Upgrading the KW2000 series of HF transceivers

by M. T. Healey, G3TNO and R. Charles

There's no denying that starting in Amateur Radio these days can be an expensive business. Gone are the days when, given a couple of evenings and a well-stocked junk-box, it was possible to knock up a rig which could hold its own against the competition on the DX bands. Today a commercially-built transceiver is a virtual necessity unless one confines oneself to CW, and even then the possessors of the latest black boxes have a considerable advantage when it comes to snaring rare DX stations. With the cheapest ready-built HF rig now selling for about £450, it is not surprising that many newly-licensed (and not so newly-licensed!) amateurs turn to the second-hand-market for their gear and, fortunately, there is plenty of good second-hand equipment available. One rig which represents particularly good value for money is the KW2000 which, in its basic form, can be obtained for as little as £75, and even in its later forms rarely sells for more than £150. The purpose of this series of articles is to familiarise newcomers to the amateur field with a rig which, although now about 15 years old, is nevertheless capable of giving a very good account of itself on the HF bands, and to describe some of the many modifications which can be carried out to bring the performance of the rig up to a standard approaching that of its vastly more expensive modern competitors.

The story so far.

It may come as a surprise to anyone who has come into Amateur Radio during the last few years to learn that there was a time not very long ago when the market for ready made equipment was not dominated by the Japanese, and when at least one British manufacturer produced a rig which sold well, and was highly respected, all over the world. The time was the late 60s, and the manufacturer concerned was KW Electronics, a firm who, happily, seem to be making something of a comeback into the market after several years of virtual absence. At that time, most amateur operation took place on HF, the Class B licence having only recently been introduced and still being restricted to frequencies above

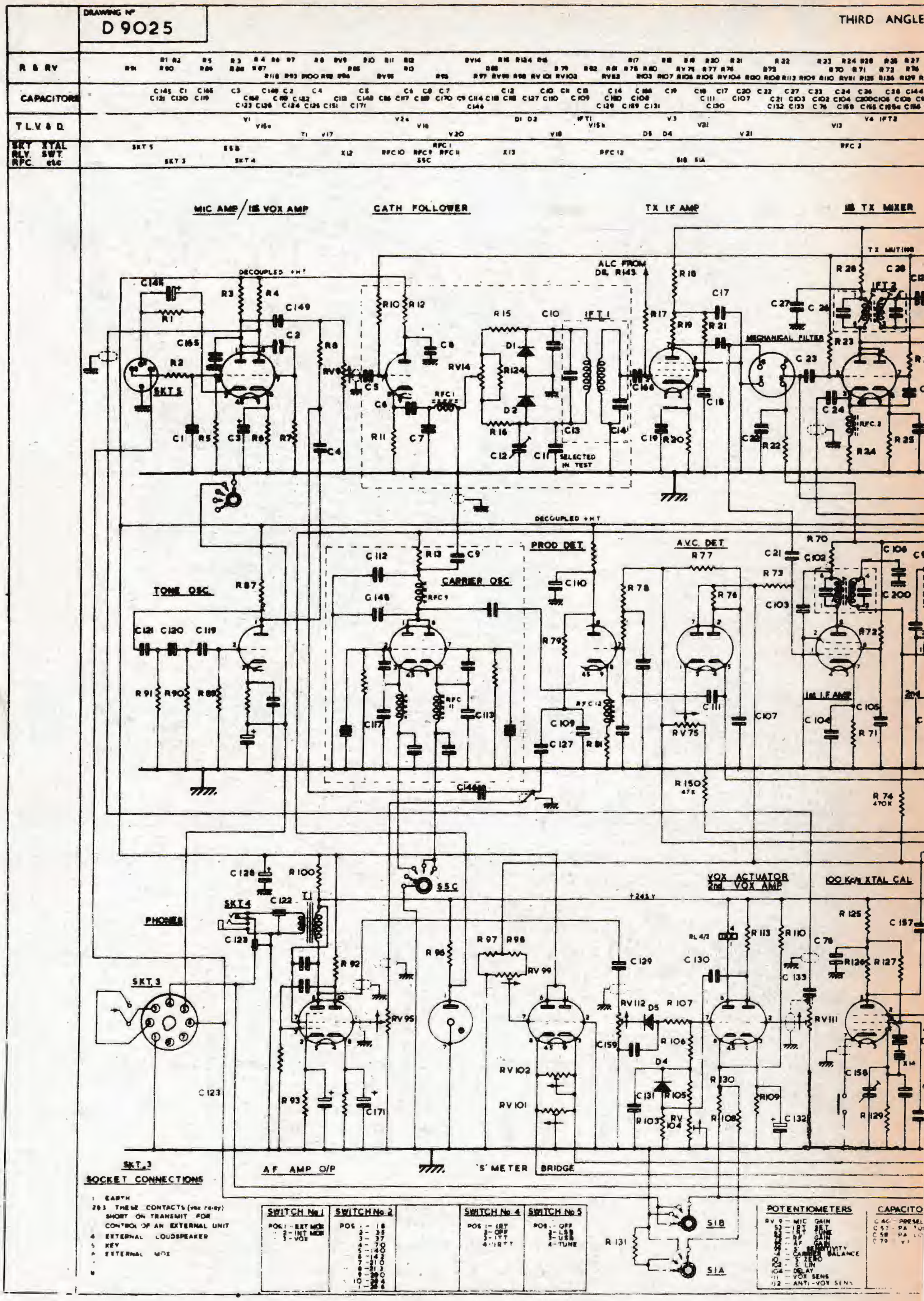
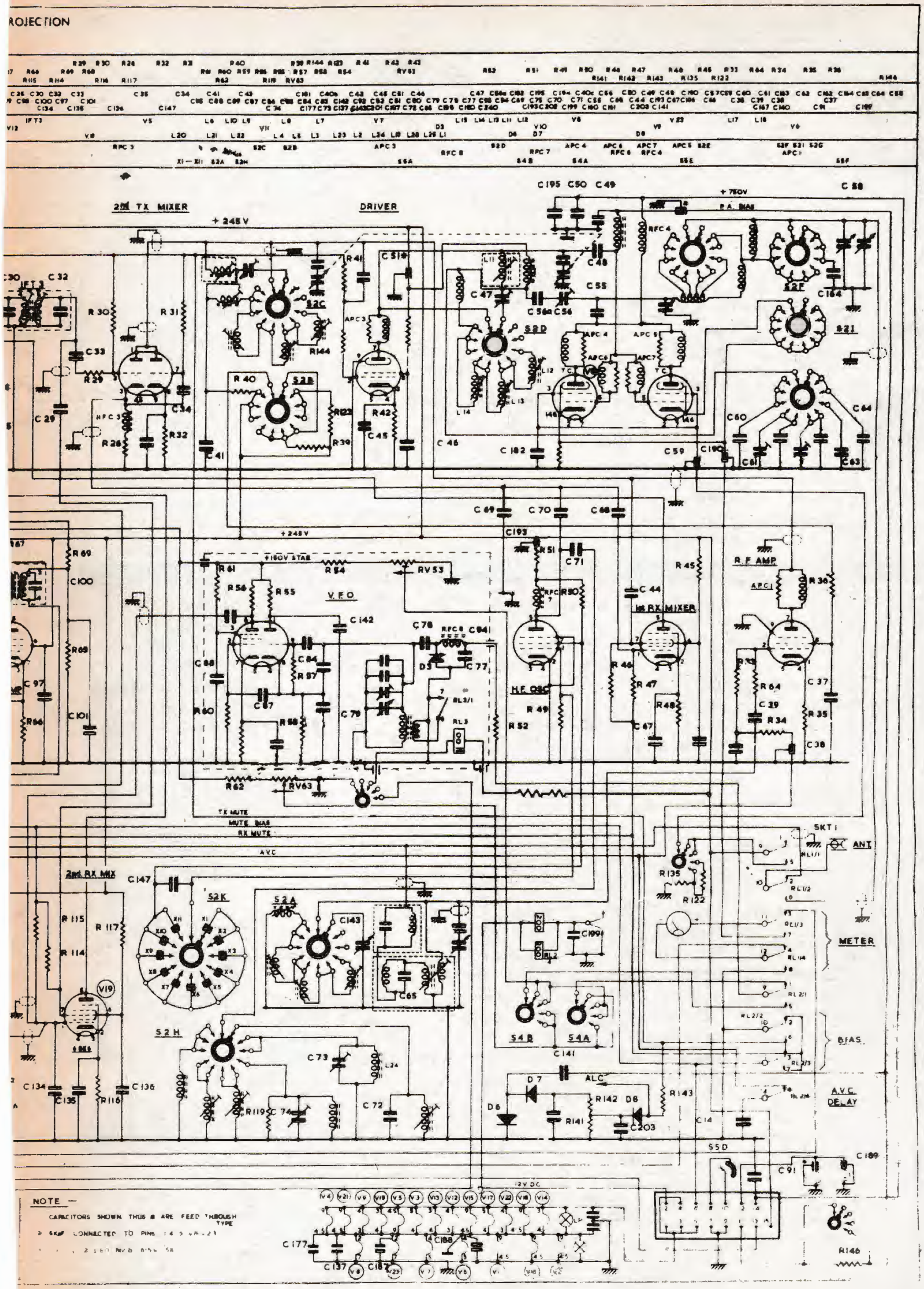


Fig. 1. Circuit of KW2000 A. KWZ000 is similar, but does not have V23 (2



PA valve) or ALC circuit (D6,D7,D8 and associated components).

