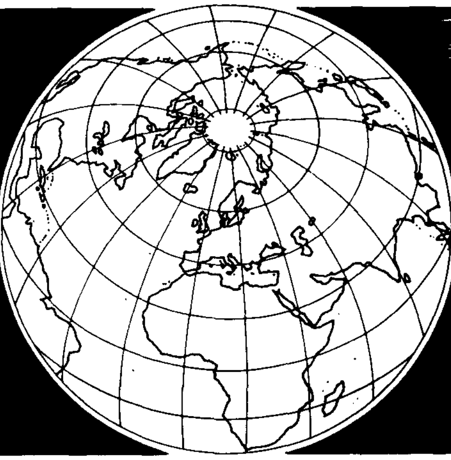
PW EPSOM

ERIC DOWDESWELL G4AR

GENERAL COVERAGE SHORT WAVE RECEIVER



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.

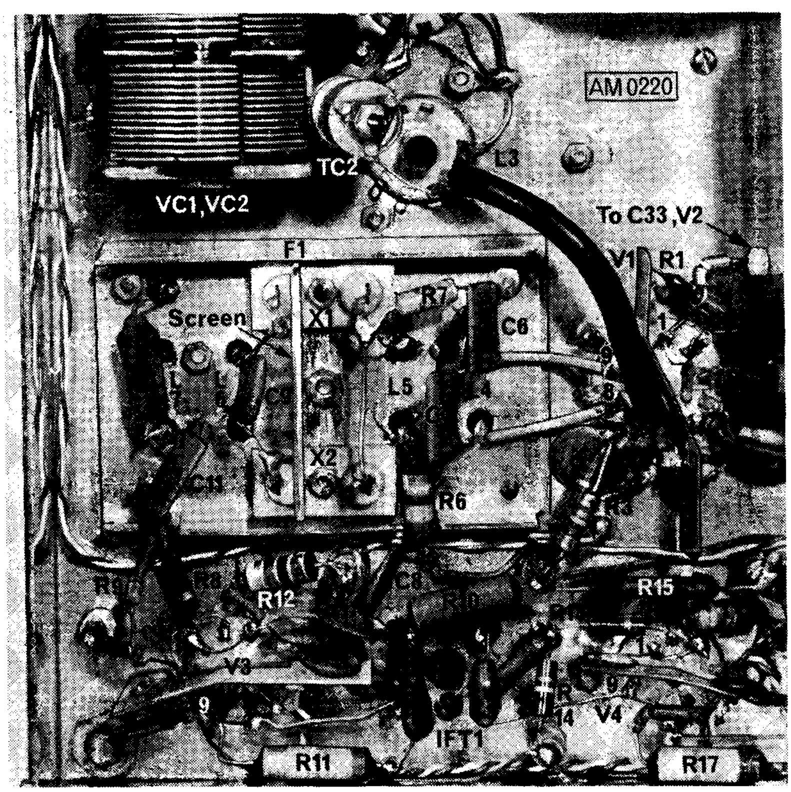
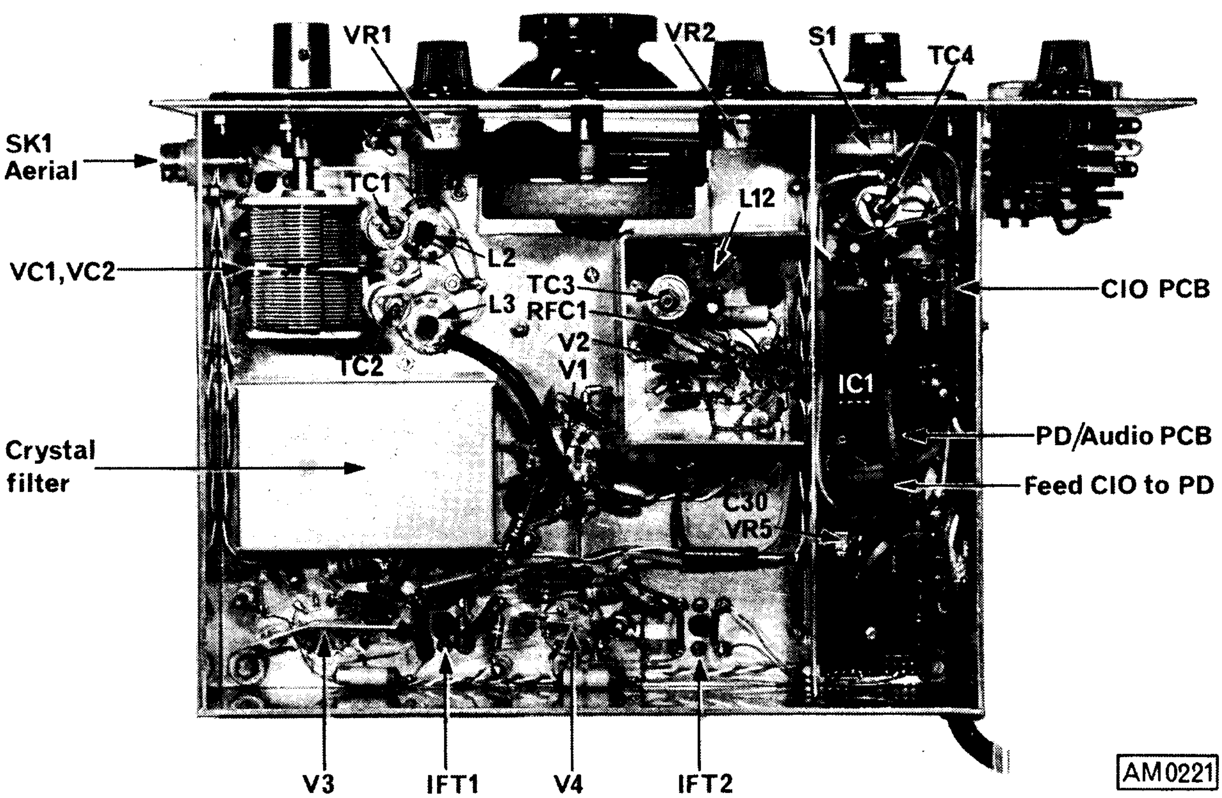


