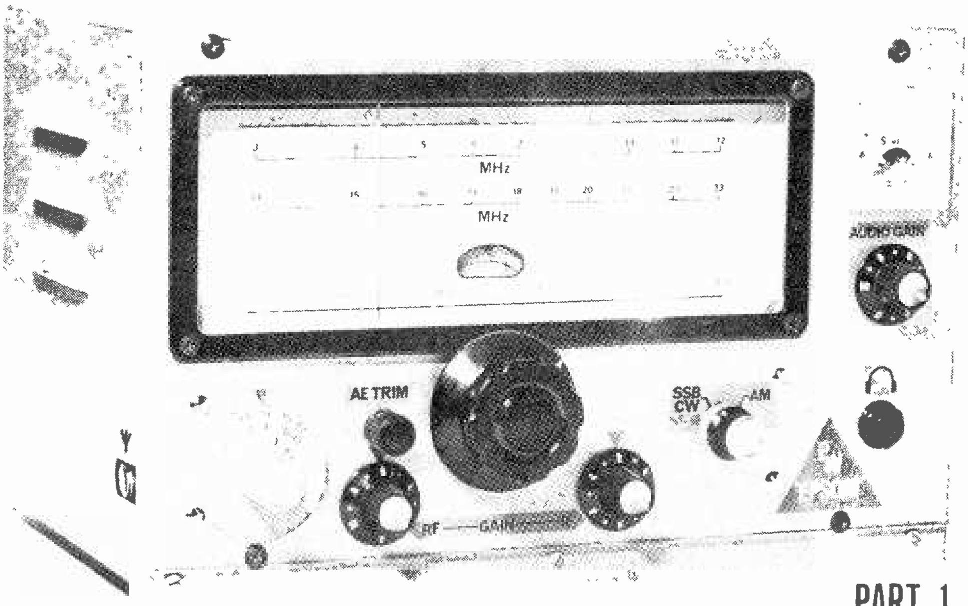


PW EPSOM

GEN
COVE

PART 1

AFTER listening around the short wave bands on various transistorised receivers it is very evident that they were all prone to an effect known as "cross-modulation". Transistors have a very limited linear input characteristic compared to valves so that early stages in a transistorised set are easily overloaded by strong input signals.

The resulting non-linearity causes strong signals to be impressed upon weak ones even when the two signals are widely spaced in terms of frequency. Two or more strong signals will combine to produce more spurious signals and the general impression is of reduced sensitivity in the presence of strong signals.

The early tuned stages should be capable of rejecting unwanted signals but strong signals can be found to exist on the leads of the transistors themselves by direct pick-up, thus driving them into non-linearity. This effect is not unknown to users of solid state hi-fi equipment when broadcast or TV signals break through from local or semi-local transmitters.

Valves can tolerate input signals of the order of volts before becoming non-linear compared to the few hundred milli-volts of transistors. To the best of my knowledge nobody has yet come up with a practical design for a transistorised receiver front-end that can equal the performance of, say, a valve series-cascode circuit using a common ECC84 and conventional components. To listen round on a receiver so equipped is a revelation, the bands seem to go quiet as the spurious teletype and jamming stations disappear and weak stations can be copied in the presence of strong signals on adjacent channels.

Transmitting radio amateurs are well aware of the problem of cross-modulation, even more so now with the rapid increase in the use of imported transceivers which are generally solid state except for the odd valve or two in the transmitter section. It is interesting to see that one of the latest designs, the FT501, has resorted to a valved front-end using the old fashioned 6BZ6 and 6U8! Nuff sed!

It must be remembered that the mixer stage of a superhet is sometimes the culprit in cross-modulation problems especially if it is preceded by an RF amplifying stage. With an efficient mixer stage an RF stage should not be required. While pentodes and triodes can be used to advantage in front-ends there is another valve, the beam deflection valve, that is even better as a mixer. The 7360 appeared around 1960 but the later and current 6JH8 has better characteristics and is considerably cheaper.

Bill Squires W2PUL repeated (QST September 1963) the principles outlined by Goodman in 1957 that a receiver capable of preventing cross-modulation and overload should have:—

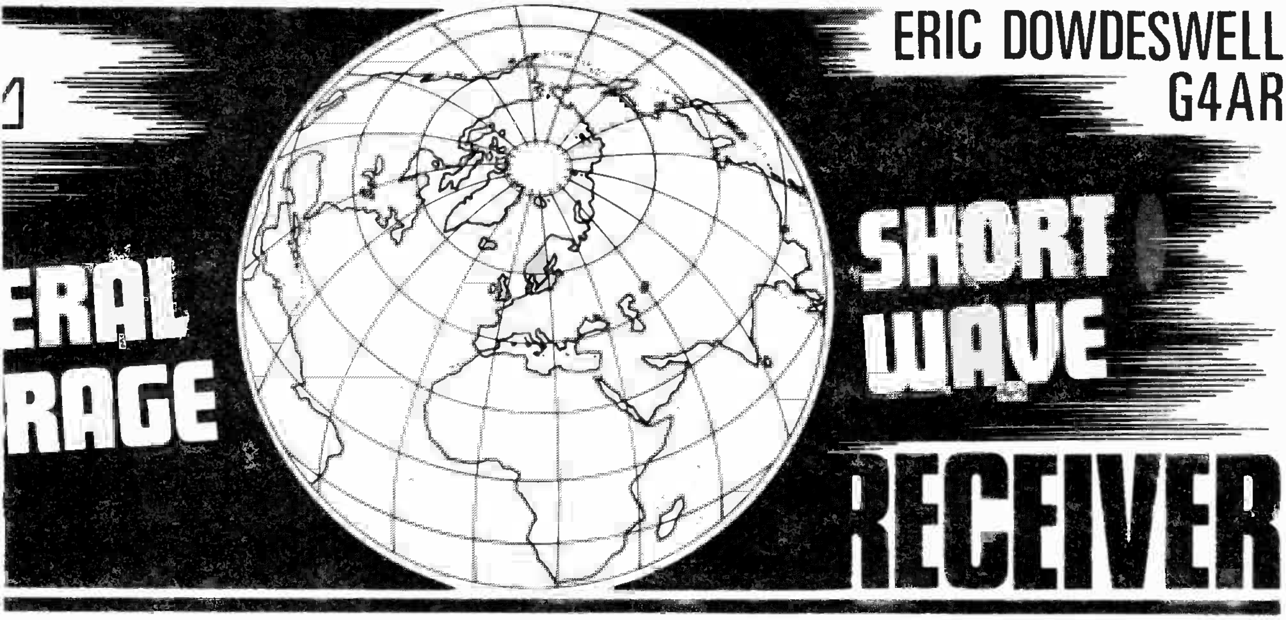
As little gain as possible before applying maximum selectivity.

Excellent linearity in any stage preceding the selectivity.

Squires therefore concluded that the ideal receiver should not have an RF stage, as few conversions as possible and that the mixer should be a linear device like a Class A amplifier . . . "conventional mixers perform only because they are non-linear . . . the local oscillator swinging the tube from nearly zero bias to nearly cut-off and no tube is linear near cut-off or near zero bias. As long as the signal is very small compared to the local oscillator voltage the mixer is quite linear but when the signal grows large violent cross-modulation occurs".

He went on to describe a mixer stage using the 7360 in which mixing takes place by switching the valve's electron stream between two anodes by means of deflector plates driven by the local oscillator voltage. See valve symbol V1 in Fig. 2. Up to the deflector plates the valve resembles a conventional pentode.

PW SUPER SEPARATES



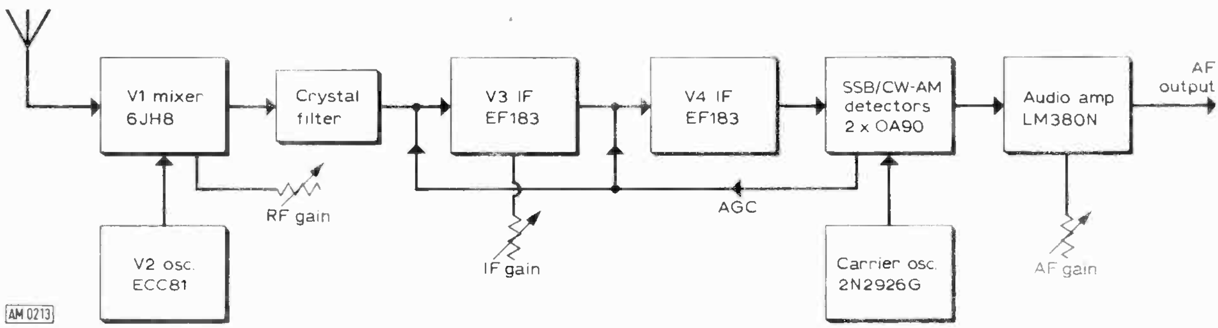


Fig. 1: Block diagram to show the functions of the various stages in the receiver.

W2PUL again . . . "since the two output anodes can be operated in push-pull the valve can be inherently balanced against the input signal frequency, hence good IF rejection".

No RF stage is used with the receiver described here but because of the problem of second channel interference (signals 2 × intermediate frequency from signal frequency) a much higher IF is required than the conventional 455kHz. In this design the IF is 5·5MHz, second channel now being 11MHz away from the signal frequency and adequately attenuated by two tuned circuits at signal frequency. Several circuits and much useful information on the 7360/6JH8 can be found in Pat Hawker's book, **Amateur Radio Techniques** published by the RSGB.

THE DESIGN

The circuit used in the "Epsom" is a hybrid one, using valves in the mixer and two IF stages, where linearity is important, and the first oscillator stage. Diodes are employed in the switchable AM or SSB/CW detector while the associated carrier insertion oscillator (CIO) uses a transistor. The single audio stage utilises an LM380N integrated circuit. The general arrangement is shown in Fig. 1.