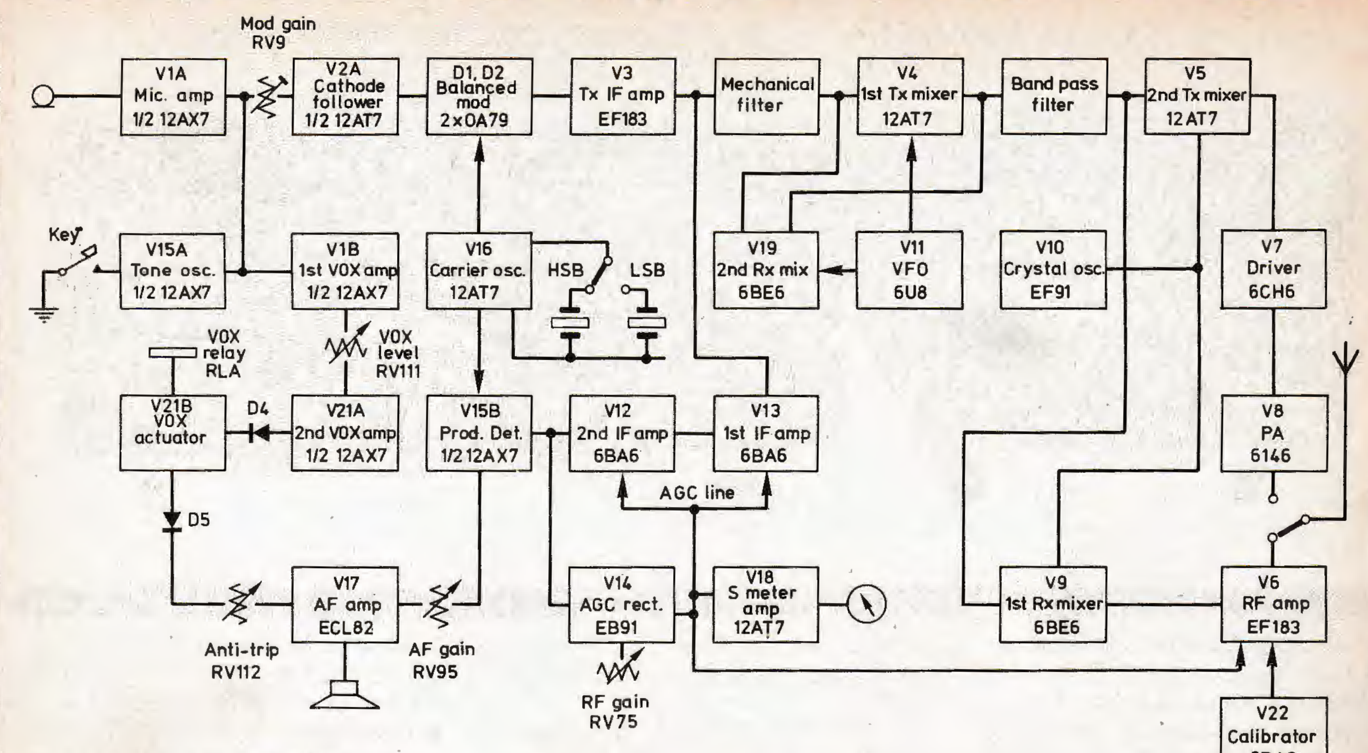


FIG. 2 Block diagram of KW2000

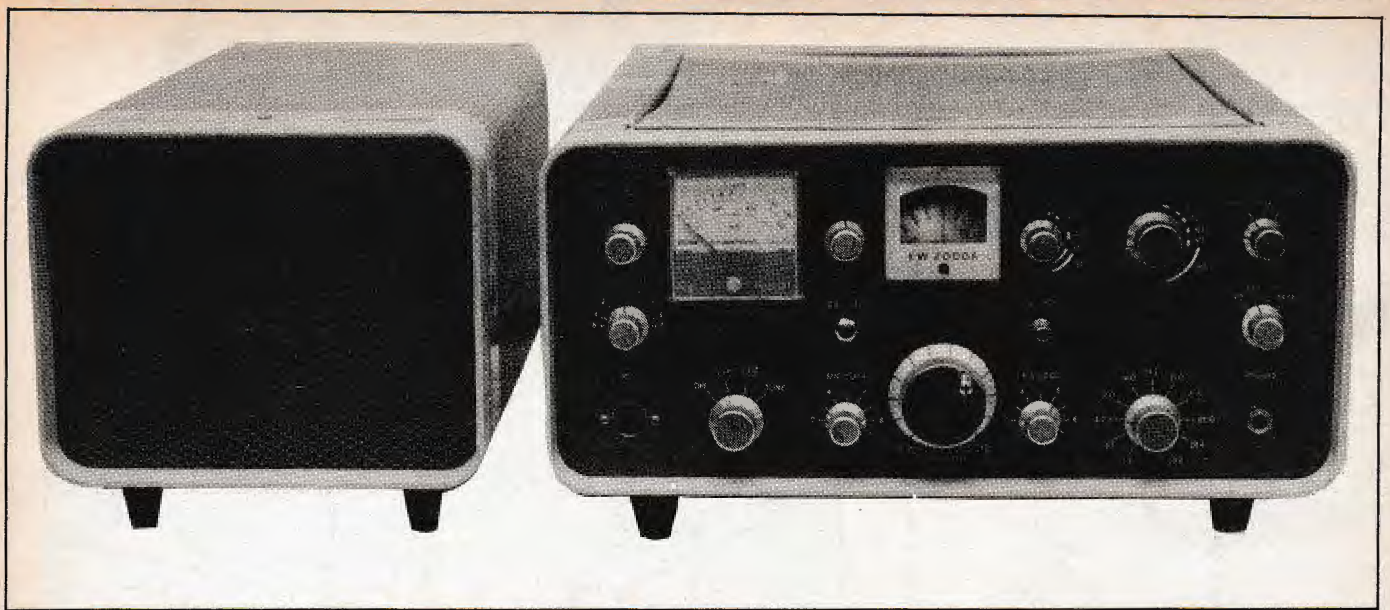
420MHz (yes, 70cms started at 420MHz in those days!), and the dominant mode was AM. It was the very end of the era when normal practice had been to buy an ex-forces communications receiver such as an AR88 or HRO, and to build a simple all valve transmitter to use with it. SSB was just beginning to appear on the bands and was regarded with great suspicion by some of the older hands! It soon became apparent even to them that SSB was the mode that would mainly be used in future, and more and more amateurs put their old AM rigs to one side and began to use sideband. The greater complexity of SSB transmitters as compared to those for AM deterred many who would normally have built their own gear from doing so, and there was thus a great upsurge in the demand for commercially built equipment. It was this new market that KW Electronics tapped, first with the Viceroy transmitter, and then with the KW2000 transceiver which, with its successors, was undoubtedly their most successful model. In its heyday it sold all over the world (including Japan) and was widely regarded as representing the state-of-the-art in amateur equipment. *It was also one of the first transceivers, as opposed to separate transmitters and receivers, to appear on the market and, with its successors the KW2000A, B, and E, it remained in production until, in about the mid 70s, it was overtaken by more modern designs from Japan. However, many thousands were sold, and most of them are still around and still giving a good account of themselves on the air.

Circuit description

The basic KW2000 was an all valve transceiver covering the 1.8, 3.5, 7, 14, 21, and 28 MHz bands, and producing an output of 50 watts from a single 6146. Its appearance can be seen from **Fig. 1**, which actually shows the KW2000A; however, the appearance of the KW2000 was virtually identical. Despite being all valve it was not significantly larger than its modern counterparts,although, as can be seen, the power supply was separate from the transceiver, an alternative mobile power supply being available. The actual dimensions were 35x15x27 ins for the transceiver and 20x15x27 ins for the mains power supply, their weights being 7.25kg and 9kg respectively. The cases of both units were of 'wrap around' construction, meaning that they formed complete removable sleeves around the chassis. After removing the four feet the cabinet could be slid away from the rig leaving both sides of the chassis exposed. In addition, a hinged flap was provided in the top of the transceiver case allowing valves and pilot lights to be replaced without the case being removed.

A block diagram of the transceiver is shown in **Fig. 2**. Starting at the top left, the signal from the microphone is amplified by a single valve VIA (½ 12AX7), and then fed via a complete follower V2A (½ 12AT7) to the balanced modulator which consists of two germanium diodes (OA79). In common with many rigs produced in the early days of SSB, the KW2000 generates its SSB signal at a comparatively low

** A rather frivolous indication of the esteem in which it was held is that, when Peter O'Donnell wanted to introduce an Amateur Radio interest into his "Modesty Blaise" cartoon strip, he showed Modesty and Willie using KW2000Bs to maintain contact between London and South America. It was obviously considered that no well-equipped amateur would use any other rig!*



frequency, 455 kHz to be precise, and it is approximately this frequency which is fed to the balanced modulator by the carrier oscillator V16 (12AT7). A front panel switch allows the selection of either of two carrier crystals, one HF and one LF of the filter passband, producing lower sideband or upper sideband respectively.* From the modulator the signal passes through the sideband filter, a mechanical filter 2.1 kHz wide. It is then fed to the first balanced mixer V4 (12AT7), where it is mixed with the signal from the VFO V11 (6U8), which tunes 2.5 to 2.7 MHz, to produce a tunable IF of 2.955 to 3.155 MHz. It will be noticed that this is a tuning range of only 200 kHz, and in fact all the models in the KW2000 range, with the exception of the KW2000E, cover the bands in 200 kHz segments rather than the 500 kHz segments common on more modern rigs. In practice this is no great drawback until we reach the 21 MHz band to which only two segments are allocated, resulting in a gap of 100kHz in the middle of the band! The situation is even worse on 28 MHz, where only 600 kHz of this 1.7 MHz wide band are covered, namely 28.0 to 28.2 and 28.4 to 28.8 MHz. However, it is quite easy to modify the rig to overcome this deficiency, as will be described later.

In fact, the sidebands are inverted in a subsequent mixing process, so that the LF carrier crystal actually produces the lower sideband at the output of the rig, and vice versa.

The VFO utilises both sections of VII, the triode section being the actual oscillator and the pentode section functioning as a buffer amplifier. Both sections are supplied from a stabilised volt HT supply, V20 (OA2) being the regulator, and their heater is obtained from a separate 6.3 volt supply which can be regulated to improve VFO stability (see modification in a later article). Incremental tuning is provided by a varicap diode D3, and this can be switched to operate on receive only, transmit only, both or neither. In addition, a small relay RL3 introduces a shorted one turn link into the VFO coil when LSB is selected, reducing the inductance and hence moving the VFO slightly HF. This ensures that the output carrier frequency remains constant when sideboards are switched, a feature not always found in modern rigs!

The tunable IF signal from V4 passes through a bandpass filter composed of two back-to-back IF transformers and is then applied to a second balances mixer V5 (12AT7). Here it mixes with the output of the crystal oscillator V10 (EF91) to produce the desired output frequency. The crystal frequency is always on the high side of the output frequency, and this results in the frequency range being inverted. In other words, as the VFO tunes from the LF end of its range to the HF end, the output frequency moves from HF to LF. It is important to remember this if the VFO ever has to be serviced! From the second mixer the signal passes via the driver valve V7 (6CH6)* to the PA, a 6146 operating in class AB.

On receive, the signal traverses a similar path in the opposite direction, using mostly the same filters. The signal from the aerial is first amplified by the RF amplifier V6 (EF183) and then passed to the first receive mixer V9 (6BE6), the tuned circuit used between the two valves being the same one as is used between the second transmit mixer and the driver stage. V9 is also fed with the signal from the crystal oscillator V10, and thus converts the incoming signal down to the tunable IF, which is passed through the bandpass filter to the second receive mixer V19 (6BE6). Here it mixes with the VFO signal to produce 455 kHz, which passes through the mechanical filter before being ampilified by two IF stages, V13 and V12 in that order (both 6BA6). It is then fed to the product detector V15B (½ 12AX7) and from there via the AF gain control RV95 to the two stage AF amplifier V17 (ECL82) which drives the loudspeaker.

The IF signal from V12 also drives the AGC rectifier, one half of V14 (EB91), and the AGC voltage developed controls the two

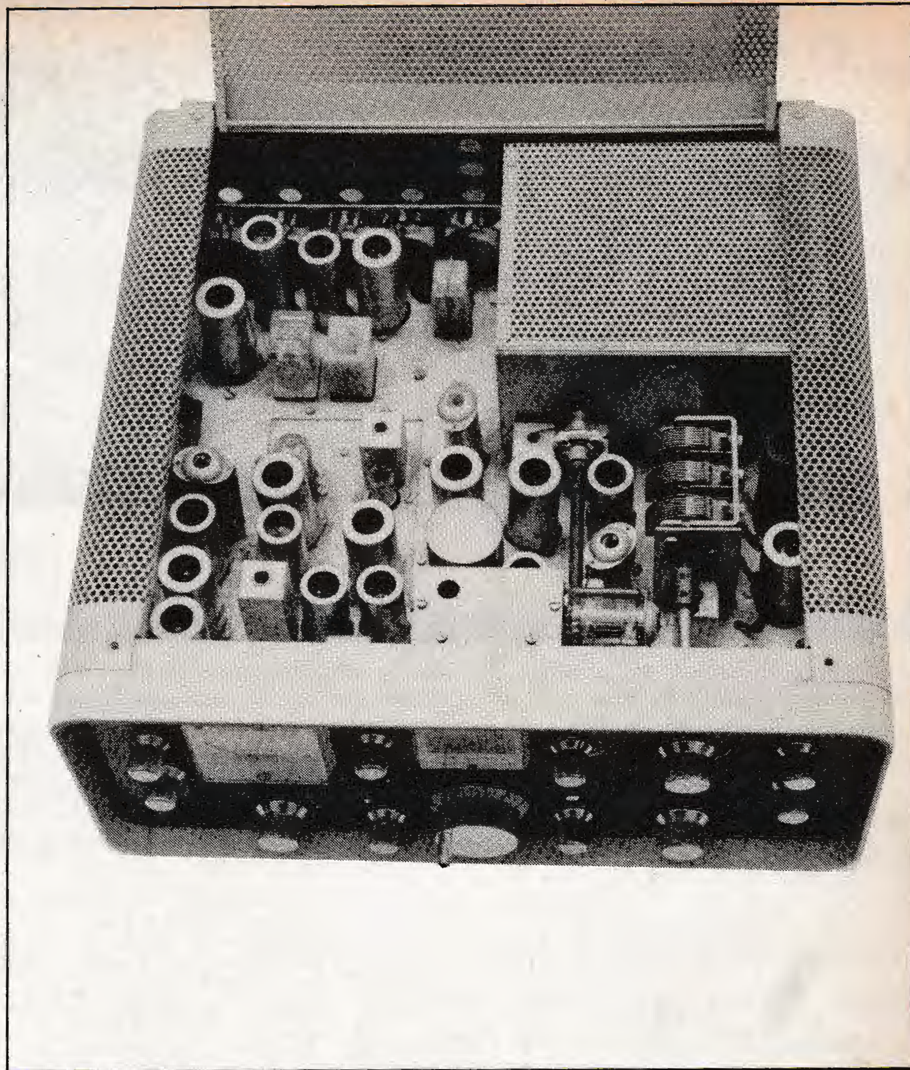
**This valve, by the way, is ridiculously expensive, costing almost twice as much as the PA valve!*

IF stages V12 and V13 and the RF stage V6. The RF gain control also acts via the AGC line, a fixed negative voltage being applied to the AGC line from the RF gain control RV75 via the other half of V14. The S meter is operated from the AGC line via V18 (12AT7). This, incidentally, is arranged to give a true logarithmic characteristic, which means that the 'S' calibrations and dB markings are accurate unlike many modern so-called 'S meters' which simple measure the AGC voltage on a linear scale. The meter is switched by a relay to read PA cathode current on transmit.

For CW operation an audio oscillator V15A (½ 12AX7) is keyed, its output being coupled at low level to the modulation gain control RV9. The audio tone is also fed to the receiver AF gain control RV95 to produce side tone. The tone oscillator is also used for tuning up; when the function switch is put into the TUNE position the rig is switched to transmit, the tone oscillator is switched on and the PA is put into Class C and its screen voltage is reduced.