Fig. 8: Close-up of the crystal filter box and associated components. The crystal sockets shown are those used with surplus crystals in the original experiments with the filter. The crystals and holders supplied by Senator Crystals are HC6U style.



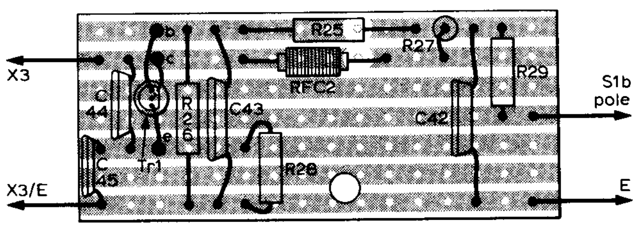
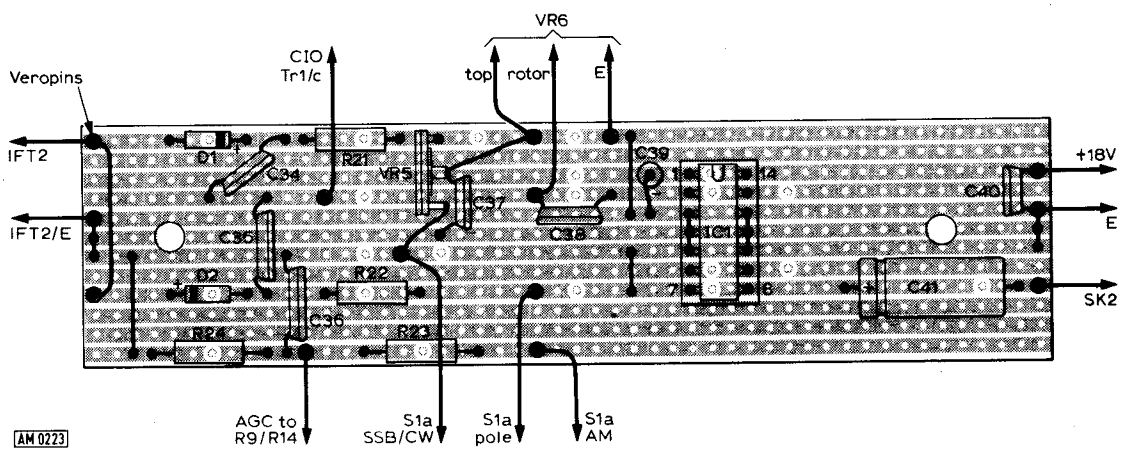


Fig. 9: above, gives the location of the principal components under the chassis. Figs. 10 and 11, left, show the layouts for the carrier insertion oscillator and product detector boards, actual size. Each board can be tested before being fitted into the chassis.



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.