In detail, it will be seen from Fig. 2 that the signal passes via the 5·5MHz IF signal trap L1/C1 to the two capacity coupled tuned circuits L2/VC1 and L3/VC2 which feed the signal grid of the 6JH8 mixer V1. Three pairs of plug-in coils cover the whole of the tuning range. The first oscillator V2, an ECC81, employs the very effective cathode coupled oscillator circuit, Fig. 4. Harmonic content is low and a minimum of components contributes to good stability.

The oscillator tuning range is 8 to 18MHz only, no bandswitching being required, the oscillator frequency being added to or subtracted from the input signal frequency in the mixer stage to produce the intermediate frequency of 5·5MHz thus:—

MHz Signal Tuning Range	Osc. Tuning Range MHz
2·5 to 12·5	+5·5MHz=8 to 18
13·5 to 23·5	−5·5MHz=8 to 18

The gap between 12·5MHz and 13·5MHz does not contain any broadcast or amateur band. There is also a gap in the tuning around the set's IF of 5·5MHz but again this is not an important part of the short wave spectrum. Another important aspect of this method of mixing is mentioned later when discussing sideband switching.

The oscillator voltage, approx. 3V RMS, is applied to the deflection plates of the mixer. A balanced circuit is desirable here but the practical difficulties

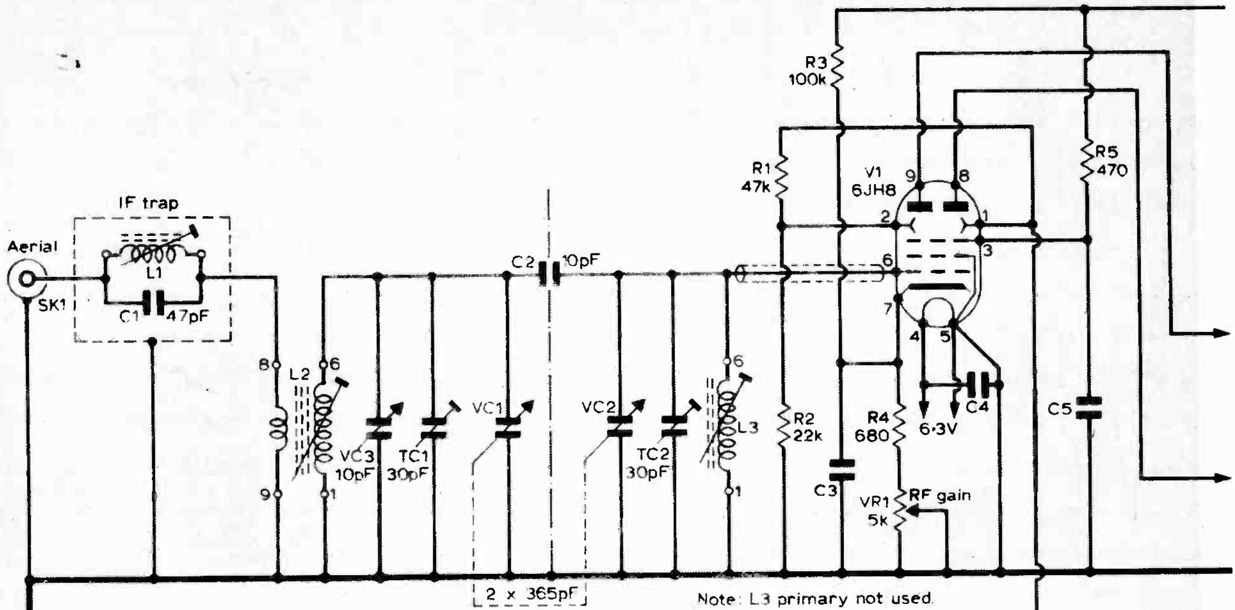


Fig. 2: The input signal is fed to the 6JH8 beam deflection mixer stage via an IF trap and two tuned circuits. The injection voltage applied to the deflection plates is derived from the first oscillator stage, Fig. 4.

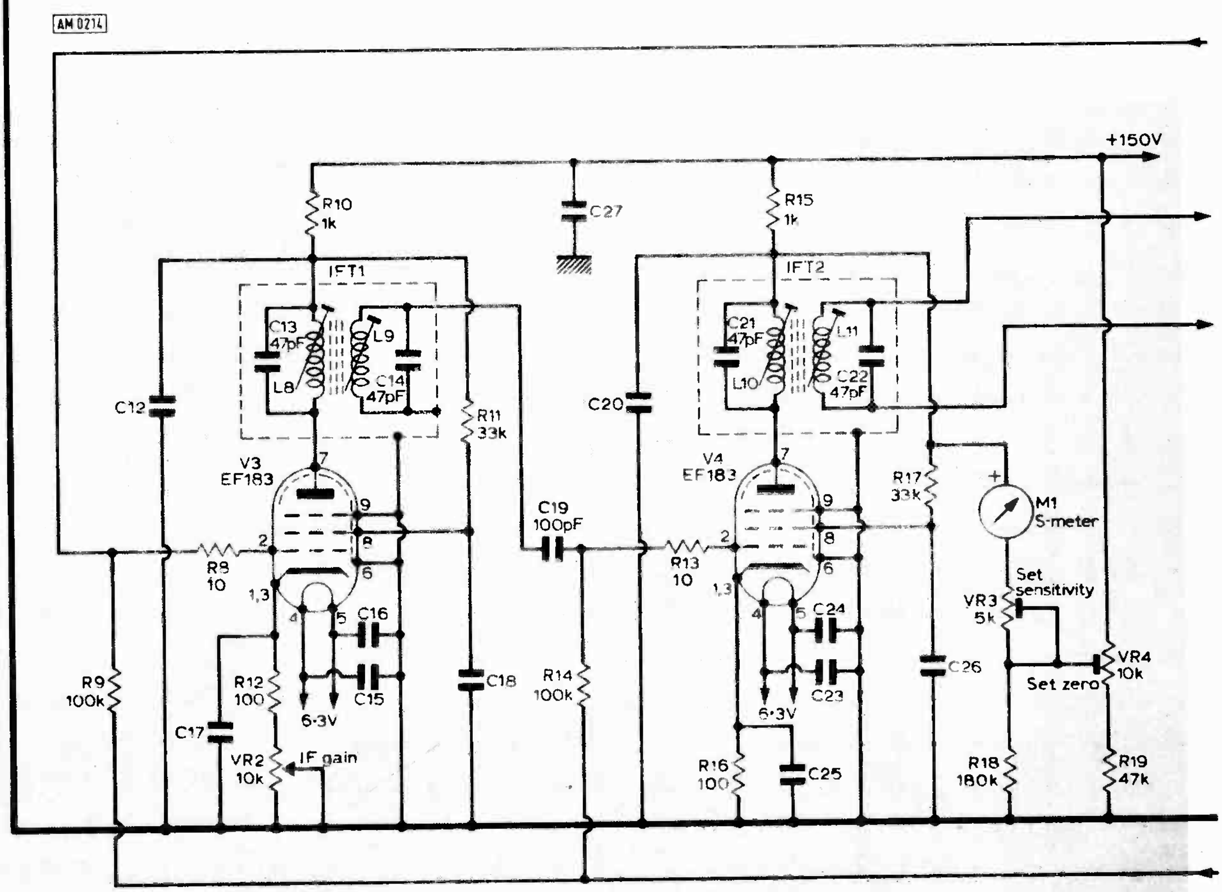


Fig. 3: The low-level signal from the filter is amplified by this two stage amplifier operating at 5·5MHz. Its gain can be controlled manually and by the AGC voltage on AM reception.

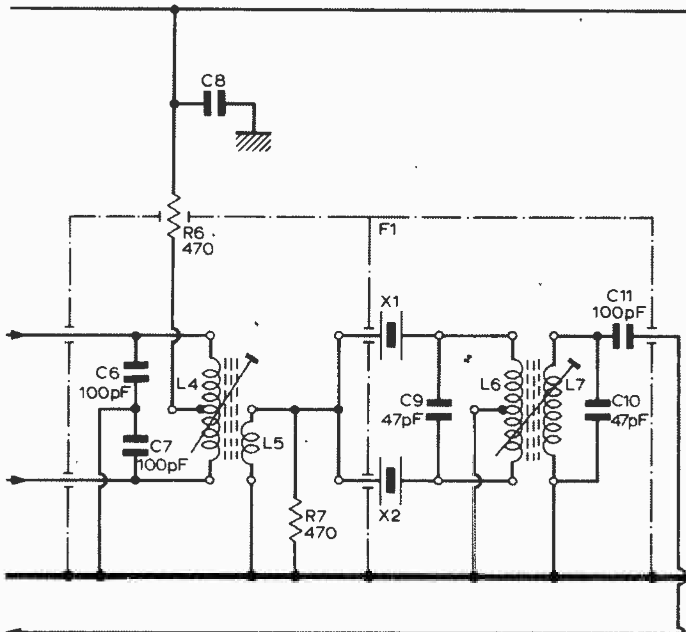


Fig. 2a: The output of the mixer stage, left, feeds into this half lattice crystal filter at 5·5MHz. Input and output circuits must be screened from each other to prevent signal leakage round the filter.

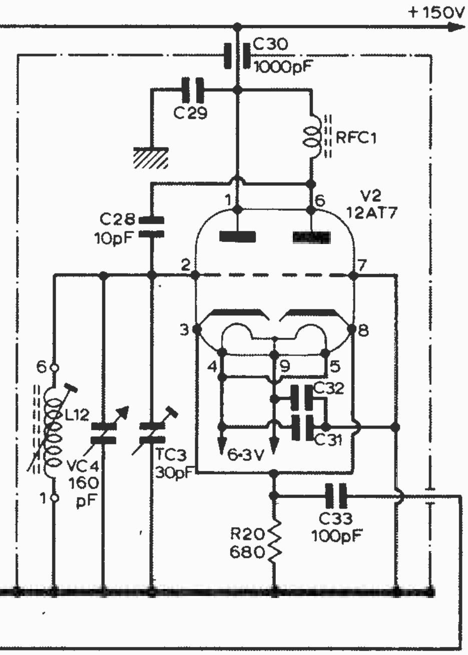


Fig. 4: The first oscillator stage uses very few components. Stability is improved by the absence of any bandswitching complications.