The VOX circuit employs two valves, VIB (½ 12AX7) and V21 (12AT7). VIB is fed with audio from the anode of the VIA (which point, incidentally, is also connected to the top end of the mod gain control, and hence receives the signal from the tone oscillator V15A). VIB further amplifies the audio before applying it to the VOX gain control RV111 which feeds a further amplifier V21A. The output of V12A is rectified and used to turn on V12B whose anode lead contains the VOX relay RL4. The signal from the anode of the receiver output stage V17B is rectified in the opposite sense and used to provide anti-trip, the level being controlled by RV112. One pair of contacts of RL4 operate the main send/receive relays RL1 and RL2, and the other set of contacts are brought out to pins on the accessory socket to control external equipment such as linears.

The one valve which has not so far been mentioned, V22 (EF91) is a 100 kHz crystal calibrator, activated by a push button on the front panel. A small knob allows the cursor on the VFO tuning dial



to be moved by about ±10 kHz to correct calibration errors.

The power supply unit provides two HF voltages, 245 volts which is used by most of the stages and 750 volts for the PA anode (the screen is fed from the 245 volt rail). In addition, two negative bias supplies are provided, one variable between 50 and 65 volts, which provides the operating bias for the PA, and the other fixed at 65 volts, which is used to switch off whichever stages are not being used in either transmit or receive modes, and also to provide the RF gain control voltage. In addition, the power supply produces -12 volts DC for the relays, 12.6 volts AC for most of the heaters, and a separate 6.3 volt supply for the heaters of the V10 and V11.

Variations on the basic theme.

The KW2000 was quickly followed by the KW2000A, which used two 6146s in the PA thus increasing the 100 watts, and also possessed an ALC system, which derives its control voltage from the spurious audio which appears at the PA grid when that stage is driven into grid current. The ALC voltage is applied to the grid of the transmit IF amplifier V3, controlling its gain. The next model to appear was the KW2000B whose main improvement was a better slow motion drive for the VFO. The last, and least successful, member of this family was the KW2000E, which increased the VFO tuning range to 500kHz, but at the expense of stability. The C and D suffixes were used for models produced for professional use, eg ship to shore communication. ●

The next article in this series will deal with common faults, and tell the reader how to return a newly acquired KW2000 to full working order, which should be done before any modifications are attempted.

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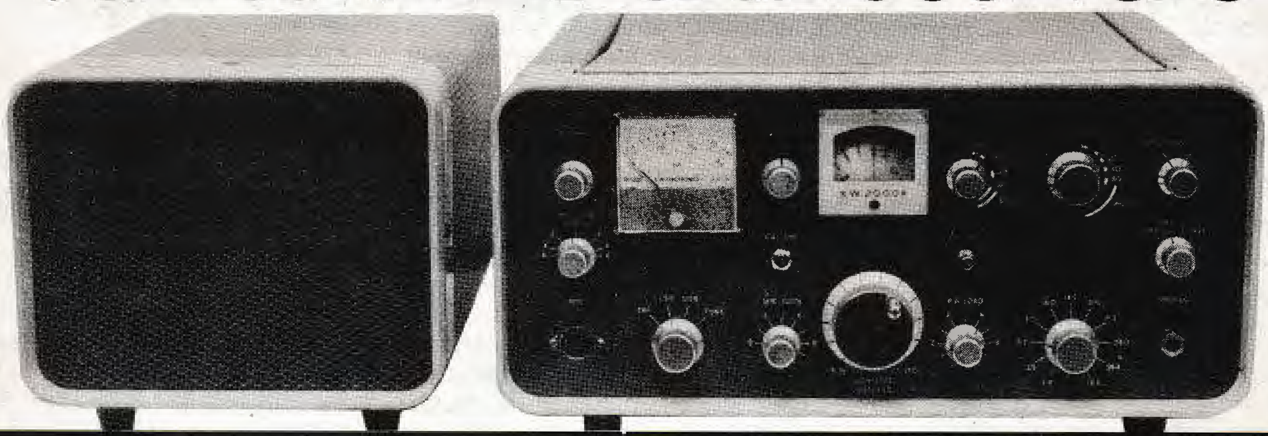


Part 2

By M. T. Healey, G3TNO and R. Charles

Making good the wear and tear

In Part 1 of this series a general description was given of the *KW2000* series of HF transceivers, which represent particularly good value-for-money on the second-hand market at present. This second article gives guidance on the diagnosis of any faults which may be present, and the third article will cover the alignment procedure. Subsequent articles will give details of some of the many modifications which can be carried out to improve various aspects of the performance. Before any modifications are attempted it is strongly recommended that the test procedure to be given in this article is followed since any fault which may exist may well be more difficult to trace after modification, and it may well not be obvious whether a malfunction is due to an error in the modification or whether it already existed! It is assumed that the reader possesses a few hand tools including a *decent* soldering iron, a set of proper alignment tools, ie. hex nylon type (DO NOT USE A MATCHSTICK OR FILED-DOWN KNITTING NEEDLE AS THIS CAN BREAK THE HEXAGONAL CORES!) and a multi-range test meter (not DVM) of at least 20k ohm/volt which is able to measure up to 10M ohm resistance. A good quality signal generator is also useful although not essential unless the alignment has been severely tampered with. A dummy load and some means of measuring RF output power (eg. an SWR meter) are also required, and a general coverage receiver is useful if the 2000 has been badly misaligned.

Initial test procedure

In this section a complete test procedure is given which should be adopted with a newly acquired rig to verify that all sections are operating correctly before any modifications are attempted. If a fault is found at any stage during the testing it should be repaired before proceeding any further with the tests. The causes and cures for various commonly encountered faults are given later in this article.

The transceiver should first be removed from its case by removing all four feet on the underside of the cabinet and then gently sliding the chassis forward to clear the case. At this stage it is as well to have a completely clear bench on which to work. Next the power supply and a suitable aerial system should be connected, and the transceiver switched on and allowed to warm up for 5-10 minutes. Following the list in **Table 1**, the various controls should be checked for smoothness of operation and absence of crackles or any intermittency of operation, checking through the bands on receive only from 28MHz to 1.8MHz, placing a tick in the right-hand box of **Table 1** if a control is considered to be working correctly, and noting any faults found in the centre column. There is no point in continuing until there is a complete set of ticks since the same ground may have to be covered twice if any problems are ignored at this stage. It is useful to keep the check list for future reference in case of the recurrence of a fault; this will save the repeated investigation of the same problem!

Next the transmitter's basic operation should be checked. The aerial system should be removed and the rig connected to a good dummy load as shown in **Figure 2A.** Filament lamps should not be used as a load since their resistance changes with power level, they are inductive and they tend to radiate! The 3.7MHz should be selected and, with the MIC GAIN control at minimum, the rig is set to TUNE and tuned up as described in the handbook, that is by gradually increasing the mic gain and adjusting PRE-SELECT and PA TUNE and LOAD for maximum output. The function switch is then set to either USB or LSB, the MIC GAIN set to minimum and INT. MOX selected. This puts the rig into transmit but with no drive to the PA, so there should be no power indicated on the power output meter or SWR meter. Assuming this is so, the PA standing current can be checked, the correct value being 50mA on the KW2000A and B, and 25mA on the KW2000 which has only one PA valve. If the correct current is not observed the PA bias control, which is on the rear of the PSU chassis, should be adjusted to obtain the correct value. A useful check of the matching of the two PA valves in the KW2000A and B is to return the rig to receive by switching from INT. MOX to EXT. MOX, reset the bandswitch to 1.8MHz and tune up as before. Following the procedure given above, the PA standing current should now be checked, the correct value in this case being 25mA (again, with no RF output).* If this condition is not met (ie. standing current 50mA on all bands except 1.8MHz where it should be 25mA), and two PA valves are not a matched pair. The best course of action in this case is to fit a new matched pair, but it may be possible to find a valve in the junk-box which will give a reasonable match with one of the pair already fitted. As before there is no point in proceeding further until these conditions can be achieved.

Assuming that the above conditions can be met a table similar to Table 1 should be drawn up listing the remaining controls, ie. MIC GAIN, PA TUNE and PA LOAD, and these should be checked for smoothness of operation. The PRE-SELECTOR should also be checked in the TUNE mode. Any jumpiness of PA current as the MIC GAIN is varied in the TUNE mode should be noted, since the current should rise smoothly from zero up to 125mA on the KW2000A and B (and approximately 70mA on the KW2000) on 3.5MHz. If any jumpiness exists it may indicate a faulty (or dirty) MIC GAIN control. The power output under key down conditions should be checked against the figures given in **Figure 2B**, the PA current being 200mA in the case of the KW2000A and B or 100mA for the KW2000.

Table 1

CONTROL	FAULT IF ANY	TICK IF OK
On/Off Sideband Select and Tune		
AF Gain		
RF Gain		
VFO Tuning		
IRT Tuning		
IRT, ITT etc Switch		
Pre-Selector Tuning		
Band Select		
Cal. on Button		
Cal. Set		

Curing problems with the controls

It is the firm opinion of the writers that any of the potentiometers which are in any way intermittent should be replaced by good quality new components rather than attempting to clean or repair them. Such a repair is unlikely to last very long, and it is worth avoiding later problems for the price of a new component.

Cleaning

VFO tuning control: if this feels notchy or lumpy as so often happens the only cure is to replace the ball bearing reduction drive with a new one. On the KW2000B the reduction drive is part of the VFO tuning capacitor so the capacitor will have to be replaced as well! If the tuning of the VFO is intermittent as the tuning control is rotated, and it is difficult to net, the most likely cause is a worn tuning capacitor and again a replacement is really the only cure.
Switches: if stiff or rough in operation the indexing mechanism at the front of the switch should be cleaned, after which a 'trace' of light grease should be applied to ball-bearings, not forgetting to oil the shaft lightly where it passes through the bush on the front panel.

Noisy switches can almost always be cured with a good quality switch cleaner (aerosol) with its own lubricant, for example RS components contact cleaner/lubricant cat. no. 554-175 or similar. Cleaners of the type containing carbon tetrachloride should not be used as these can damage the switches and also are considered to be hazardous to health.

When cleaning switches, a small amount of cleaner should be applied to each wafer in turn, at the same time operating the switch from position to position. This actually helps the cleaner to do its job. It should be ensured that the power is off!

After switch cleaning some time should be allowed to elapse before switching on, as the switch cleaner will cause drift of the RF circuits around the band-switch.

*The reason for the drop in standing current is that one PA valve is switched out of circuit on 1.8MHz to reduce the output power.

Failure to receive or poor receive

If during the preceding checks the receiver is found to be poor or inoperative, checks will have to be made to determine if the fault is in the AF, IF, mixer or RF stages, or, indeed, the power supply.

REMEMBER THAT THE VOLTAGES THAT EXIST IN THIS TRANSCEIVER CAN BE LETHAL, SO TAKE GREAT CARE, AND REMOVE THE MAINS PLUG FROM ITS SOCKET IF YOU NEED TO SOLDER COMPONENTS, ETC. SWITCHING THE TRANSCEIVER OFF AT THE FRONT PANEL IS *NOT* ENOUGH AS MAINS VOLTAGE IS STILL PRESENT WITHIN THE TRANSCEIVER AND POWER-SUPPLY CABINETS UNDER SWITCH-OFF CONDITIONS.

Assuming, first of all, that the receiver is totally dead, the following procedure should be adopted:

1. Switch on and observe that all valve heaters are glowing.
2. If not, switch off and check the heater of the offending valve or valves for continuity on the ohm range of the multimeter. (There should be only a few ohms across the heater pins.) If just V11 (VFO) and V10 (HF oscillator) are not glowing it is as well to remember that these two valves have their heaters supplied separately from all the other valves, and a check should be made on the supply voltages at the valve pins of the HF oscillator V10. (It is impossible to measure the heater voltage actually at the pins of V11 VFO as these are in the VFO compartment.) Replace any valves with open circuit heaters with new replacement valve(s). (See VFO footnote **Table 2**).
3. If, however, only a few valve heaters are glowing, and possibly very brightly, switch off immediately! Remove mains plug from socket! Now check the wiring to the multiway plug/socket from the power supply as these are rather prone to breakage, especially in the plug.

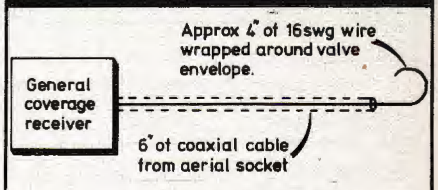


FIG. 4. Set up used to check for the presence of signals at various stages as listed in table 4. Remove screening can from valve before applying probe.

Assuming that all valve heaters are glowing and the receiver is still dead, look at the voltage stabiliser V20. This should be seen to glow a purple colour. If not, most probably either V20 is defective or no HT is being supplied from the PSU. Check leads/plugs/back to PSU and

Table 2

Voltage checks. Receive condition. Control settings. LSB, Bandswitch, 3.5MHz. AF Gain, Midway. RF Gain Minimum. EXT MOX.