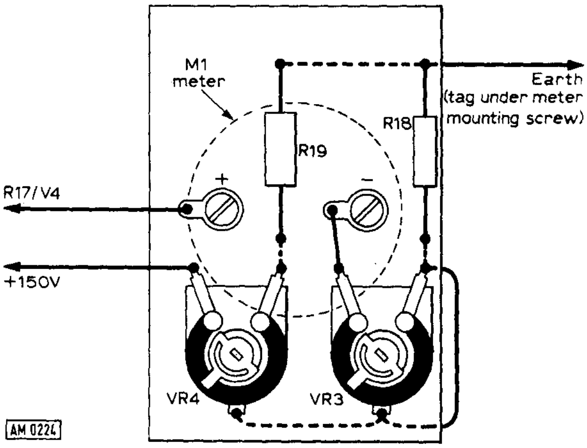


Fig. 12: Layout of the components in the S-meter circuit.

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.

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 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.

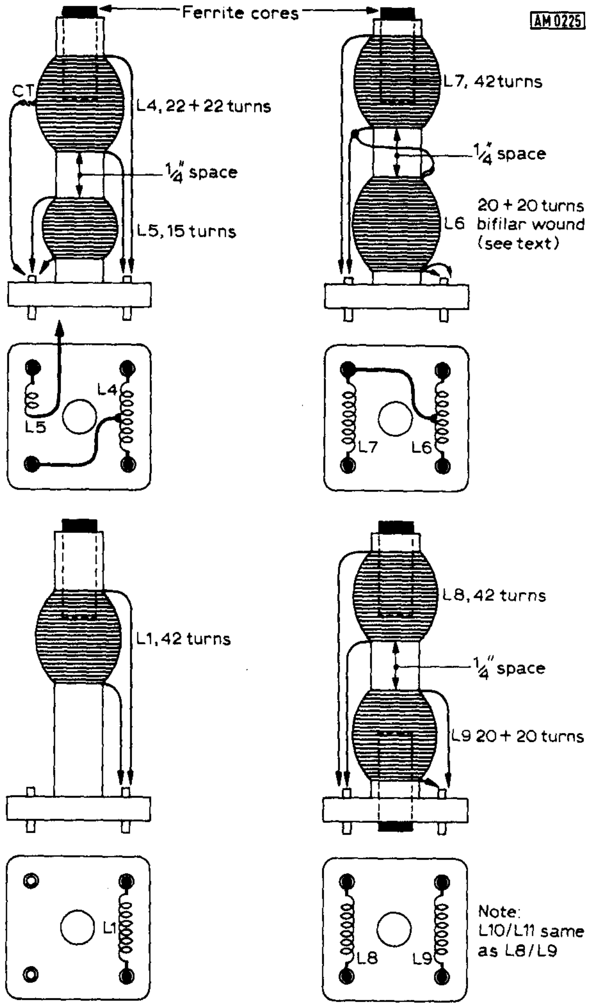


Fig. 13: Details of the windings for the filter and IF transformers and the IF trap. The former length is 1⅝in. and not 1¼in. as shown in components list.

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.

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.

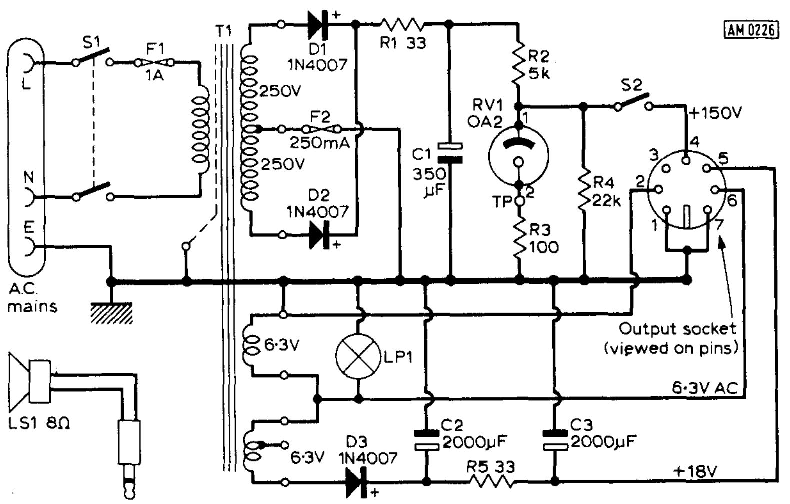


Fig. 14: Circuit of the power supply unit which provides a stabilised 150V line plus 18V DC for the CIO and PD boards and 6·3V AC for the valve heaters.

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 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.