AM 0215

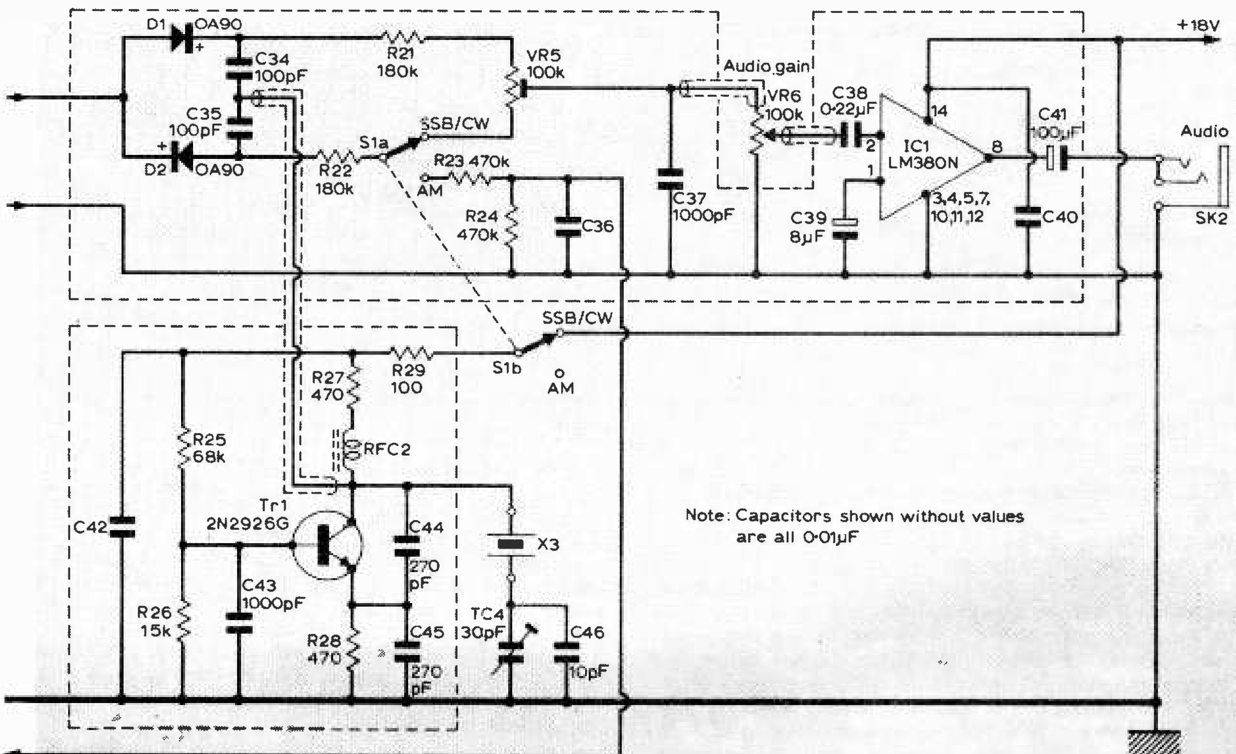


Fig. 5: The output of the IF amplifier, left, feeds a diode detector switchable for optimum operation on SSB/CW or AM reception. The resultant audio is amplified by the LM380N audio IC. The carrier insertion oscillator Tr1 operates only on SSB/CW.

★ components list

Resistors

R1 47kΩ	R11 33kΩ	R21 180kΩ
R2 22kΩ	R12 100Ω	R22 180kΩ
R3 100kΩ	R13 10Ω	R23 470kΩ
R4 680Ω	R14 100kΩ	R24 470kΩ
R5 470Ω	R15 1kΩ	R25 68kΩ
R6 470Ω	R16 100Ω	R26 15kΩ
R7 470Ω	R17 33kΩ	R27 470Ω
R8 10Ω	R18 180kΩ	R28 470Ω
R9 100kΩ	R19 47kΩ	R29 100Ω
R10 1kΩ	R20 680Ω	

All 5% or 10% and ⅓ or ½ watt

VR1 5kΩ lin.	VR2 10kΩ lin.	VR3 5kΩ lin. preset
VR4 10kΩ lin. preset	VR5 100kΩ lin. preset	VR6 100kΩ log.

Capacitors

C1 47pF SM	C16 0·01μF DC	C31 0·01μF DC
C2 10pF SM	C17 0·01μF DC	C32 0·01μF DC
C3 0·01μF DC	C18 0·01μF DC	C33 100pF SM
C4 0·01μF DC	C19 100pF SM	C34 100pF SM
C5 0·01μF DC	C20 0·01μF DC	C35 100pF SM
C6 100pF SM 5%	C21 47pF SM	C36 0·01μF DC
C7 100pF SM 5%	C22 47pF SM	C37 1000pF DC
C8 0·01μF DC	C23 0·01μF DC	C38 0·22μF DC 25V
C9 47pF SM	C24 0·01μF DC	C39 8μF 25V
C10 47pF SM	C25 0·01μF DC	C40 0·01μF DC
C11 100pF SM	C26 0·01μF DC	C41 100μF 25V
C12 0·01μF DC	C27 0·01μF DC	C42 0·01μF DC
C13 47pF SM	C28 10pF SM	C43 1000pF SM
C14 47pF SM	C29 0·01μF DC	C44 270pF SM
C15 0·01μF DC	C30 1000pF FT	C45 270pF SM
	C46 10pF SM	

DC=Disc Ceramic 250V SM=Silver Mica
FT=Feedthrough
VC1/2 2 x 365pF (Jackson 02) VC3 10pF variable
VC4 160pF variable (Jackson Wavemaster 92/057/160)
TC1/2/3/4 30pF airspaced trimmers, beehive type

Semiconductors

D1/2 OA90 IC1 LM380N Tr1 2N2926G

Valves

V1 6JH8*	V2 ECC81 (12AT7)
V3 EF183	V4 EF183

* obtainable from Electronic Component Supplies, Thames Avenue, Windsor, Berks.

Crystals

X1 5·5008MHz X2 5·5024MHz X3 5·5000MHz

Nominal frequencies. A kit of the three crystals (Type HC6U) with holders is available from Senator Crystals, 36 Valleyfield Road, London SW16 2HR for £7·43 inc. VAT and P/P. Kit reference SC/PW/533

Inductors

L1 see text
L2/3 'Blue' Ranges 3, 4 and 5, two of each. (Denco miniature dual purpose)
L4/11 see text
L12 'Blue' Range 4 (Denco miniature dual purpose)
RFC1/2 RF choke 2·5mH miniature, ferrite core

Metalwork

Aluminium cabinet and panel (12 x 7 x 7in.) (Type W)
Chassis 9 x 6½ x 2in. but see text
Aluminium box with lid 3 x 2 x 1in. (1 off) 4 x 2¼ x 1¼in. (1 off)
Screens from 18swg aluminium 15 x 1¾in. with ¼in. flange.
Panel bracket 4 x 4in.

The above metalwork is available from H. L. Smith & Co. 287 Edgware Road, London W2.

Miscellaneous

Valveholders B9A (ceramic or PTFE) with skirt and screen (4 off) without skirt (2 off). Switch S1 2 pole 2 way wafer switch. 14 pin DIL socket for IC1. Dial, Eddystone Type 898 or Jackson Type 4103 see text. Slow motion drive (Jackson Type 4511/4). Flexible coupling for ¼in. spindle.* Coil formers 1¾in. x ¼in. dia. with square base (Home Radio CR12) and screening cans (CR13) (5 off each). Dust cores (CR19) (7 off). Sk1 coaxial aerial socket. Sk2 stereo jack socket. S-meter 1mA Type MR52P (Henry's Radio). Calibrated knobs (3 off) (H. L. Smith Type F21). Plain knobs (3 off). Screened cable, 4 way. Stand-off insulators (12 off).*

Veroboard 5 x 1¼in. 0·1in. matrix, 2½ x 1¼in. 0·15in. matrix. Veroboard plain 2¼ x 1½in. 0·15in. matrix.

*Available from H. L. Smith & Co.

involved are not easy to overcome. The output circuit of the mixer is kept very carefully balanced however so that any input signal voltages present at the mixer output are cancelled out as far as is possible, as mentioned previously. A small trimming capacitor is sometimes added to one side or the other of the mixer anodes circuit to ensure best balance but it was not thought to be necessary here.

The IF filter unit Fig. 2a is full screened to prevent signal leakage across the filter and comprises two crystals X1 and X2 in a half lattice arrangement, with associated coils. Senator Crystals have agreed to supply a kit of these crystals plus the carrier insertion oscillator crystal X3 and three holders. The crystals are produced to close tolerances and it is hoped thereby that readers will be able to reproduce the results obtained by the author without too much difficulty. Commercial HF crystal filters are very expensive but perform better, of course, than the simple filter used here.

A feature of this particular receiver is that with a CIO crystal of precisely 5·5MHz and a single tuning range in the first oscillator the calibration problems are very considerably reduced, as will be seen later during the alignment procedure.