	PIN NUMBERS									
VALVE	1	2	3	4	5	6	7	8	9	NOTES
V20	+ 150				+ 150		0	—	—	IF voltage low or high check V20, R96, R100
V17	0	20	0	50Hz 6.3	50Hz 12.6	225	240	1	70	IF voltage on Pin 2 low, check, V17,Ti T, Primary, R100, C151 IF voltage Pin 2 high check V17, R93, C125 IF voltage pin 9 low, check, V17, R92, C125 IF voltage pin 9 high, check, V17, R94, RV95 slider to chassis
V16	100	−.5	0	0	0	100	0	3.5	50Hz 6.3	IF voltage pin 1 or 6 low check voltage at V20, RFC9, R13
V15	175	0	A/C 2.6	A/C 6.3	6.3	135	−1	.6	A/C 12.6	IF voltage pin 6 high/low check V15, R82, R81, C109, C127
V14	0	−.3	A/C 12.6	A/C 6.3	4	–	−.43	–	–	IF voltage pin 5 low, RX gain will be low, check V14, R68, R69
V13	0	–	A/C 6.3	A/C 12.6	200	135	3.5	–	–	IF voltages high/low check V13, R70, R72, R71, C105, C104, IFT4
V12	0	–	A/C 6.3	A/C 12.6	215	3.0	–	–		IF voltages high/low check V12, R22, C22, C97, C98, R66, IFT5
V11	115	0	7.8	A/C 6.3	A/C 12.6	72	1.2	4.5	4.2	VFO See note below. But check V11 and voltage from V20
V10	Approx −2.5	0	A/C 6.3	0	220	0	170	–	–	IF voltages high/low check V10, R51, RFC7, R49, C71, C75, C193
V9	−1	1.2	A/C 6.3	A/C 12.6	235	52	0	–	–	IF voltages high/low check V9, R46, R47, R48, IFT2, C27, R28. Also V4 if pin 5 V9 low
V19	0	1.2	A/C 6.3	A/C 12.6	240	52	0	–	–	IF voltages high/low check V19, R114, R115, R116, R117, R221, C22, C134, C135, C136, Mech. filter
V6	.35	−23	.35	A/C 6.3	0	0	235	35*	0	*Voltage pin 8 depends on band selected. IF voltages high/low check R39, R40, R123, R36, APC1, R35, V6, C37
	Note: All voltages ± 10%									Note: All voltages within the VFO are difficult to measure and a 9 pin plug/valve holder with suitable test points on it and interposed between valve and VFO. If any resistors are found defective in the VFO it is best to replace them all.

fuses. Invert the transceiver chassis and measure from the *low* voltage HT rail to chassis (the HT rail is wired in red). A reading of 250V should be obtained. If no voltage is present check the fuses in the PSU. If the heaters are glowing and HT is present but the receiver is still dead check the voltages on the pins of the receiver valves against the values given in Table 2, working from the output stage back to the RF stage. A simple check on the output stage (V17) is to switch on and, with the multimeter set to ohms and one probe to chassis, connect the other probe to the G1 pin of the pentode section (pin 3). A loud pop should be heard as the probe is connected and disconnected from the grid. If not, and all voltages around V17 are correct, check the PHONES socket as this incorporates a switch which disconnects the loudspeaker when headphones are used, and this sometimes gives trouble through wear and tear. Another point to be borne in mind is that, due to a fault in the change-over circuits, the rig may be permanently in transmit. This can be checked by measuring the voltage on pin 6 of V21 (VOX amplifier), which should be approximately 240 volts if the rig is in the receive mode; if it is much lower the 2000 may well be stuck in transmit. Removing V21 from its socket briefly will prove the point, as the rig will then revert to receive. However, do not leave V21 out for more than a few seconds as this unbalances the heater voltages to the other valves. If removal of V21 does bring the receiver to life, and replacement by a new valve does not cure the fault, check all the resistors on pin 7. These resistors are of high value and have a nasty habit of going open circuit. Also check the capacitors in the circuit for leakage. If the receiver persists in remaining dead proceed through the voltage checks of Table 2. The correction of any problems found during the voltage checks will normally cure even the most stubbornly deaf 2000 unless, that is, someone has had a go at the alignment and left it miles out of adjustment! It is worth noting that the RF/IF alignment of an untouched KW2000 receiver will remain extremely stable over a period of many years. At worst a slight "tweak" may be required on the 10, 15 and 20 metre bands only, and then only if com-

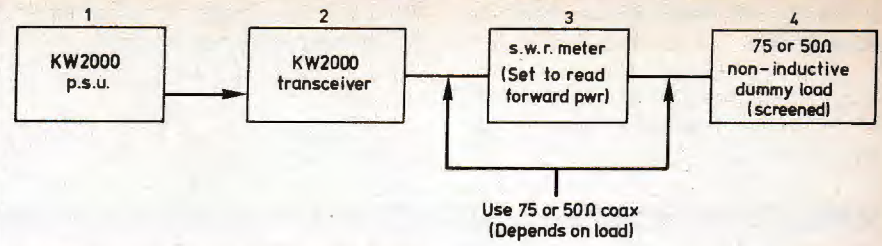


FIG. 5. Set-up for checking Tx into a dummy load.

Table 3

Voltage check. In TX condition. Control settings — Band 3.5MHz. Mic gain — Minimum, LSB, Int Mox, Mic connected.

	PIN NUMBERS									
VALVE	1	2	3	4	5	6	7	8	9	COMMENTS
V1	70	0	0.4	0	0	90	0	0.8	A/C 6.3	If pins 1 or 6, low, V1, R3, R4, C2, C145, C3.
V2A	—	—	—	0	0	150	0	2.6	A/C 6.3	If pin 6 low check, V2, R12, R11, R10, C8.
V3	1.0	0	1.0	A/C 6.3	A/C 12.6	0	45	50	0	If pin 7 or 8 low, check R18, R19, R21, (++)
V4	170	0	1.5	A/C 6.3	A/C 6.3	170	0	1.45	A/C 12.6	If voltage pins 1+6 low check V4, R28, C23.
V5	210	0	1.7	A/C 12.6	A/C 12.6	210	0	1.7	A/C 6.3	If voltages pins 3+8 low check V5, R32, R26.
V8	0	A/C 6.3	225	0	−50	0	0	0	TopCap 750	If no volts on Top Cap check RFC4, HT fuses
V23	0	6.3	225	0	−50	0	0	0	TopCap 750	in P.S.U. wire broken in multi-way connector on back of KW2000

Note: Most of the faults found in KW2000 series on TX ie. low drive or intermittent drive were caused by R18, R19, R21, going very high in value due to ageing.

(++) = These resistors are often the cause of low/intermittent TX drive.

Table 4

STEP	Fit sniffer to:	External RX Frequency	Checking
1	V16	455KHz approx	Carrier OSC. See xtals in KW2000 for exact frequency
2	V11	Depends on VFO setting. 2.5MHz to 2.7MHz	*Exact* frequency depends on KW2000 VFO setting. Checks VFO
3	V4	2.995 to 3.155MHz Depends on VFO setting	Check 1st TX mixer to see if *some* output is present *ON TX* ONLY ie. 455KHz + VFO
4	V5	Depends on KW2000 VFO and band selected. But on frequencies dialled up on KW2000.	Checks 2nd TX mixer to see if *some* output is present *ON TX* only
5	V7	As above	Checks *some* output is present from driver stage
	If signals are present in steps 1-5 there is no point in doing step 6.		
6	V10	Tune RX to LF edge of band selected on KW2000 + 3.155MHz eg. Band selected on KW2000 = 3.5MHz + 3.155MHz = 6.655MHz etc. This checks V10. HF oscillator is working on all bands.	

ponents such as capacitors or resistors have been changed in the RF stage or mixer. However, the complete alignment procedure will be given in the next article for anyone who wishes to carry it out.

If the receiver is working it is not normally very difficult to get the transmitter going, so if performance is poor on transmit it is worth checking the stages which are common to both receive and transmit paths, namely the VFO, HF oscillator and carrier oscillator. This is far easier to do on receive as you can hear what is happening.

Faults on transmitter

In the case of a transmitter fault the voltages in Table 2 should be checked as well as those in **Table 3** since a fault in the receiver can reduce the transmitter drive, parts of the signal path being common to both modes. There are, however, a few conditions in which it is inadvisable to leave the rig while checking the receiver performance:

1. No control of PA bias, ie. PA hard on.
2. Blown HT fuse to PA anode circuits as this can damage the screen grids of the PA valves.

These dangerous conditions can be discovered rapidly in the following manner:-

1. No control of bias: set the rig to INT MOX and note the standing current on the front panel meter. if this is high, adjust the bias control on the PSU. If it is found that the bias control does not affect the current SWITCH OFF IMMEDIATELY and check the grid bias components for the PA including the valves and C48 which, if short circuit, puts HT onto the control grids. The wiring to the multi-way plug on the back of the KW2000 should also be checked for broken wires under the clamp.

2. Blown HT fuse in anode circuit: this can be caused by faulty PA valves, no bias on control grids, incorrect tuning, or instability (incorrect neutralising can cause the PA to go unstable — see next article). If a fuse blows persistently the fault should be investigated at once. The fuse should NEVER simply be replaced by one of a higher value as this can cause expensive damage! A blown HT fuse is often indicated by a sudden drop in PA standing current to virtually zero (the meter reads PA cathode current so there will still be a slight reading, caused by screen current, even with no anode volts present in transmit mode).

There is one fault on the transmitter which is obvious without too much trouble, namely absence of CW sidetone and output power, and VOX inoperative with key down. The rig will also produce no output in the TUNE mode. This is due to the tone oscillator V15 failing to oscillate. A check should be made either in TUNE or with the key down and with the receiver AF gain control at about one third, when the tone should be heard in the loudspeaker. If not check V15, R87, R88, R89, R90, R91, C4, C119, C120, and C121. The tone oscillator can be very 'touchy' if these components have aged.

Do not proceed to check the transmitter without the tone oscillator as it is used to provide drive during tune up and on CW. Without it, it is very difficult to tune up correctly!

Assuming that the proceeding tests have been carried out and any faults found have been repaired, the transceiver should now show signs of life on both transmit and receive unless, of course, the alignment has been tampered with. There are a few simple tests which can help if there is still a problem such as no transmit output or low receive sensitivity. A general coverage receiver can be used to listen for signals from the various parts of the circuit, lightly coupling the receiver to the KW2000 as shown in **Fig. 4. Table 4** gives details of what should be observed in each case. Note that in steps 3 to 5 the transceiver should be set to TUNE with the MIC GAIN turned fully up. However, the PA current (if any) should be monitored and not allowed to rise above 100mA at any time. If the current is too high reduce the MIC GAIN. The information gained from Table 4 can be used to provide clues to the location of the fault. For example, if signal is present in steps 1 and 2 but not in step 3 it is possible that there is a fault in or around V3 (transmit IF amplifier). This means that no signal is arriving at the grid of the first transmit mixer V4, so there is no mixer output. Alternatively, V4 may not be mixing due to valve or component failure. If that is so, re-check those stages very carefully using the tests given in Tables 2 and 3. The tests of Table 4 will at least identify the area in which the fault is located.

Once all the tests in Tables 1 to 4 have been carried out the rig should be working well enough for the alignment to be checked. However, this will only be necessary if:-

1. The rig has been tampered with.
2. Max receive gain and max transmit drive do not coincide when adjusting the pre-selector tuning.
3. Components have been replaced in a particular stage, in which case it should only be necessary to re-align the stage concerned, or at worst the stages before and after.
4. If some of the modifications to be described later have been carried out.
5. It is desired to get the best results possible!

The complete alignment procedure will be given in the next article. ●

Table 5

Approximate power ± 10% output to be expected Key down in LSB or USB		Measured output power (Yours)	Band
KW2000 A/B	KW2000		
25 watts*	25 watts*		1.8MHz
100 watts	50 watts		3.5/3.7MHz
100 watts	50 watts		7.0MHz
100 watts	50 watts		14.0MHz
85 watts	46 watts		21.0MHz
80 watts	40 watts		28-28.6MHz
Measured on my KW2000A on bird thro' line watt—meter into 50	Measured on friends KW2000 on Bird thro' line watt meter into 50	Power output figures are included only to give a rough guide as to what to expect.	

*Reduced HT to P/A by switch on P.S.U.

Technicalities

SPEECH PROCESSING

By Frank Ogden G4JST

The topic for discussion this month is speech processing, the adding of 'punch' to transmitted audio.

Given the boring uniformity of modern commercial radio gear, the variation in 'received' quality of the audio constantly surprises me. Without doubt some people have a resonance of voice which accords well with the limited bandwidth transmissions used in amateur radio. Other individuals, perhaps using identical equipment, sound thin, watery and difficult to pick out of the noise or QRM.