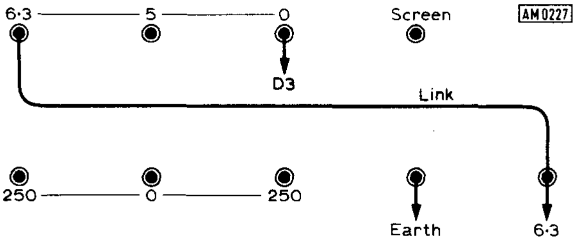
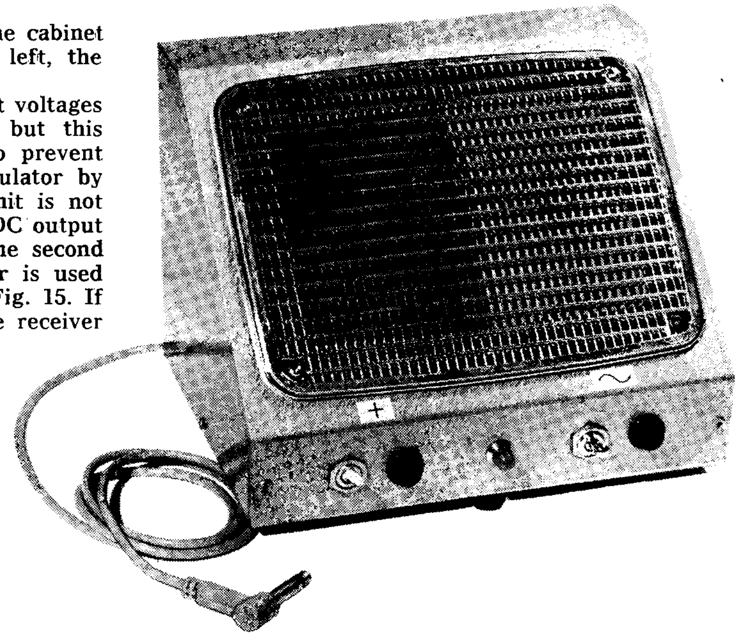


Fig. 15: If the specified transformer is used the wiring of the two 6·3V windings will be as shown here, for correct phasing.

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 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.



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.

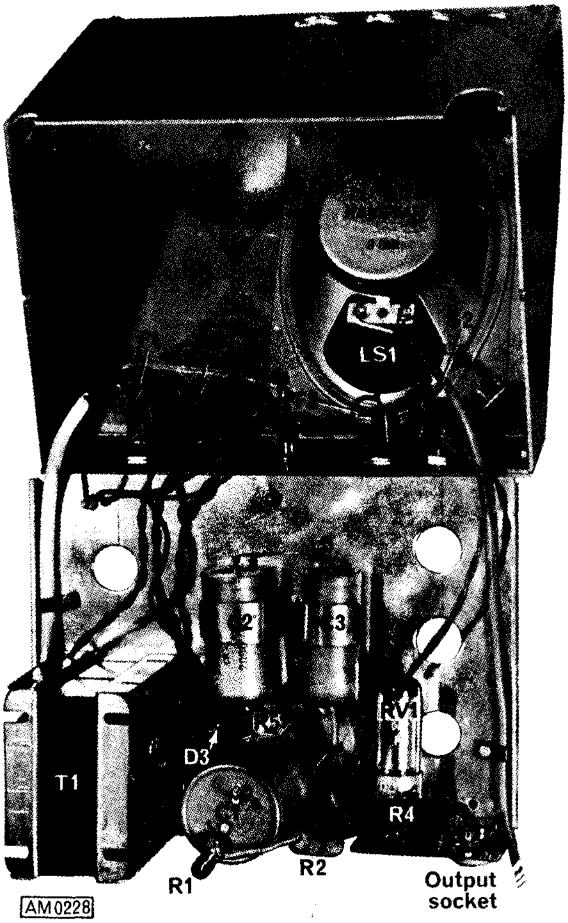
ALIGNMENT PROCEDURE

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.

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

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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.

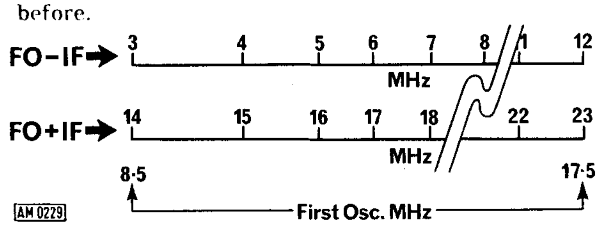

Fig. 16: Illustrating the way in which the single range first oscillator is used to provide the calibration of the two ranges actually marked on the dial.

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. ■