The filter output from L7 goes to conventional IF amplifying stages V3 and V4, Fig. 3, using EF183 frame grid valves. "Conventional" is perhaps not quite correct since the IF stages are operating at 5·5MHz! The signal grids are also connected to the AGC line and the gain of V3 can also be varied by the IF gain control VR2. The S-meter monitors signal levels on AM and is operated by V4, the AGC voltage being derived from the signal. IFT1 and IFT2 peak the 5·5MHz IF signal which is then fed from L11 to diodes D1 and D2, Fig. 5, which are switched

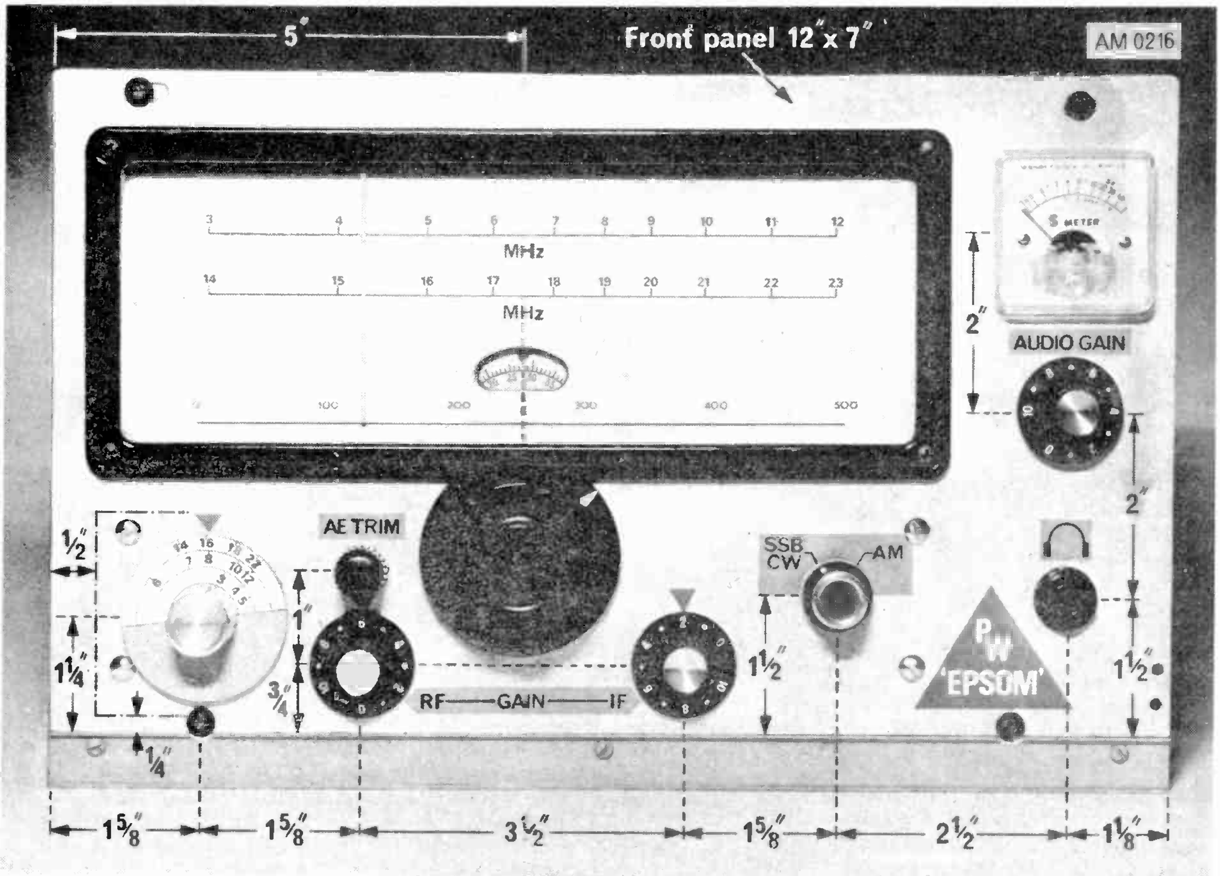
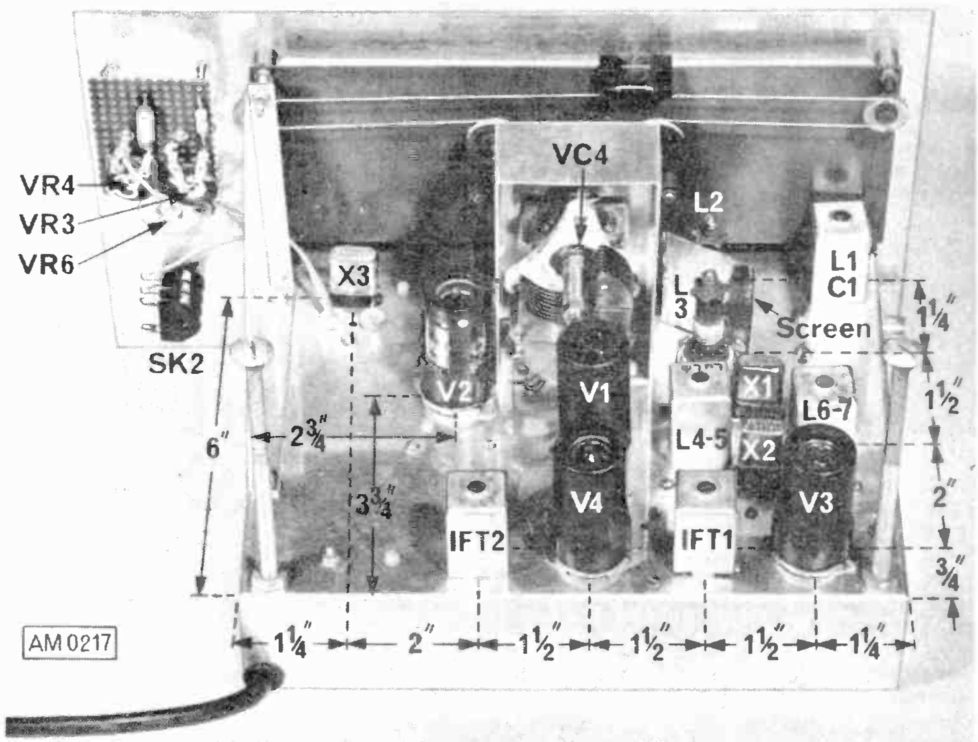


Fig. 6: above. Location of the components mounted on the panel is shown in this photograph. The left hand edge of the chassis is indicated to show its position on the panel. Fig. 7: below, identifies the components mounted on top of the chassis. The long bolts, subsequently removed, are of great assistance when working on wiring etc. inside the chassis.



by S1 to operate either as a normal diode detector on AM or as a product detector on SSB and CW. In the latter modes the crystal controlled CIO, Tr1, is switched on and fed to the diodes via C34 and C35.

The CIO crystal X3 is 800Hz lower in frequency than X1 in the filter unit and it is important to note that the change from lower sideband (LSB) to upper sideband (USB) is automatically achieved by the additive and subtractive method of mixing mentioned previously. Thus only one CIO crystal is required. Generally LSB is employed below 10MHz and USB above. The precise frequency of X3 is adjusted by TC4 for best resolution of SSB signals.

The negative AGC voltage is obtained from the detector stage on AM only, being developed across R23 and R24 and fed to the IF stages V3 and V4. An SSB/CW the product detector output is switched across the preset resistor VR5 which can be adjusted to give virtually complete rejection of an AM signal, the null being quite sharp. This adjustment ensures correct operation of the PD on SSB/CW.

From VR5 the audio signal goes to the volume control VR6 before feeding the audio IC. Capacitor C39 on pin 1 of the IC helps to reduce hum and noise on the 18V supply line. (Further information on using the LM380N IC can be obtained from the December 1973 issue of *PW*). The output of the IC is fed via C41 to the panel stereo headphone socket Sk2. The output impedance is low, intended to operate a speaker of 4-16 ohms, but in this case a pair of stereo headphones is used, the units being connected in parallel at the socket. This may be a breakaway from the conventional high impedance headphones generally used with receivers but it is hoped that since stereo headphones are now very commonplace it will induce short wave listeners to use them instead of a loudspeaker!

Another point to note is that the AGC voltage is not applied to the mixer stage since it is very unlikely that it will ever be overloaded! In consequence the usual signal grid DC blocking capacitor and resistor are omitted which means that large blocking voltages cannot build up on the signal grid, such as can occur in the vicinity of a transmitter.

The number of components has been kept to a minimum, only 29 resistors in the receiver proper and 46 capacitors of which 21 are 0·01μF decoupling capacitors! With the exception of components comprising the various tuned circuits (RF and IF) the values of the resistors and capacitors generally are not very critical, an important point in a period of component shortages. Resistor R20 in the cathode circuit of the first oscillator V2 was adjusted carefully for maximum oscillator output to the mixer stage and the value of 680 ohms specified should be used. An attempt has also been made to reduce the number of different values required of resistors and capacitors.

CONSTRUCTION

Remember that the valves, S-meter and crystals are relatively fragile so do not undertake the drilling or cutting of any holes in the chassis when any of them are in position on the chassis, especially if a power drill is being used. In practice it is unnecessary to touch them at all until after all the wiring is completed and double checked.

When wiring the valveholders fit any old unserviceable B9A based valves into the valveholders. This will keep the pin sockets in their correct positions and prevent any soldering resin from entering them. Once the wiring to the holders has been completed don't forget to remove the old valves! If construction periods are limited it might be some while before the work is finished and the old valves could be easily overlooked. A short-circuited heater winding could result, or even worse!

The chassis as supplied by H. L. Smith to go with their cabinet and panel is 11 x 6¾ x 2in which is 2in longer than that used in the prototype. If this chassis is used it is only necessary to keep the various stages in the positions round the edges, as shown in the layout, increasing the length of the leads from the output of the IF strip, L11, to the product detector board. More space will be available in the centre of the chassis and a possible refinement could be the placing of the CIO board and its external components in a separate screened compartment.

The general layout of the components on the chassis and panel is shown in the photographs Figs. 6 and 7, but it is not necessary to copy it precisely provided the usual precautions are taken with screening between stages, short wiring in RF circuits etc. The dial used in the prototype, an Eddystone E898, has seen service on several other bits of equipment over the years and a new one today is rather expensive. The Jackson 4103 dial, available from H. L. Smith Ltd., is a suitable substitute having blank calibration scales as well as a two-speed drive mechanism.