What makes it even odder is the lack of correlation between a person's normal voice and how they sound over the air. There are operators who sound the same both on the air and face-to-face. There are others that you wouldn't even recognise when going from one medium to the other. I have rationalised the difference by assuming that the spectrum of the average person's speech is split up into discrete frequency bands with very little in between. For instance the major resonances of the vocal tract may occur in the range 200 to 300Hz, 700 to 900Hz, 1.5kHz to 1.9kHz, etc. The actual pattern will depend on the individual.

Radio equipment is designed to transmit only those frequencies which fall between 0.3 to 3kHz. I think that the reason for this will be obvious to everyone: the higher the modulation frequency, the larger are the bandwidth requirements of the radio spectrum of the transmitted signal. Furthermore it is generally held that speech frequencies outside these limits are of little value in conveying the sense of the communication. The consequence of this is that radio equipment only responds to a fairly slender speech band and if the voice pattern doesn't match with the equipment pattern, then 'thin audio' will be the perceived result.

Matching voice to equipment

What can be done about this? The short answer is that the equipment must be tailored to suit the voice pattern of the individual within the constraints of the bands of frequencies between 0.3 to 3kHz. This tailoring requires that deficient areas of the individual's speech spectrum should be boosted. The way that most people do this is swapping microphones around until they find a combination which gives the most punch to their speech. This is not particularly scientific and can get a bit expensive. It is also possible to modify microphones. For instance I use a standard Yaesu desk mic. I can't remember the model number off-hand but it is the one fitted with the goose neck. I found the mic hopelessly bassy when used with my homebrew transceiver. I effected a cure by taking out the mic capsule (the transducer element) and blocking off two of the three equaliser holes in the back of the capsule. While this action had no effect on the top end of the speech spectrum (this section was OK) it neatly tailored the bottom end to suit the charactistics of my voice and the equipment in use. Result — pretty good audio.

It illustrates a point that quite a lot can be done to improve the talk power of a signal with a fairly simple modification. I could possibly have tackled the problem by placing a relatively low value capacitor in series with the mic connection to produce the required bass rolloff.

Talk power

A much more elegant solution with wide applications would be to use a graphic equaliser. I have actually tried one of these devices in radio work and I can report that they do quite a lot for an otherwise poor signal. A graphic equaliser is a

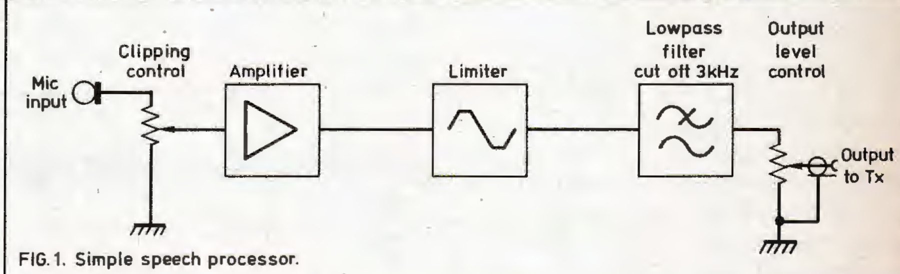


FIG. 1. Simple speech processor.

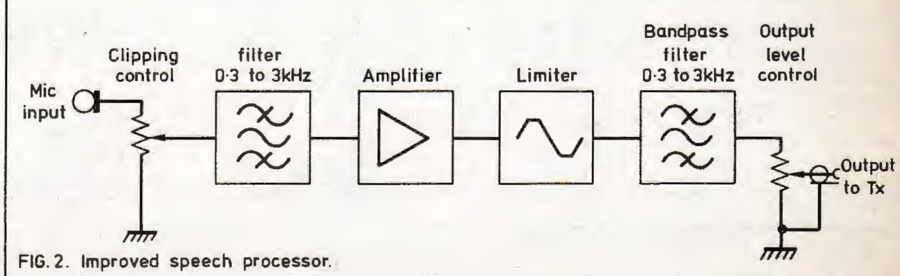
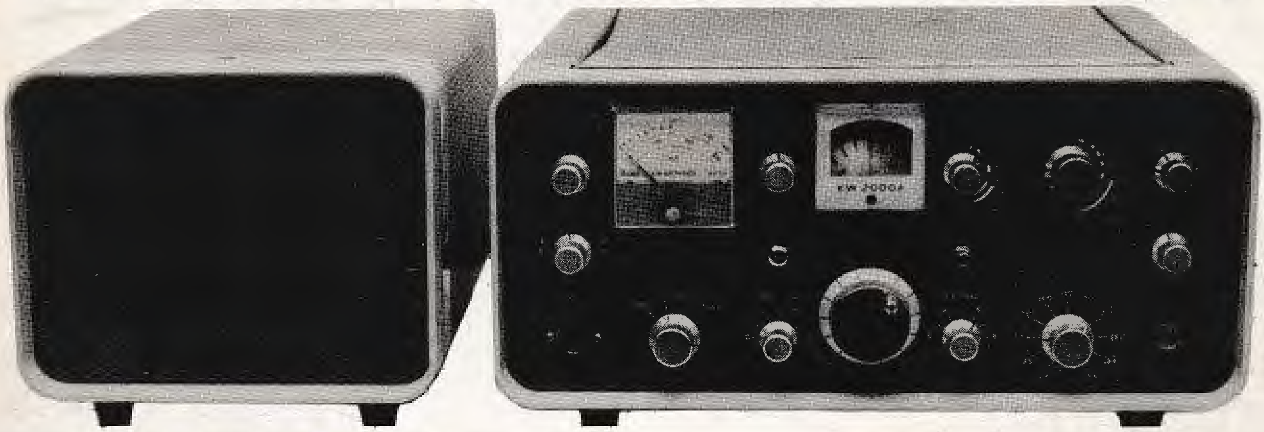


FIG. 2. Improved speech processor.

Upgrading the KW2000 series of HF transceivers



Part 3

Alignment procedure

by M.T. Healey, G3TNO
and R. Charles

The previous articles in this series have dealt with the location of faults in the KW2000 series of HF transceivers. If the procedure given has been followed it is likely that the rig will now be working reasonably well. This article describes the procedure to be adopted necessary to realign the transceiver.

Let's start with a caution: In the majority of cases, alignment will probably not be necessary, and if the rig seems to be operating satisfactorily it is best left alone! Having decided to tackle the job, the following tools should be available before beginning:

1. Hexagonal trimming tool, nylon/ plastic.
2. Acetone to dissolve the coil sealing compound (nail varnish remover is suitable).
3. Clear nail varnish to lock to cores.
4. Dummy load — filament lamps

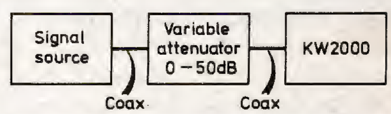
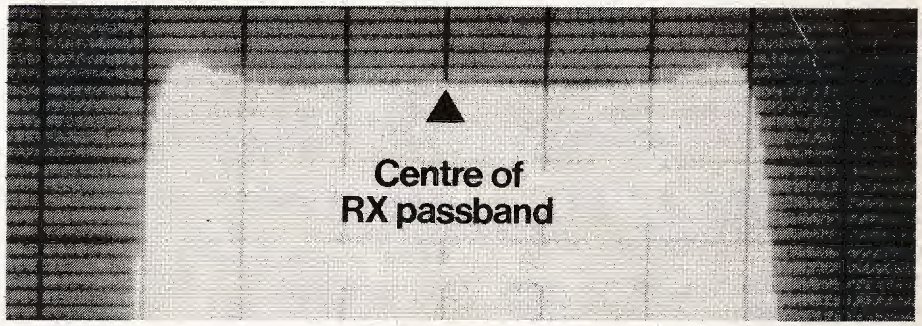


FIG. 1. Typical test set-up for Rx alignment.



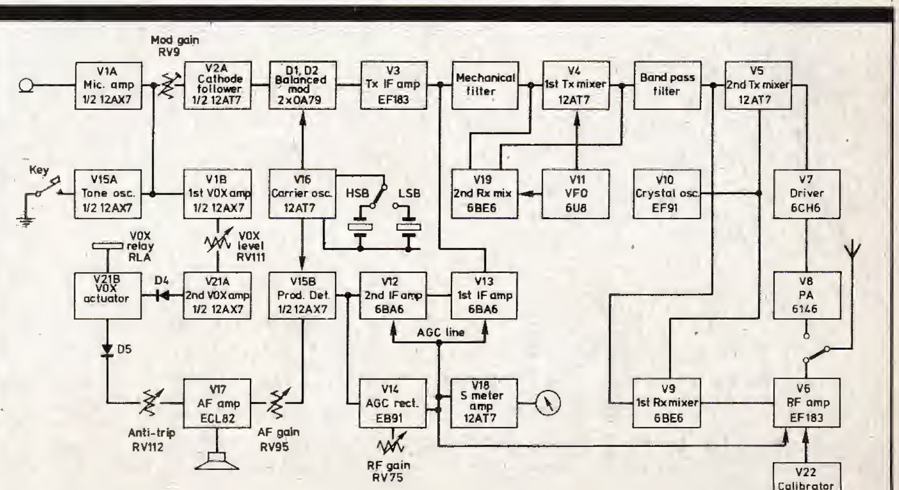


FIG. 2 Block diagram of KW2000

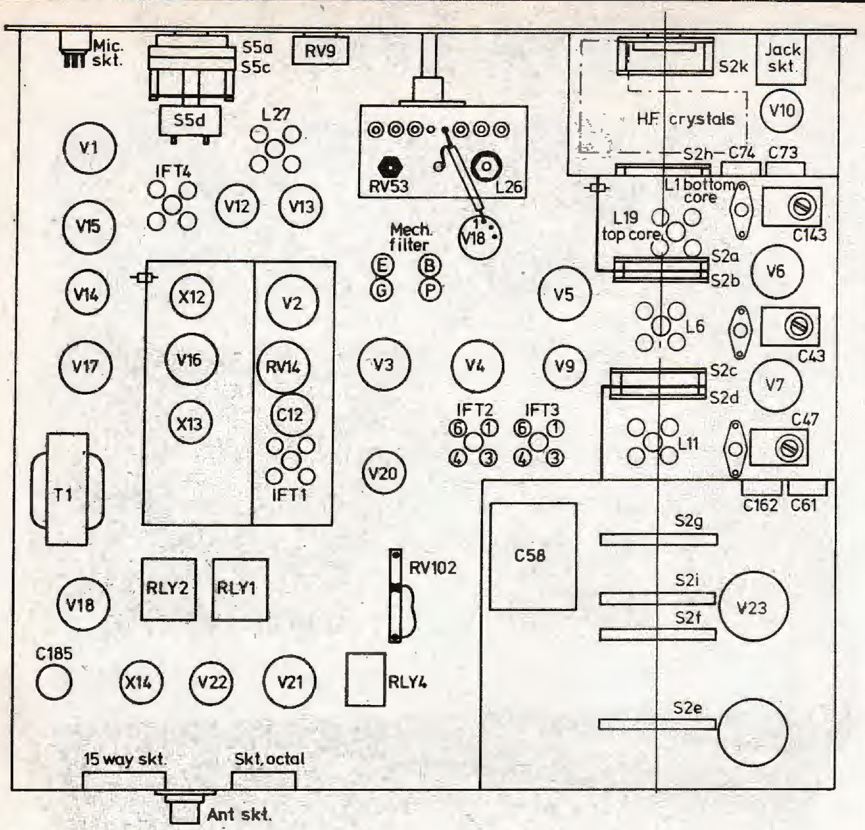


FIG.3. Component location—below chassis.

should not be used as they are inductive, and their impedance changes with temperature.

5. Means of indicating RF power, eg. 'Thruline' wattmeter or SWR bridge.
6. Swamping tool consisting of a 0.01 uF 400v capacitor in series with a 1k ohm, ½W resistor.

If the rig is a long way out of adjustment the following additional items may be required.

7. Signal generator, or some other means of producing a 455kHz signal.
8. Band edge markers, ie. signals at 1.8MHz, 3.5MHz, etc.
9. Variable attenuator 0-50dB.
10. A general coverage receiver is useful for checking VFO, crystal oscillator frequencies, etc., and also for monitoring the final completed equipment on transmit.
11. RF milivoltmeter with probe.

The following instructions may not all need to be followed. It may be, for example, that the receiver is performing well but the transmitter suffers from low drive on one band only. In this case only part of the procedure need be carried out but **BEWARE!** Adjustments carried out to, say, the 28MHz coils will affect the alignment on 21MHz and, to a lesser extent, on 14MHz, so make sure that adjustments carried out to the alignment on the higher frequency bands have not drastically upset the alignment on the lower bands. The rig should be allowed to warm up for at least 15 minutes before any adjustments are made.

Checking 100kHz calibrator.

