time. The sets were very popular, and are said to be the first sets to pass the million-mark in Europe. Who assembled the British version, I do not know. The brand is still one of the best known in Germany, today under the name "Loewe Opta", with works in Berlin, Kronach and Düsseldorf.

Jim F. Rowland, hailing from Kauhajoki KK, Suomi, Finland, says . . . "I am the proud possessor of a Philips Radio Type 2531 serial number 016824N1 complete with its original loudspeaker.

Valve line up is: 506—E442—E443—E424. Bands: 200—450, 400—950, 900—2100 meters. The speaker line out plug is also a three position switch.

I was rather lucky to get this set, I was in fact in the process of moving from my house near Vaasa when my next door neighbour came to ask me if I could help him with an old radio he had found in his loft. Well I helped him with a small token of my appreciation with a fiver!!

The wireless is to the best of my knowledge in perfect condition, that is to say that with a little bit of howl, wow and whistle. We manage to listen to the immaculate BBC in the evenings around 2300hrs local time (ours).

Well now, if you find this interesting and would like photos of the object, let me know. Should you be able to enlighten me as to its year of origin and perhaps country I should be very much obliged."

Yes, we would like to see photos of your receiver Mr. Rowland. Sorry, we don't know year of manufacture, but it was probably made in Holland.

Mr. D. M. Findlay, 2a St. George's Drive, Carpenders Park, Watford, Herts, writes in to say . . .

"I found an old radio in the loft of my last house. As a computer engineer with an appreciation of the 'oldies' in the wireless world, I am looking for any info. on this piece of equipment.

Basically it is called 'The Reece-Mace'. It's portable, in a leather case size 13in. x 11in. x 6·5in. The speaker and frame aerial are in the lid. Long and short wave only, four valve line up:—PM12—PM1LF—LP2—DEL210(?). Reactance circuit with variometer and volume control."

So if anyone has any ideas, will they drop Mr. Findlay a line?