Once the major cut-outs and holes have been made in them the panel and chassis can be bolted together, after ensuring that all burrs on holes have been removed. Then, two 5in bolts, about ¼in dia, are bolted temporarily to the rear of the chassis top. These are absolutely invaluable in keeping the chassis level when it is upside down for wiring and testing and they need only be removed when the set is finally installed in its cabinet.

The fitting of the main internal screens can be left to the end when all the wiring is finished, small cut-outs being made along the inside edges of the screens as required to clear wiring passing under the screens.

Part 2 will continue with the construction of the 'Epsom' and also deal with the power supply. The simplified alignment procedure will then be described.

★ components list

POWER SUPPLY UNIT

R1	33Ω ½W	C1	350μF 350V
R2	5kΩ 10W WW	C2	2000μF 30V
R3	100Ω ½W	C3	2000μF 30V
R4	22kΩ 2W	F1	Fuse 1A
R5	33Ω ½W	F2	Fuse 250mA

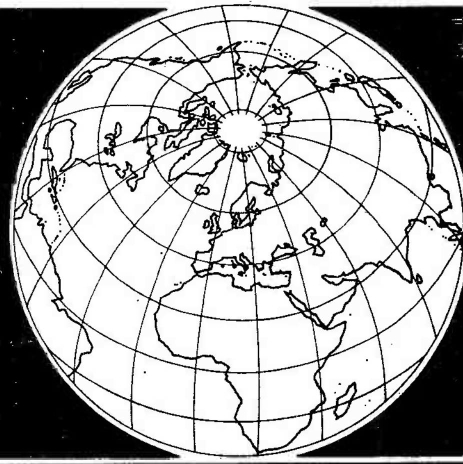
Miscellaneous

D1/2/3, 1N4007. S1, 2 pole on-off. S2, Single pole on-off. Fuseholders (2). Valveholders B7G (2). Cable plug B7G. Panel indicator lamp 6·3V. T1, Transformer 250-0-250V 80mA, 6·3V + 6·3V (Douglas MT1AT). Case 8 x 6 x 6 in. (H. L. Smith & Co. Type U). RV1, voltage stabiliser OA2. Speaker 6 x 4 in. elliptical 8Ω, with cable and jack plug. Speaker grill.

For convenience the components list for the power supply unit is given here. The unit will be described in Part 2.

PW EPSOM

GENERAL COVERAGE SHORT WAVE RECEIVER



ERIC DOWDESWELL G4AR

PART 2

CONSTRUCTION *(continued)*

The crystal filter unit, Fig. 8, can be wired and completed on the 3 x 2in box lid before installing it in the chassis but initially the lid should be placed in position and fixing holes and clearing holes for the crystal sockets drilled through the lid and chassis. Notches are cut in the lid flanges and in the edges of the box to clear the various leadout wires. The main tuning capacitor is fitted to the other aluminium box which is mounted vertically on the chassis providing a solid mounting but a simple stiff bracket could suffice here since there is a flexible coupling between the dial drive spindle and the tuning capacitor.

Note the correct position of the pins of the IF valveholders, Fig. 8, and ensure that the small screens, cut from thin tin plate, are correctly placed or instability could result. Each screen is soldered to a tag under a mounting bolt and to the centre spigot of the valveholder. Similarly, the anode pins of the mixer valveholder are placed for the shortest leads to the filter box, again aiming at a balanced layout as far as is possible. Another important screen is that between the RF coil sockets on top of the chassis.

The first oscillator V2 is very simple, keep wiring short and direct and components firmly mounted. Capacitor C29 should be connected with shortest possible leads from pin to earth. Fig. 9 shows the layout.

The CIO and the PD together with the IC audio stage are built up on two pieces of Veroboard as shown in Figs. 10 and 11. Spacers or extra nuts are used to keep the boards clear of the chassis. The three central earth rails on the PD board are directly earthed by the fixing bolts and nuts. Veropins provide connections to the external circuitry. The IC should be inserted only **after** carefully checking the wiring and, in particular, checking for solder splashes or blobs between the copper rails on the boards.

The S-meter should be fitted after all the drilling has been done, to avoid damaging the meter by excessive vibration. The components associated with the S-meter are mounted on a small piece of plain Veroboard which is held under the terminal screws of the meter. Fig. 12 shows the arrangement.

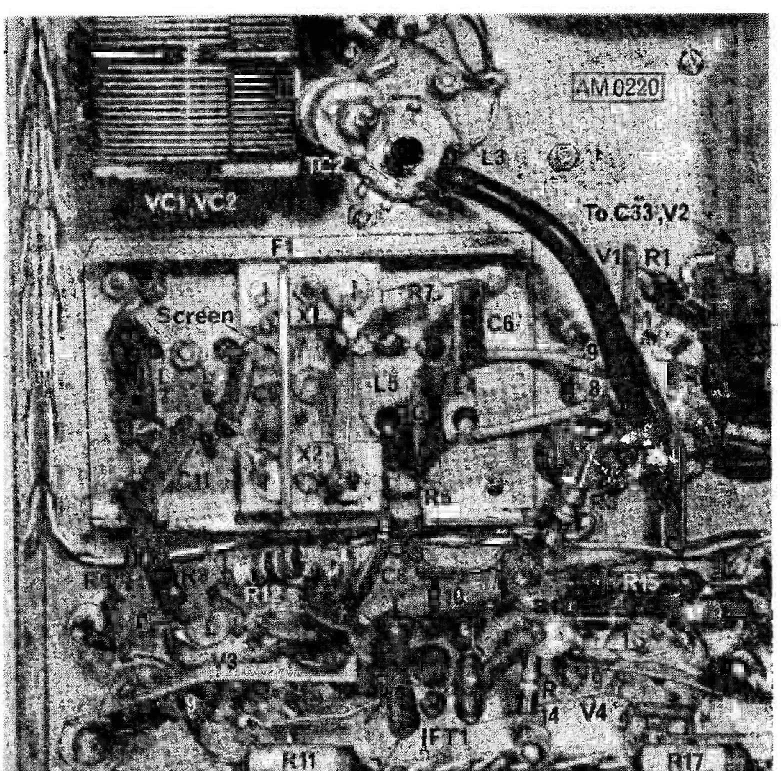
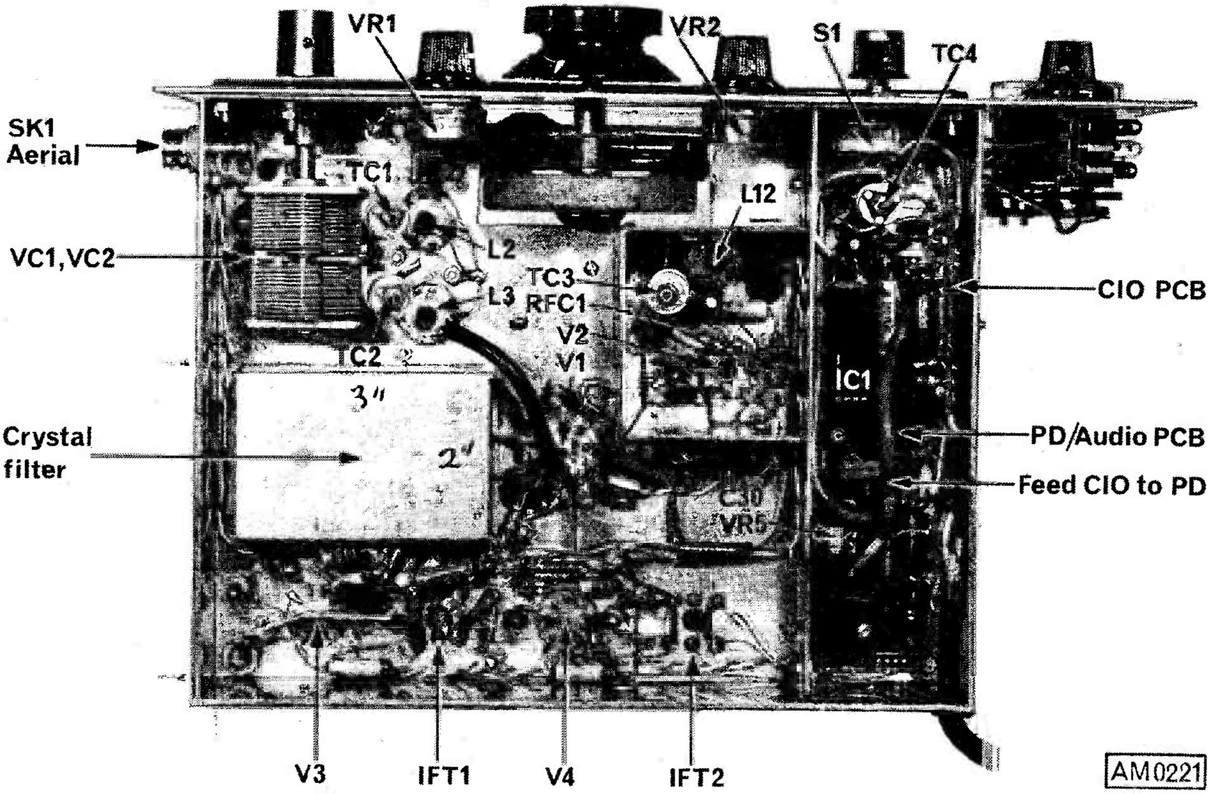


Fig. 8: Close-up of the crystal filter box and associated components. The crystal sockets shown are those used with surplus crystals in the original experiments with the filter. The crystals and holders supplied by Senator Crystals are HC6U style.