Tune a spare receiver (the family portable will do) to the BBC Radio 4 transmission on 200kHz, and place it close to the rear of the KW2000 adjacent to V22 and X14. Press the calibrator button on the KW2000, and adjust the coupling between the external radio and the rig until a satisfactory beat-note is obtained. The lower this is in frequency, the nearer the calibrator is to 100kHz. Adjust C158 to obtain zero beat on the external receiver.

Alignment of 455kHz IF stages

It is assumed that the receiver section of the KW2000 is now working to some degree and showing some signs of life. If it is totally dead, go back to the voltage checks listed earlier, as slight misalignment will not make the receiver totally dead.

The rig should be set up as in **Fig. 1**, with the RF gain at maximum and the AF gain midway. Tune the receiver to a stable signal (the author uses a harmonic of the shack frequency standard), and adjust the tuning so that the signal is in the centre of the passband (see **Fig. 2**). Adjust the core of L27 and the upper and lower cores of IFT4 for maxi-

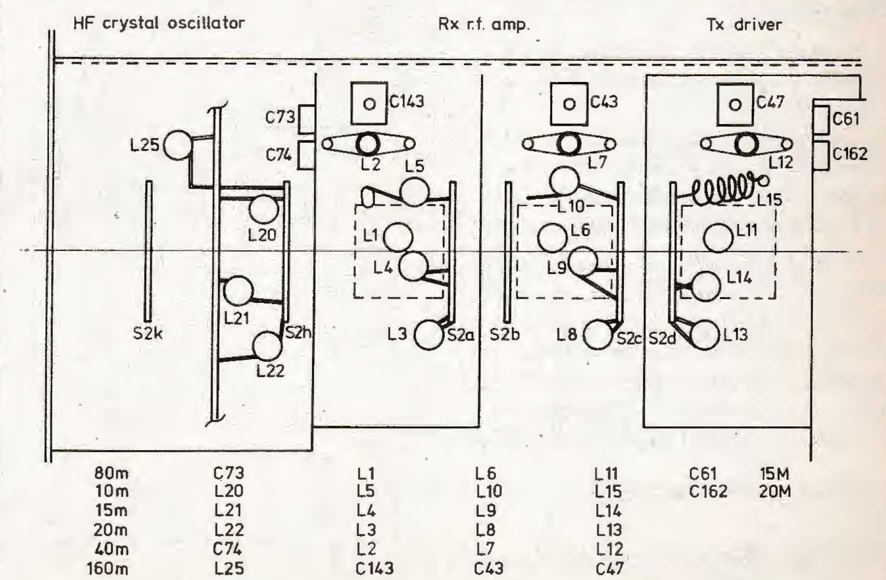


FIG.4. Location of tuned circuits.

mum S-meter reading, reducing the level of the input signal as the receiver comes into alignment so taht the meter does not read above S5. Repeat these adjustments until no further improvement can be obtained. **Fig. 5** shows the location of the tuned circuits concerned. It is important to use the minimum possible signal level for alignment purposes, since with high levels, the peak of the adjustment may be masked due to AGC action or, in extreme cases, limiting!

If the receiver is a long way out of alignment if may be necessary to inject a 455kHz signal into the input of the second mixer V3 (pin 2) via a 0.01 uF capacitor.

VFO alignment

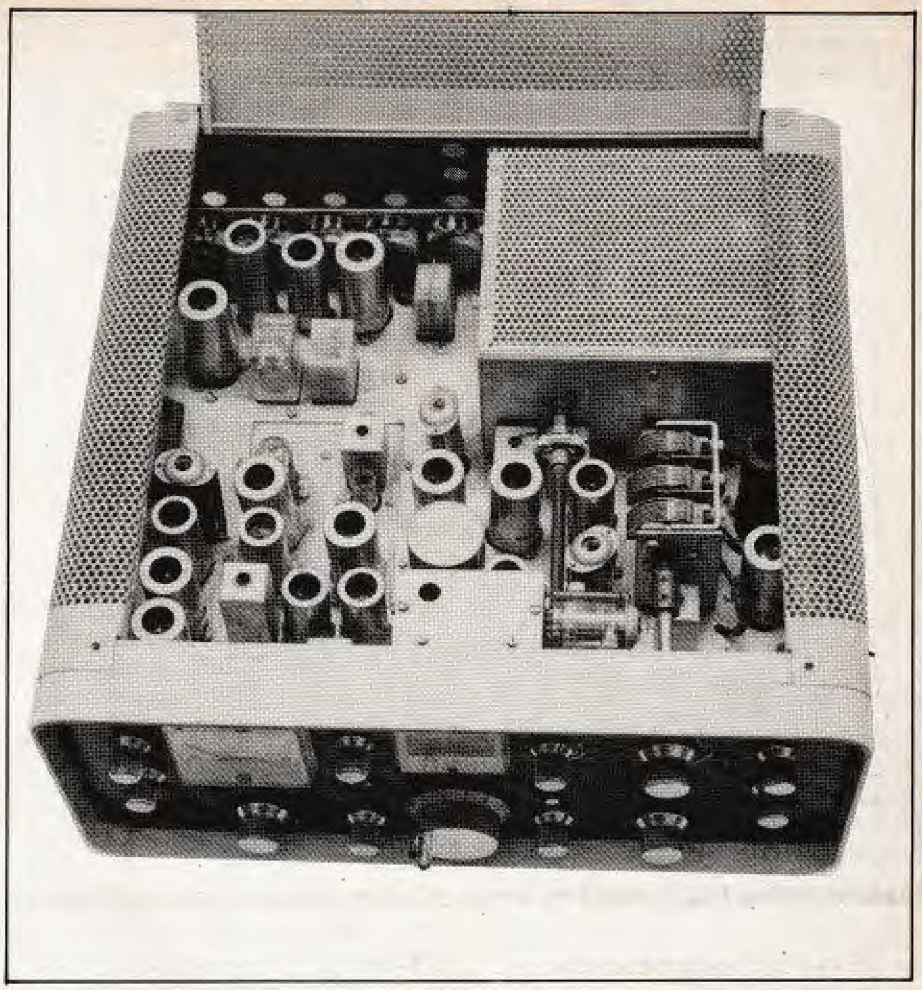
Set the KW2000 to the 3.5-3.7MHz band, tune to 3.5MHz and peak the preselector, using the internal calibrator as a signal source. Ensure that the IRT is turned off. Tune the VFO to 000, 100 and 200 in turn and look for zero beat and accuracy of the dial indication. If errors exist, procede as follows:

1. Set VFO to 000 and switch IRT on. Set IRT tuning accurately to 0.
2. Using an insulated probe (e.g. a knitting needle), adjust C80, which is accessible via a hole in the top of the VFO unit, for zero beat with the calibrator signal.
3. Reset VFO to 200. Adjust the core of L26, which is on the lower side of the VFO, for zero beat with the calibrator signal. See **Fig. 3** for the position of L26.
4. Repeat steps 1 to 3 until the calibration is correct at 000, 100 and 200.
5. Set VFO to 100. Switch IRT off and adjust RV53 for zero beat with the calibrator signal. See **Fig. 3** for position of RV53.

If the VFO is a long way out of adjustment a band edge marker signal at 3.5MHz may be needed to identify which of the harmonics of the calibrator you are tuned to. This marker signal should be injected into the aerial socket of the KW2000.

USB/ LSB switching

Set the KW2000 to 3.6MHz on USB with the IRT off, and tune to zero beat with the calibrator signal.



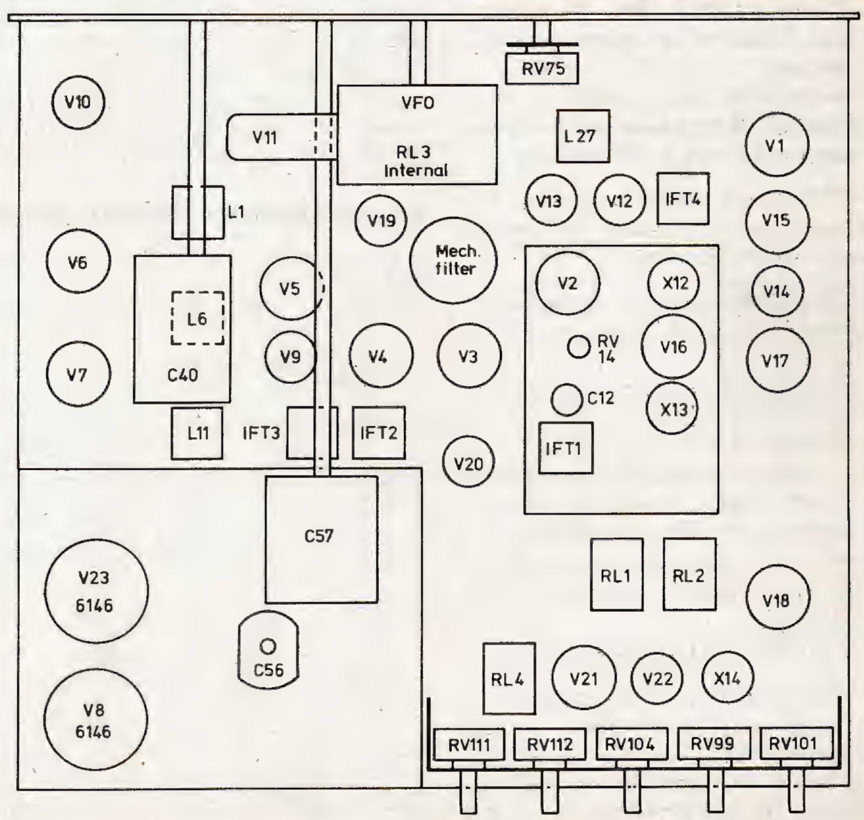


FIG. 5. Component location – above chassis.

Now switch to LSB, and, if zero beat is not obtained, adjust the link on L28, which is accessible through a hole in the side of the VFO, for zero beat. Re-check for zero beat on USB and then LSB, adjusting main VFO tuning on USB and the link on LSB, until zero beat is obtained in both positions.

Adjustment of wide-band coupler

Tune the receiver to 3.6MHz and inject a signal at 3.6MHz into the aerial socket.

2. Connect the swamping tool between pin 4 of IFT2 and chassis (see Fig. 3 for location of IFT2). Adjust lower core of IFT2 for peak on S-meter, reducing input signal if necessary to keep reading below S5. *SWITCH OFF KW2000.*
3. Connect swamping tool between pin 6 of IFT2 and chassis. Switch rig back on, and adjust upper core of IFT2 for peak on S-meter. *SWITCH OFF.*
3. Connect swamping tool between pin 4 of IFT3 and chassis. Switch on, and adjust lower core of IFT3 for S-meter peak. *SWITCH OFF.*
4. Connect swamping tool between pin 6 of IFT3 and chassis. Switch on, and adjust upper core of IFT3 for S-meter peak. *SWITCH OFF.*
5. Repeat steps 1-4 in that order until no further improvement can be obtained.

NB It is important to switch off between steps in the above procedure as there is 250 volts HT on some of the IFT pins mentioned above!

Receiver front — end alignment

The following points should be remembered when aligning the front-end:-

1. As the receiver comes into alignment the input signal should be reduced to keep the S-meter reading below S5. For the final 'touch-up' below S3 is preferable.
2. Use acetone to free the cores of the inductances without formers. After freeing, allow at least half an hour for the coils to dry out before commencing alignment.
3. Set pre-selector control to just short of the LF edge of the appropriate band marking on the front panel, except on 160m, where it should be set to the centre of the band segments.
4. **Table 1** gives the sequence of adjustments to be followed, and **Fig. 4** shows the position of the various tuned circuits. Always tune to the first peak arrived at by screwing the tuning core into the coil, ie. nearest the top of the coil former for the upper core; nearest the lower edge of the former for lower cores.

Alignment of IF trap

Set KW2000 to 3.5MHz and inject a low level 3.5MHz at the aerial socket. Set RF gain to maximum AF gain midway, and tune the pre-selector for maximum signal. Now remove the 3.5MHz signal and inject a 3.155MHz signal to the aerial socket; tune L19 for *minimum* signal.

An alternative method, which can be used if no signal generator is available, is to set the controls as above and connect the rig to an aerial. If the pre-selector is rotated clockwise from the 80 meter peak and the VFO is tuned HF by a few kHz non-amateur signals should be heard. Having tuned to such a signal, adjust L19 for minimum signal level. Note that L19 is on the same former as L1, but is the upper core whereas L1 is the lower. After tuning L19, retune rig to 3.5MHz and retune L1 and L6 for maximum signal.

4.190MHz trap

Set KW2000 as above except for the frequency which should be 3.8MHz. Inject 4.190MHz to aerial socket of rig. Move VFO back and forth a little to locate the signal and adjust L29 for minimum signal on S-meter.

Transmitter alignment

The transmit and receive alignment have deliberately been separated since it has been found easier to get the receiver going first. When adjusting the transmitter alignment it is important that, prior to aligning the driver stage tuning, the pre-selector control is peaked for optimum on *receive* and is then left untouched whilst the PA grid circuit and the neturalising are adjusted.

The rig should be set up as shown in **Fig. 6** and switched to TUNE. The MIC GAIN should then be set to give a PA current of 50mA or less, and the PA tuned for maximum output into the dummy load. The PA grid coil is then adjusted for maximum PA current, reducing the MIC GAIN as necessary to keep the PA current below 100mA. After this, the neutralisation is checked, and the PA grid circuit readjusted if it has been necessary to alter the neutralisation setting, since this will affect the tuning of the grid circuit. Neutralisation adjustment is not necessary on 7, 8.5, and 1.8MHz. **Table 2** gives the sequence of adjustments, and **Fig. 4** shows the position of the components concerned.

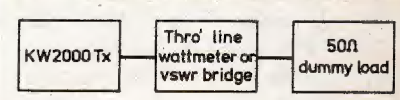


FIG.6. Typical test set-up for Tx alignment.

After alignment has been completed and before re-locking the cores in the various tuned circuits, it is as well to re-check the transceiver performance by giving it an on air check. The following should be noted:

General receive performance
Transmitter drive
The transmitter should not have any signs of instability or poor neutralisation.

It is also important to note that the setting of the pre-selector for optimum receive performance should coincide with that giving maximum transmitter drive.

HF crystal oscillator alignment

The tuned circuits associated with the HF crystal oscillator are very stable even over a period of years, and hence very rarely require adjustment. However, if alignment is required, procede as follows:-

1. Connect an RF milivoltmeter to

the junction of C70 and C69.

2. Loosen the cores of the coils with acetone, and allow at least half an hour for them to dry out.
3. Adjust as in **Table 3** with KW2000 in receive mode. Fig. 4 shows the coil locations.

Carrier balance adjustment

Connect KW2000 to a dummy load, switch on and allow at least half an hour for warm up. Tune rig to 3.6MHz. Tune up and then switch to LSB and select INT MOX. Set MIC GAIN to minimum. Tune a second receiver to 3.6MHz when a signal should be heard. Reduce the level of this signal to as low a level as possible by adjusting RV14 and C12 in KW2000 for minimum carrier. These two adjustments interact, and so they should be adjusted alternately until no further improvement can be obtained. Having done this, switch to USB and compare the carrier level with that obtained in LSB. It has been found that with some KW2000s a compromise has to be made between the two as regards carrier balance.

S-meter adjustment

KW Electronics state in their handbook that with a signal input of 50mV at 3.6MHz the S-meter should read S9, and with 5mV it should read S9+40dB. To set the meter for these conditions procede as follows:-

1. Set RV102 to the centre of its travel.
2. With no signal input, adjust S-meter to zero using RV101.
3. Inject a 3.6MHz signal at 50uV into the aerial socket, and tune pre-selector for maximum S-meter reading.
4. Adjust RV99 so that the meter reads S9.
5. Increase the input signal to 5mV and adjust RV102 so that the meter reads S9+40dB.
6. Remove input signal and re-adjust meter to zero with RV101.
7. Repeat the above procedure until readings are correct at all three specified levels.

Now that the KW2000 is working correctly it is safe to start carrying out modifications. Next months's article will give details of some of these.

RX ALIGNMENT (RF STAGES)

Table 1

Input frequency	Adjust for max 'S' meter readings
28.1	Adjust L5, L10 (Repeat 2-3 times)
21.1	Adjust L4, L9. *Note:* If L4 has no core. Rock pre-selector back and forth. Peak with L9 ONLY
14.1	Adjust L3 and L8 (Repeat 2-3 times)
7.1	Adjust L2 and L7 (Repeat 2-3 times)
3.6	Adjust L1 and L6 (Repeat 2-3 times)
1.9	Adjust C143 and C43 (Repeat 2-3 times)
NOTE	Always align RF stages **HF** bands first. Never in reverse order!

TX ALIGNMENT

Table 2(a)

Frequency	Adjust for maximum drive	Neutralising adjustment
28.1	L15 Repeat this adjustment if neutralising has been adjusted.	Max output from P/A should be at 'Dip'. If max o/p is obtained with P/A current meter, then reduce valve of C56. If max is on HF side of Dip, increase value of C56 (neutralising capacitor).
21.1	L14 Repeat this adjustment if neutralising has been adjusted.	**Note:** If max o/p from P/A is at 'Dip', if max o/p is LF of Dip. Increase C61. If max o/p is HF of Dip. Decrease C61
14.1	L13 Repeat if neutralising has been adjusted	**Note:** If max o/p from P/A is at 'Dip'. If max o/p is LF of 'Dip' increase C162. If max o/p is HF of 'Dip' decrease C162.

Table 2(b)

Frequency	Adjust for max drive
7.1MHz	Adjust L12
3.6MHz	Adjust L11
1.9	Adjust C47

Table 3

Band	Adjust for max reading on RF mA meter
28.4	L20
21.0	L21
14.0	L22
7.0	C74
3.5	C73
1.8	L25

NEWCOMER'S

Circular polarisation reaches the parts other polarisations cannot reach...

The subject this month is the use of circular polarisation at VHF/UHF, particularly 2m prompted by several new licencees interested in my own resurrected use of this method at the new QTH.

Most of you will have read of the need for this type of polarisation for satellite communications, where the polarisation is constantly changing, partly due to spin and changing satellite attitude, and partly to Faraday Rotation imparted by the ionosphere as the signal passes through it. If you have tried receiving one of the OSCAR series of satellites using your normal beam or HF antenna, you will have noticed that the signal regularly peaks as the received signal first matches the polarisation of your antenna, then fades as the opposite occurs.

It is not only when using satellites that the advantages of circular polarisation show up as I hope to demonstrate, without too much recourse to complicated theory. Normal communications on 2m or 70cm can reap the benefits, sometimes in a quite spectacular manner. How many of you out there have a crossed Yagi, but only use it for either vertical or horizontal polarisation? With a bit of switching, you can have four types of polarisation available with much better chances of QSO's at distance.

The normal vertical or horizontally mounted antenna radiates linearly polarised signals in the direction of its main lobe ie, the electrical field is vertically or horizontally polarised in space, and will maintain this polarisation as long as it meets no obstructions, or is not being reflected off the ionosphere. However, the fun starts when, as inevitably it will, the signal meets an obstruction.

There are two effects from such an obstruction. One, there will be a loss of signal strength, depending both on the frequency of the signal (more loss at 70cm than 2m) and the polarisation of the obstruction relative to the signal polarisation. As one would expect, a vertically polarised signal meeting a tall clump of trees, would suffer more loss than if the signal were horizontally polarised.

Two, the obstruction will reflect the signal, and in so doing part of the radiated wave will change polar-

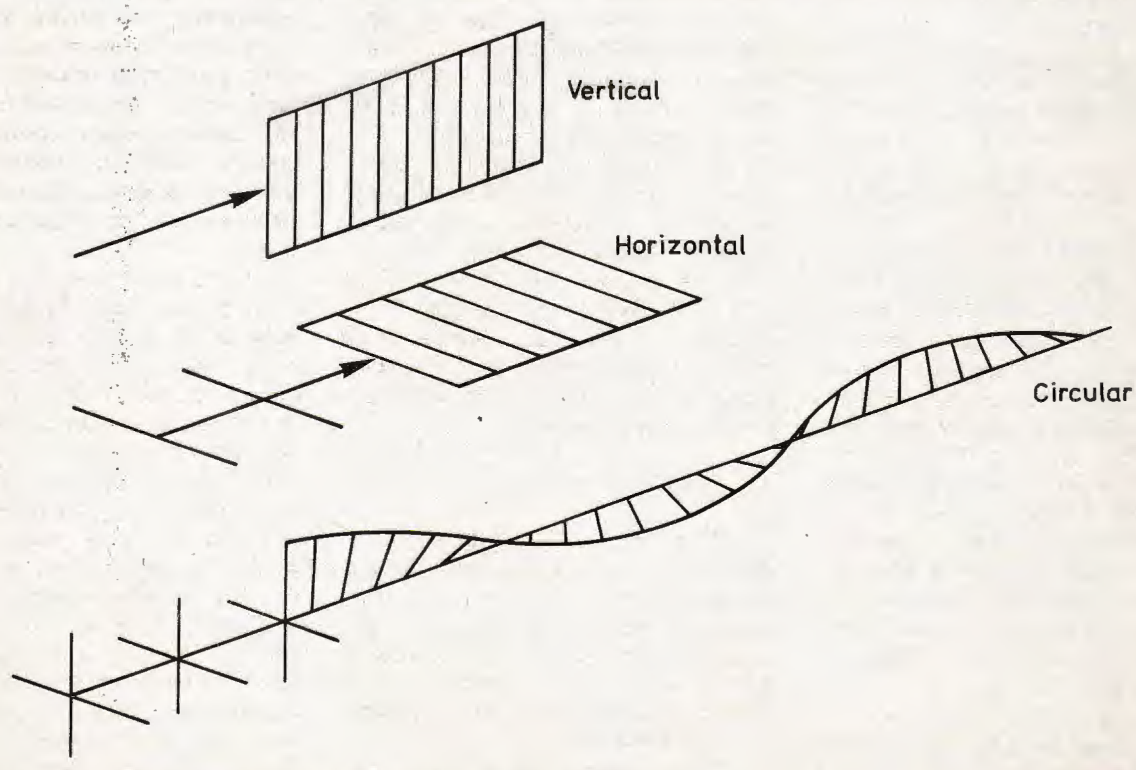
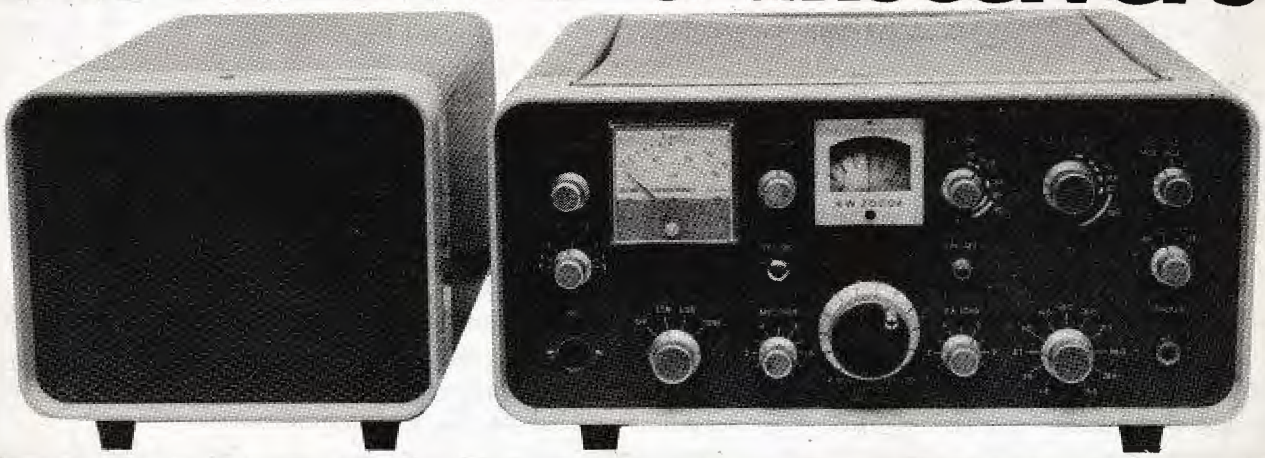


FIG.1. Representations of varying polarisations

Upgrading the KW2000 series of HF transceivers



Part 4

Modifications

By M.T. Healey, G3TNO, and R. Charles

If you have followed the procedure given in previous articles your *KW2000* should now be working reasonably well. You may well now feel that it is worth while making some improvements to the rig, and adding some features that it does not possess in its standard form. A possible list of 'things that would be nice to do' might be as follows:

1. Stop the VFO drifting with changing mains voltage, due to the heater voltage of the VFO changing.
2. Improve the receive sensitivity on the 21 and 28MHz bands, which is not as good as more modern designs.
3. Improve the selectivity on CW, since the passband, which is designed for SSB, is uncomfortably wide for CW, particularly under contest or crowded band conditions.
4. Improve the note on CW transmit. The *KW2000* has a very distinctive sound on CW that is less than perfect to the CW purist.
5. There are no facilities for any of the WARC bands, and on 21 and 28MHz the whole of the band is not covered.
6. Cross-modulation performance is poor, particularly on 7MHz.
7. It would be useful to be able to vary the transmit power on SSB and CW properly, i.e. by some other means than using the MIC GAIN control.

The methods by which the writers have improved the above features are described below. However, there are many alternative ways of tackling all of them, and the way in which any individual tackles them will, of course, depend on his personal preference, and the contents of his junk box!