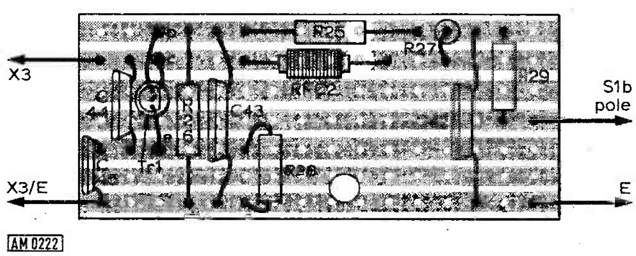
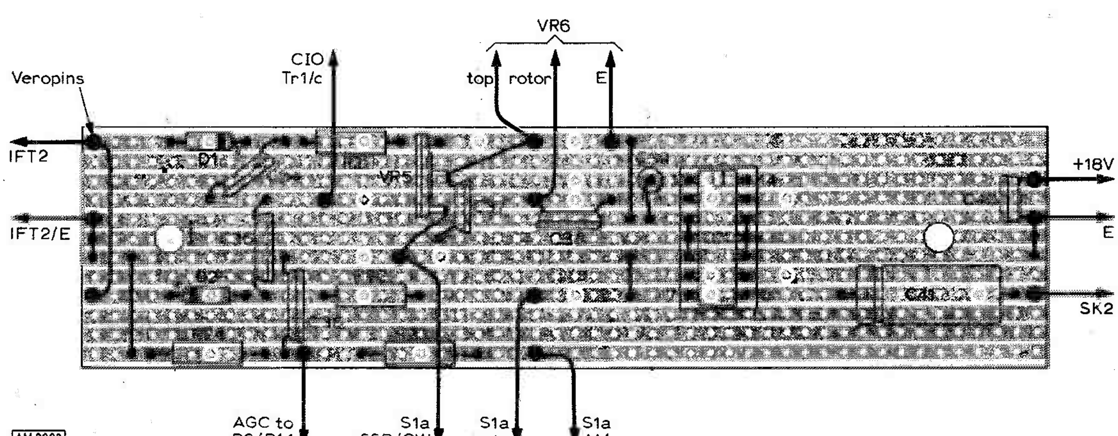


Fig. 9: above, gives the location of the principal components under the chassis. Figs. 10 and 11, left, show the layouts for the carrier insertion oscillator and product detector boards, actual size. Each board can be tested before being fitted into the chassis.



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The various IF coils are wound as shown in Fig. 13. Turns are scramble wound and held in place by a spot of polystyrene cement similar to that used in model-making. It is a good idea to make a note of the pin numbers used for each winding on the coil formers to ensure correct positioning of the IFTs on the chassis.

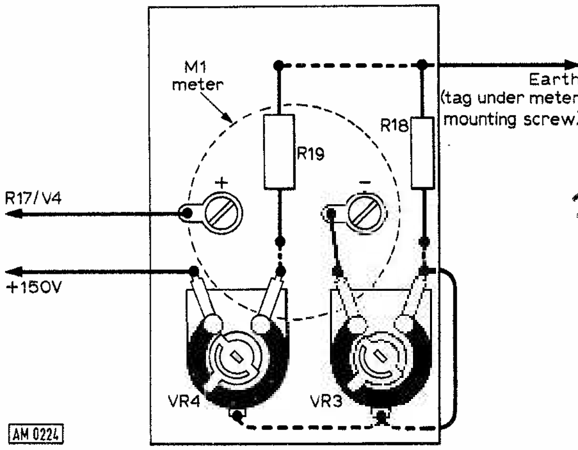


Fig. 12: Layout of the components in the S-meter circuit.

Note that L6 is bifilar wound. Take a length of wire sufficient for both windings, double over at the centre and wind on the requisite number of turns keeping the wires together, winding them as one. The earth end of L5 is taken out through the base of the coil former and soldered to an earth tag.

Scrape clean the ends of all the windings before soldering to the pins on the formers. Ensure that the holes in the chassis are big enough to clear the pins or, to be quite sure, slip a short piece of insulating sleeving over each pin.

As there are several holes to be drilled for each IFT it is a good idea to take a spare coil former and remove the pins thus enabling the former to be used as a template for marking out the holes, after the central hole is drilled.

The RF tuning ganged capacitor is mounted off the chassis with washers on the mounting bolts. First fit the slow motion drive to the panel in the correct position and then adjust the number of washers until the capacitor spindle fits into the drive without difficulty. If it is misaligned the drive will bind and stick. The slow motion drive is essential as the RF tuning is quite sharp. A small metal or card disc is fitted to the flange on the drive and eventually calibrated for the three RF tuning ranges.

HEATERS

The heater wires, preferably of differing colours, are twisted together between valveholders and one side earthed at the mixer valveholder **only**, the corresponding wire being earthed again in the power supply unit, hence the coding. The chassis should not be used for heater earth at other valveholders. Small stand-off insulators are used to support the otherwise free ends of resistors etc.

A slot is cut in the left hand side of the cabinet to clear the coaxial aerial socket and short leads go from the socket to the IF trap L1/C1 and from the trap to the RF tuning capacitor. The aerial socket could be mounted on the rear drop of the chassis and a short length of coaxial cable run back to the trap. This would necessitate cutting a hole in the

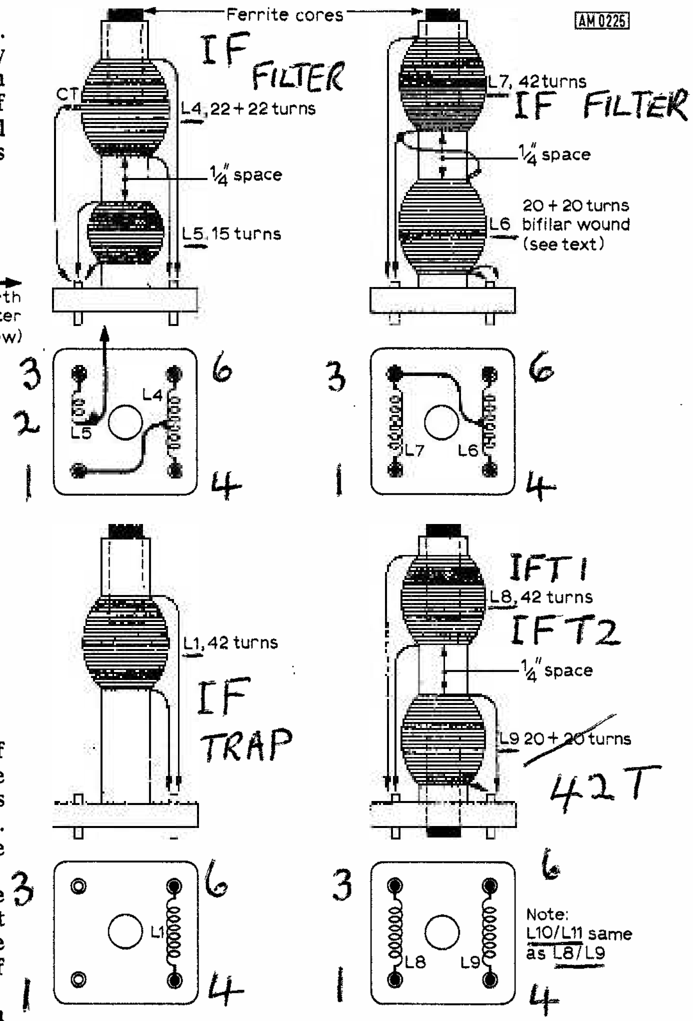


Fig. 13: Details of the windings for the filter and IF transformers and the IF trap. The former length is $1\frac{3}{8}$in. and not $1\frac{3}{4}$in. as shown in components list.

back of the cabinet to clear the aerial socket. In any case, a similar size hole is required at the back for the plug on the end of the power supply cable to pass through.

TESTING CIO/PD

The CIO board can be tested before it is fitted into the chassis by temporarily connecting the crystal to the board (do not solder to the crystal pins!!), ignoring capacitors TC4 and C46 and feeding a low voltage supply, from a 9V battery, to R29 and the earth line. The 5·5MHz signal should be heard on a short wave receiver at this frequency if the oscillator is placed close to the receiver's aerial socket. The receiver's BFO should be on.

Similarly the audio section of the PD and audio board can be tested, connecting the phone jack, volume control and a low voltage supply to the pins on the board. A test signal from a transistor radio headphone socket can be fed to the top of the volume control.

A five-way terminal strip is fitted inside the chassis where the power supply cable enters. The four-way screened cable is terminated with a B7G plug, plugging into a socket on the power unit.

(10)

POWER SUPPLY

The circuit of the power supply unit is shown in Fig. 14. All the valves in the receiver are fed from the 150V stabilised line rather than from the more conventional unstabilised 250V. The general result is improved frequency stability and less heat dissipation in valves and resistors. The 6·3V secondary feeding the valve heaters is also connected in series with the second 6·3V secondary (tapped at 5V) to provide 18V DC for the audio IC and CIO stage via rectifier D3 and smoothing components C2, C3 and R5.

The switch in the 150V line is very useful when testing and making adjustments. Even this voltage can produce an unpleasant shock! Resistor R4 is more of a safety device, discharging C1 when the unit is switched off. It also imposes a minimum load on the rectifier, lowering off-load peak voltages.

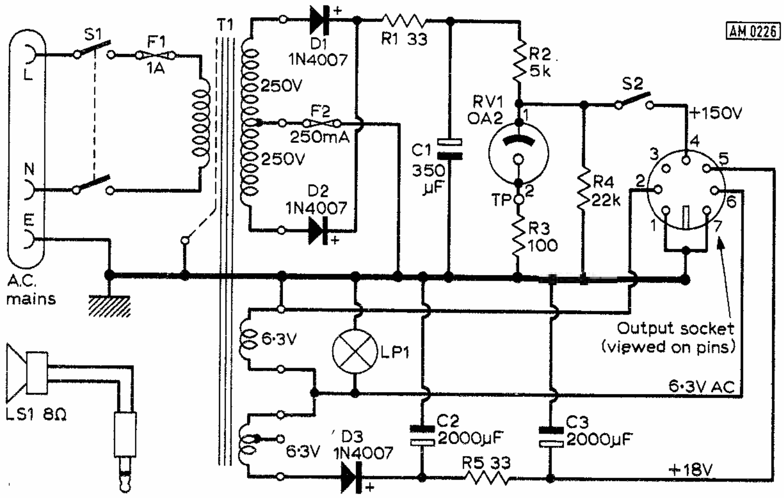
★ components list

POWER SUPPLY UNIT

R1	33Ω ½W	C1	350µF 350V
R2	5kΩ 10W WW	C2	2000µF 30V
R3	100Ω ½W	C3	2000µF 30V
R4	22kΩ 2W	F1	Fuse 1A
R5	33Ω ½W	F2	Fuse 250mA

Miscellaneous

D1/2/3, 1N4007. S1, 2 pole on-off. S2, Single pole on-off. Fuseholders (2). Valveholders B7G (2). Cable plug B7G. Panel indicator lamp 6·3V. T1, Transformer 250-0-250V 80mA, 6·3V + 6·3V (Douglas MT1AT). Case 8 x 6 x 6 in. (H. L. Smith & Co. Type U). RV1, voltage stabiliser OA2. Speaker 6 x 4 in. elliptical 8Ω, with cable and jack plug. Speaker grill.



250-0-250 80ma
6·3V - 3·5a
6·3V - 1a Tapped 5V 2a

Fig. 14: Circuit of the power supply unit which provides a stabilised 150V line plus 18V DC for the CIO and PD boards and 6·3V AC for the valve heaters.

The indicator lamp could be fitted to the set itself in the form of a dial light but this has never been found necessary with the 898 dial. The 100Ω resistor in the cathode side of the OA2 stabiliser is very useful as it enables the current in the OA2 to be monitored very easily. This should be around 10mA for best regulation which means 1V drop across the resistor. The important point is that OA2 should be seen to be working, by its glow, at all times. The current may be varied by changing the value of R2. Where a lower value is needed add low wattage resistors of 20kΩ or so in parallel with R2, rather than changing R2 itself. The total HT current taken by the receiver is approximately 40mA at 150V.

The supply to the CIO stage could be stabilised by means of a zener diode but since the stage is crystal controlled this was not thought to be necessary. The various output voltages are taken to a B7G valveholder at the rear of the unit.

CONSTRUCTION

The particular cabinet used to house the power supply unit and speaker has a pleasing appearance but there is nothing special in the choice or in the general construction. The layout can be seen in the photographs and only one or two points need any explanation.

A common bracket is used for the B7G valveholder for the OA2, mounted on long 6BA bolts, and the B7G output socket to which the various supplies are taken. Fuses, switches and the indicator lamp are fitted to the front edge of the cabinet, with twisted flex to each from the rest of the components mounted on the base plate. Make these leads of adequate length so that the cabinet can be separated from the base plate while the unit is working, for testing and checking purposes. The existing screw holes in the side of the cabinet are made into slots to facilitate this operation. When wiring any panel type fuse-holders always connect the live side of the circuit to the rear tag on the fuseholder to prevent the accidental touching of a live circuit via the fuse if it is being inserted with the fingers.

A large rectangular hole is cut in the front left hand side of the cabinet to suit the speaker chosen. This may seem a tedious job but by drilling a ¼in. hole in each corner and using a Mole Supercut tool it can be done in a couple of minutes. Alternatively, drill a series of small holes round the rectangle, cut between the holes with a pair of sidecutters and file clean. Yet another way is to punch a symmetrical series of holes over the area with a chassis punch such as will probably have been used to make the holes for the valveholders in the receiver. A plastic grille over the front of the cabinet gives a professional appearance to the unit.

Initially it was the intention to mount the speaker in the receiver cabinet but since the beam deflection valve is susceptible to external magnetic fields it was thought wiser to keep the speaker's permanent magnet well out of the way!

While in the mood punch a number of holes in the base plate and at the top edge of the back of the cabinet to provide through ventilation, assisted by fixing three rubber or plastic feet to the base

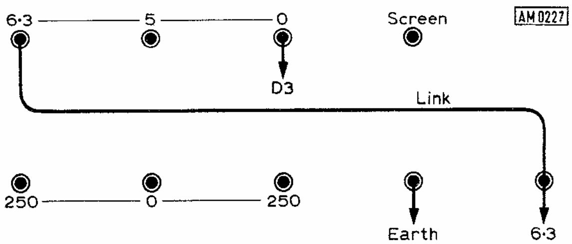


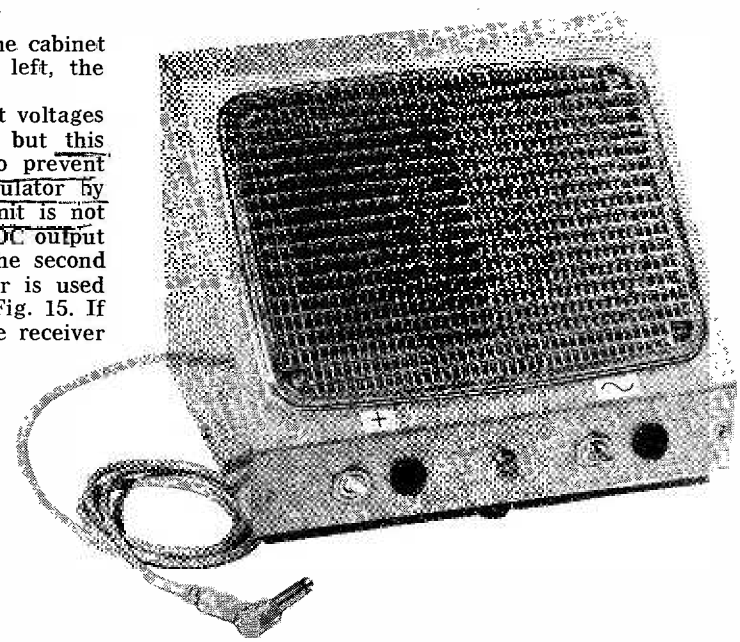
Fig. 15: If the specified transformer is used the wiring of the two 6·3V windings will be as shown here, for correct phasing.

plate. Slots are required in the back of the cabinet to clear the power outlet socket at the left, the speaker lead and the mains input lead.

The unit can be tested for correct output voltages before being connected to the receiver but this should be done as quickly as possible to prevent possible damage to the OA2 voltage regulator by excessive current through it when the unit is not being loaded by the receiver. If the 18V DC output is very low, reverse the connections to the second 6·3V winding. If the MT1AT transformer is used the correct connections are as shown in Fig. 15. If all is well plug in the B7G plug from the receiver and continue with the alignment procedure.

Initial adjustments. After checking and double checking the wiring of the receiver and power unit and with the mains switch off, fit all the valves and their screens with the exception of the ECC81. Fit the pair of Range 3 RF coils into their sockets. It is a good idea to mark the coil formers with a small label so that they are always used as correct pairs in the correct sockets. Use, for example, '3F' and '3R' meaning Range 3 front and rear. Once aligned the coils must not be interchanged. Ensure that 6BA lock nuts are fitted to each core screw.

Insert the IC, noting the correct position of pin 1 from Fig. 10, and then the three crystals again noting the correct position for each frequency from the Components List. With the HT switched off, switch on the power supply. The OA2 voltage regulator should glow and a background hiss heard in the headphones, controllable by the volume control. If the mode switch is on SSB/CW the hiss will increase slightly due to the CIO becoming operative. Check the low voltage supply at about 18V but if it is very



The finished power unit incorporates a loudspeaker having its own lead and plug enabling it to be used with the receiver or any other audio equipment. The supply lead from the receiver plugs into the back of the cabinet.

ALIGNMENT PROCEDURE

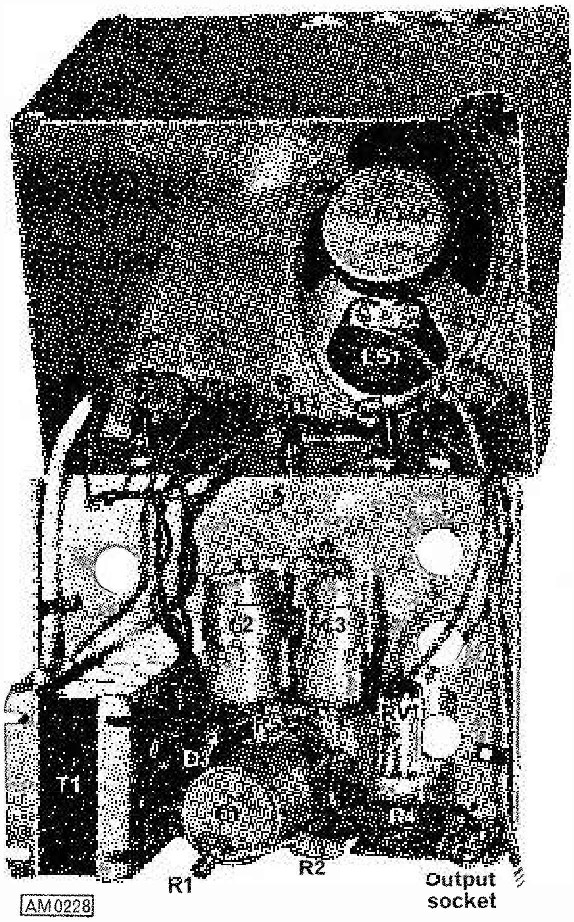
While a modulated signal generator is a highly desirable piece of equipment for aligning a receiver it is possible, in this design, to get adequate results without one. A 1MHz/100kHz crystal calibrator would help but failing even that it is possible to use either another short wave receiver or a domestic receiver having a short wave range covering the frequency of 8MHz. Calibration can be carried out by reference to stations of known frequency but this is a very tedious process.

When aligning a conventional superhet receiver it is customary to align the IF stages first at, say, 455kHz and then to feed test signals into the input stages adjusting the first oscillator until calibration is correct. The oscillator will in fact be working at signal frequency ±IF frequency, depending on the design. In this receiver the single range first oscillator is calibrated directly, initially at one frequency only, 8MHz, the rest of the calibration being done later.

low, around zero, reverse the second of the 6·3V windings on the transformer, as noted in the section dealing with the power supply. The valve heaters should also be seen to be glowing.

Switch on the HT and check for 150V on the HT line in the receiver. Operation of the IF gain control should increase the background noise when near maximum, least resistance. The RF gain control will have little effect at this stage. With both gain controls at zero adjust VR4 on the S-meter panel until the meter reads zero.

IF Stages. Connect a few feet of wire directly to the signal grid, pin 6, of the mixer valve V1, turn up the gain controls and switch to AM when a babble of stations should be heard at the IF of 5·5MHz, the receiver in effect becoming a straight TRF. Peak the signals with the RF tuning control which should be near minimum capacity. There may be two tuning peaks but either will do. Continue to peak the signals by adjusting the six cores in the filter and IF stages, V3 and V4. The S-meter is used as a tuning indicator for all these adjustments aiming at maximum reading. If it should reach full scale reduce the sensitivity by means of VR3 on the S-meter panel.



The cover of the power supply cabinet is removed to show the components mounted on the baseplate. The earth wire of the mains lead at the left is taken to the baseplate and the cover.

Now remove each core, one at a time, beginning at the filter, apply a spot of core locking compound or similar and replace the core adjusting for maximum signal. The object of this exercise is to ensure that the first tuning peak encountered is used since a second and incorrect peak may be found if the core is screwed in any further. Eventually the alignment should be repeated after the set is working properly in every respect. The adjustments, especially on the IFTs, will be found to be interdependent to some extent.

Calibration. The great advantage of having an IF filter of known frequency, 5·5MHz, is seen when the job of calibration is begun. In this design, once the low frequency end of the oscillator tuning range is established at 8MHz the rest of the scale calibration falls into place, more or less, for both ranges, the 8MHz point corresponding to 2·5MHz on one range and to 13·5MHz on the other. See Fig. 16.

Fit the ECC81 valve and its screen. Make quite sure that the tuning dial and capacitor are working smoothly from end to end of the travel, that the maximum capacity coincides with 0° on the dial and that the grub screws in the flexible coupling are tight. Unscrew the core (anticlockwise) in the oscillator coil L12 for minimum inductance and set trimmer capacitor TC3 to about the mid position of its travel. Set main tuning to 5° on the dial, almost maximum capacity.

It is only fair to mention at this point that signals around 2 to 3MHz can now be heard if an aerial is connected to the set and the RF tuning peaked, if only to demonstrate that all the work and expense has been worthwhile!

If another short wave receiver is available, having reliable calibration, set it for CW reception on 8MHz and run a short wire from its aerial terminal to the vicinity of the oscillator valve V2. Run in the core of L12 until the signal is heard on the check receiver. It is now necessary to set the upper end of the range to 18MHz, at 175° on the dial. Run the dial to this point following the signal on the check receiver and adjust TC3 to give 18MHz at 175°. Return to 5° and readjust L12 for 8MHz. This sequence should be repeated until the calibration at each end is correct, then lock the core of L12 with the nut.

Intermediate points can be filled in using the check receiver or, preferably, a 1MHz/100kHz crystal calibrator in conjunction with the check receiver. Use a soft pencil for marking the dial on a blank scale remembering that this calibration is for the first oscillator frequency only. The proper calibration can be done later for the actual tuning ranges, simply adding or subtracting 5·5MHz to or from the oscillator frequency. For example, when the oscillator is on 12MHz the scales will be marked 6·5MHz on one and 17·5MHz on the other, and so on. The intermediate 1MHz points can be filled in using the crystal calibrator at the aerial input.

All calibration should be temporary at this stage, being finalised at a later date when the receiver has been in use for a while. The initial calibration was in fact adjusted to place the 14MHz amateur band at the end of the scale.

If all else fails a domestic type short wave receiver may be pressed into service provided it can be tuned to 8MHz but its accuracy will be highly suspect! As before, take a wire from the set to the oscillator compartment and adjust L12 core until the signal is heard. As there is no BFO on the set the signal will be heard as a rushing noise unless there happens to be at station of some sort on 8MHz when a heterodyne whistle will be heard. This was tried using a cheap transistor portable enabling the 14MHz amateur band to be found a little way up the dial of the 'Epsom' without any trouble at all.

The owner of a good signal generator will presumably know how to use it to align this receiver but it should be remembered that the IF response is very sharp and to ensure that the SG is always on tune its dial should be rocked back and forth across the frequency as alignment proceeds. If the modulated CW facility of the SG is used the audio output of the receiver may be monitored at the output socket with a low range AC voltmeter but the AGC line must be temporarily shorted to earth to prevent AGC action masking the effect of alignment adjustments.

—continued on page 539

goes low and this forces a "1" at pin 8 of the Ball Blanking flip flop. This output is combined with the ball signal in AND gate IC29d, and the output signal from pin 8 of IC29 is the true BALL signal which will brighten up on the screen.

As soon as the ball appears the right hand player takes his finger off the button and the game progresses—the ball stays bright because of the latching action of the ball blanking circuit. Let's say the left hand player successfully returns the ball but the right hand player misses it. What happens?

Whenever a LEFT or RIGHT BASE signal occurs, pin 3 of IC28 goes high and this is combined with the BALL signal in IC28b. When the right hand player misses the ball there is bound to be an eventual coincidence between BALL and his end base. This shows itself by the signal at pin 6 of IC28 momentarily falling to zero (we call this the Lose signal) and this resets the ball blanking flip flop thus extinguishing the ball. It should be clear that this would also have happened had the left hand player missed because the signal at pin 3 of IC28 is RIGHT BASE or LEFT BASE.

We shall not dwell on the logic any further except to draw your attention to the two series switches in the lose line feeding pin 12 of IC27. These open circuit the lose input to Ball Blanking during a service, otherwise we could get coincident noughts at both pins 12 and 9 (IC27) if the ball happened to be bouncing off the left or right base at the time. This would cause ambiguity in the logic which has to be avoided at all costs.

We expect that the lesser experienced constructor might have some difficulty in following this brief description of a fairly complex bit of logic. Do not let this put you off constructing the project, however. It is most unlikely that you will suffer faults in this region providing you are careful with your soldering.

Part 5, next month, will deal with testing Board D, final adjustments and will include inter-connection drawing for all boards and panel.

TECHNICROSS SOLUTION NO.6

1R		2D		3A	4C	O	5U	S	6T	I	7C	S
8E	M	I	T		H		S		U		O	
S		S		9R	E	T	U	R	N	I	N	G
10I	O	T	A		F		R		E		E	
S		O		11P		12A	P	E	R			13W
14T	A	R	G	E		U			15S	16I	L	O
O		T		17R	A	D	I	18O		N		R
19R	E	S	20T			I		21H	O	T	E	L
S			22E	R	23G	O		M		E		D
	24D		N		R		25W		26B	R	O	W
27M	A	I	N	S	U	N	I	T		C		I
	T		I		N		R		28L	O	A	D
29C	A	S	S	E	T	T	E	S		M		E

PW EPSOM—*continued from page 527*

Mixer Stage. Again, this is just a matter of a logical sequence of adjustments, easier to perform than to describe! Fit Range 5 coils in the mixer stage (highest frequency range) and set dial to the low end of the scale, about 15MHz. Set trimmers on RF tuning gang capacitor and VC3 to about half way and RF gain control to maximum. If a signal generator is not available choose a station in the 20m broadcast band that is fairly steady in signal strength. Set the RF tuning to about two-thirds of maximum capacity and adjust the cores in the RF coils for maximum output, using the S-meter as before.

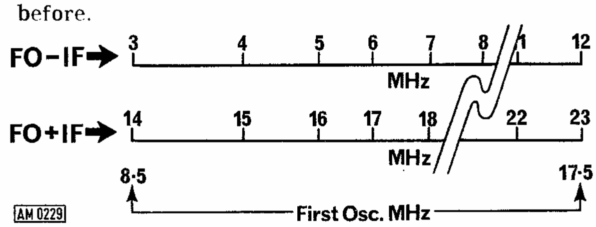


Fig. 16: Illustrating the way in which the single range first oscillator is used to provide the calibration of the two ranges actually marked on the dial.

To check this adjustment, rock the RF tuning back and forth when two peaks of maximum signal may be noted. The adjustment should aim at making the two peaks coincident. Tune to a station at the HF end of the band, the 13m broadcast band will do, and adjust trimmers TC1 and TC2 for maximum signal, aiming at a single peak. Check and readjust cores at the LF end, the trimmers again at HF. Tighten core lock nuts and seal trimmers. Mark the RF tuning dial at 1MHz points corresponding to the main dial calibration.

Repeat the above procedure with pairs of RF coils for Ranges 3 and 4 and tighten lock nut on cores. **Note:**— adjust the **cores only** on these two ranges, at the LF end of each range. Do not touch trimmers TC1 and TC2 again after they are aligned for Range 5, where they have most effect. The RF tuning dial calibration can be seen in the photographs.

Carrier Insertion Oscillator. With the mode switch on SSB/CW, tune in an SSB signal, on say the 20 or 80m amateur band, and while tuning very slowly across the signal adjust trimmer TC4 on the CIO crystal for best speech quality. Try this on several stations before finding an optimum position and then seal the trimmer.

NOTES

The 'AE Trim' control VC3 allows the input tuned circuit to be peaked for different types of aerial and will be found to be most effective at the higher frequencies. In practice the RF tuning will be found to be very sharp and can very easily be missed when the receiver will be thought to be rather dead!

There is no reason why the first oscillator circuit should not be modified to provide amateur band coverage only or particular broadcast bands, replacing the tuning capacitor, in effect, with a fixed capacitor to find the band required plus a parallel tuning capacitor. Multiband operation merely requires a multiway bandswitch, preferably ceramic or PTFE, to bring in the various combinations of capacitors. Whatever alterations are made they do not affect the RF tuning which is just peaked to the signal frequency involved. ■