VFO drift

Whilst most sections of the *KW2000* are comparatively insensitive to supply voltage variations, the VFO V11 and HF crystal oscillator V10 tend to change in frequency as their heater voltage, and hence cathode temperature, is varied. Because of this their heaters are not connected to the main 12V heater system of the transceiver, but are brought out to a separate pin, pin 12, on the multiway connector, and the mobile PSU was designed to provide a stabilised 6.3V supply for this so that the frequency did not vary with engine speed. However, the manufacturers did not consider such a refinement necessary for base station operation and, as can be seen from **Fig. 101**, the supply to pin 12 is simply derived from the main 13V heater supply via a dropping resistor R9. This means that variations in mains voltage can cause variations in frequency, which can be annoying especially if using the rig with a narrow CW filter as described later.

It is comparatively easy to modify the power supply to provide the necessary stabilised 6.3V supply for V10 and V11, and one way of doing this is shown in **Fig. 102.** This has the additional advantage of providing an unstabilised +18V supply which can be used to derive stabilised supply voltages for various bits of additional circuitry, such as the preamplifier associated with the CW filter described later. It can be seen from **Fig. 101** that the LT supply is derived from a 13V 5A winding on

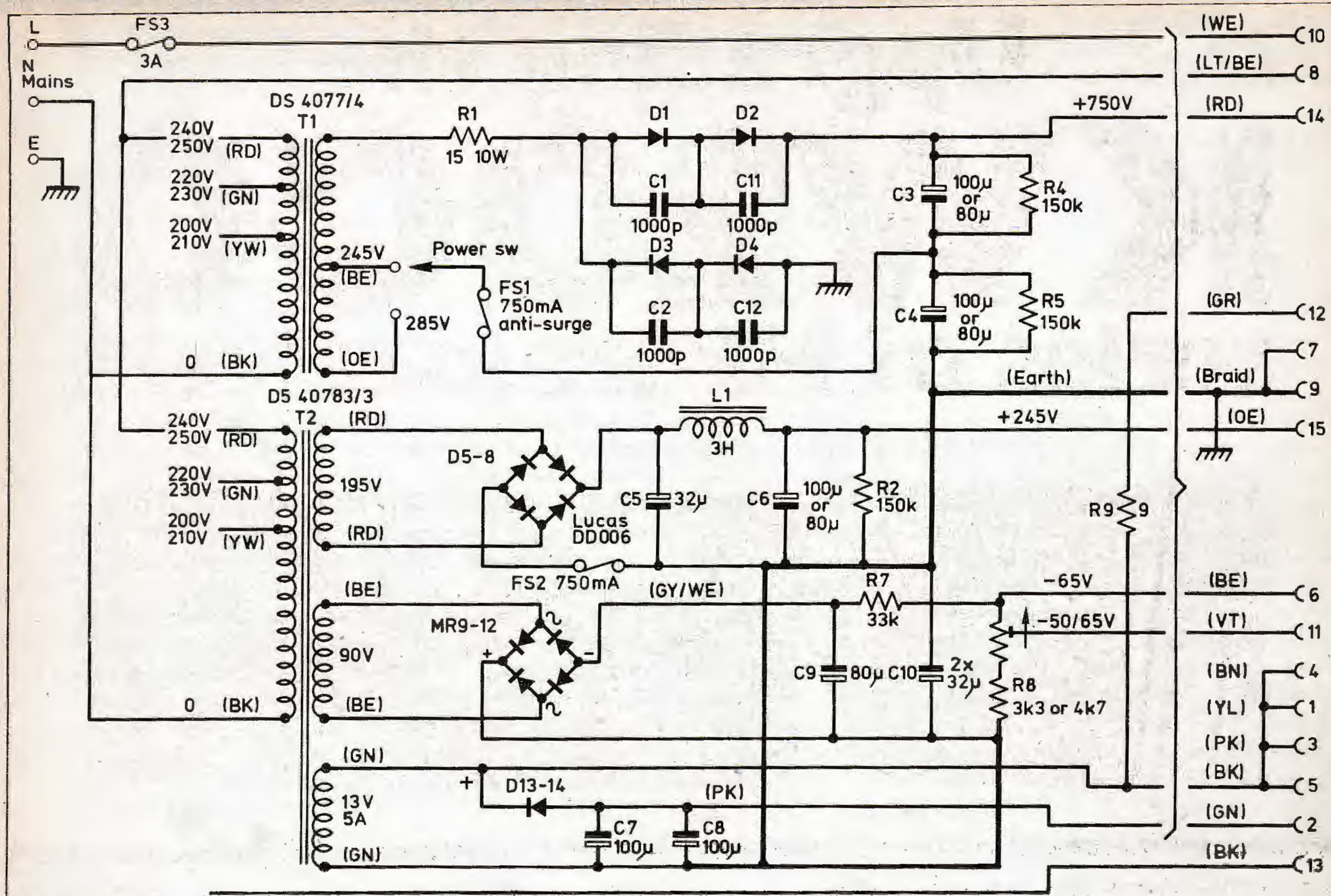


FIG. 101. Circuit of KW2000A power supply.

T2. The voltage from this winding is also half-wave rectified by D13/14, and smoothed by C7/8 to provide a DC supply for the relays. The first step in the modification process is to reverse the rectifier and remove C7/8. The current rating of the diodes should be checked and, if they are not 2 Amp types, they should be replaced by a single 2 Amp diode such as a 1N5401. In the case of one of the writers it was found that the rectifier was in fact a single 40266, which is quite adequate. C7 and C8 are now replaced by a single 5000 F 25V capacitor, mounted horizontally between T1 and T2 under the chassis. R9, which is a large ceramic disc resistor mounted on the side of the chassis, is removed and the hole in the chasis used to mount a tagstrip which will carry most of the circuitry of the new regulator. The 7805 integrated circuit is mounted alongside the tagstrip; a mica washer and insulating bush must be used since the earth tag of the IC, which is internally connected to the cooling tab, is not connected to earth in this case. The circuit is wired up as shown in **Fig. 102.**

As a result of this modification the heaters of V10 now receive a stabilised 6.3V supply, and 18V DC is available from pin 2 of the multiway connector for operating other circuits. In practical terms, the frequency of the transceiver should now remain stable once the warm-up period of about 20 minutes has been completed.

Improving receive sensitivity

The simplest way to improve receive performance on 21 and 28MHz is to fit a 3-30pF trimmer across the un-decoupled cathode

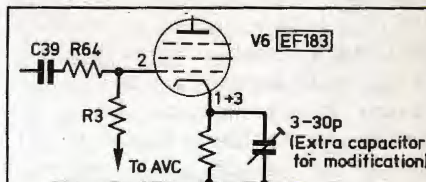


FIG.103.

bias resistor in the RF amplifier stage V6 (see **Fig. 103**). A small value has been suggested for this capacitor since, with a more normal 10 or 100nF, the gain of this stage will become excessive on the lower bands, leading to poorer cross-modulation performance. The small trimmer can be set so that it only affects the higher bands. A further

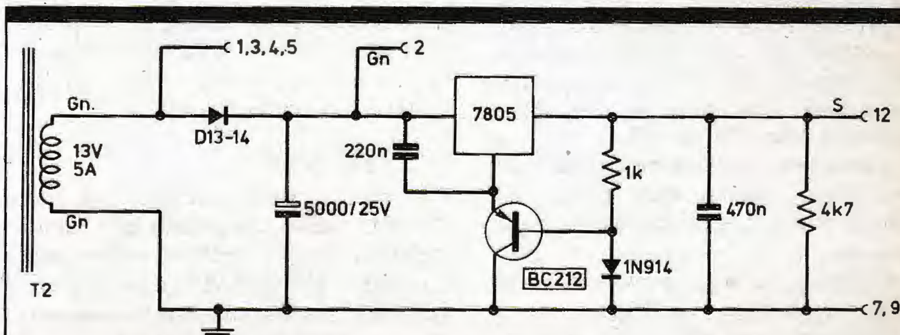


FIG. 102. Modification for stabilisation of heater supply to V10 and V11

snag is that a larger value may lead to the RF stage becoming unstable on 28MHz. A suitable component for this purpose is a Philips 'Beehive' trimmer, the central part being soldered to the earth tag adjacent to V6 on the side of the screen across the valveholder adjacent to pins 1 and 3. These two pins should be linked with a short piece of tinned copper wire and joined to the remaining terminal of the Beehive trimmer. To adjust after modification, tune up on transmit on 28MHz in the normal way, and do not touch the pre-selector after this. Switch to receive, tune to a steady incoming signal or inject a weak signal into the receiver, and set the trimmer to about half value. Adjust L5 for maximum signal as in the alignment procedure, and then check the operation of the preselector control to see whether its adjustment on receive seems to be unduly sharp. If so, reduce the capacitance of the Beehive trimmer, readjust L5 and try again. If, on the other hand, there seems to be little improvement in RF gain, increase the value of the trimmer, readjust L5 and try again. Note that the preselector peaks on receive and transmit should coincide. A convenient signal to use for these tests, particularly in the South of England where the writers live, is the GB3SX beacon. After finding the correct setting for the trimmer the operation of the receiver on 21 and 14MHz should be checked, adjusting the appropriate coils as described in the alignment section. The modification should have little or no effect on the performance on the other bands.

Improving the selectivity on CW

Two methods of improving the CW selectivity have been tried. The first, which is relatively cheap and simple, uses a single crystal and two miniature DIL relays, and despite its simplicity is fairly effective in use. To carry out this modification the coupling capacitor C21 between the mechanical filter and the grid of the first receive IF amplifier V13 is disconnected at the valveholder, and the circuit of **Fig. 104** is inserted. A convenient method of construction is to assemble the components on a piece of *Lektrokit* board and mount this board on a small bracket adjacent to the mechanical filter. It is also necessary to provide a switch on the front panel of the *KW2000* to switch the filter in and out of circuit. Since this switch only has to carry DC to the coils of RLA and RLB its position is not critical, and a convenient way of avoiding the necessity of drilling extra holes in the panel is to replace the calibrator push-button by a miniature three position toggle switch. This is wired so that the 'up' position activates the calibrator and the 'down' position switches in the CW filter, the centre position being for SSB operation. The relays RLA and RLB should be separate, rather than a single double-pole relay, in order to minimise signal leakage around the filter. The type used by the writers was RS Components type 349-399 in form C. No mechanical layout is given, since this will, to a large extent, depend on the components available, but it is advisable to keep all leads as short as possible, and to separate the input and output connections.

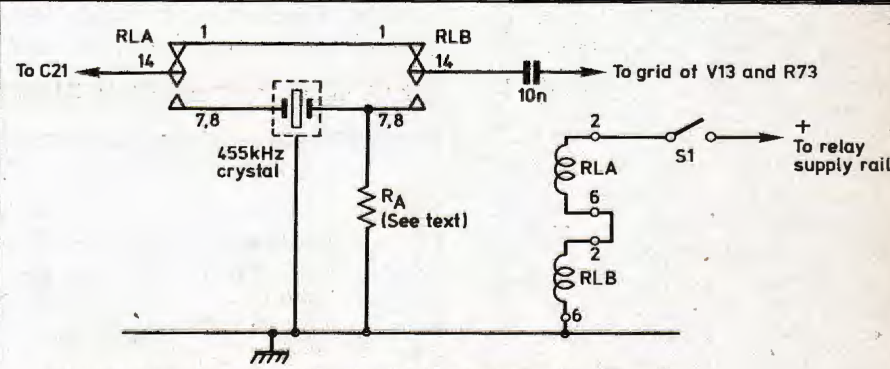
Once the filter has been installed, a temporary resistor of 4.7k ohms should be wired into the R_A position, the rig switched on and allowed to warm up. Tune to a CW signal of reasonable strength and switch the filter into circuit. A definite peak in signal strength should be found as the receiver tuning is varied. The width of this peak will depend on the value of R_A. Reducing the value narrows the peak and increasing the value widens it. There is, however, a tradeoff between selectivity and sensitivity, since reducing the value of R_A increases the insertion loss of the filter. The best value will usually lie in the range 1k to 10k, and will depend on the activity of the crystal, so some experimentation will be necessary. It is as well to note that some use of the IRT control may be necessary in practice since the filter peak may not be at quite the same frequency as the transmitted signal. Until the modification to improve the keying characteristics (described later) is carried out, the exact transmitted frequency is dependent on the frequency of the sidetone oscillator since, as mentioned in part 1 of this series, CW is generated by keying this oscillator and feeding the resultant audio into the transmitter AF section.

The filter as just described was used for about a year by one of the authors and, whilst not perfect, it was found to be a vast improvement over having no filter at all. If CW is not your main mode you may find that it is adequate; however, if like both authors, you operate mainly on the key, you may well wish for something better, as is now described.

Fitting a mechanical filter for CW

The second, more complex method of improving the CW selectivity uses a Collins 455kHz mechanical filter of 500Hz bandwidth, and is definitely the better method of the two. The drawback is that the insertion loss of this type of filter is about 10dB, and some method of replacing this lost gain must be found. The writers used a dual gate MOSFET amplifier for this purpose; **Fig. 105** shows a block diagram of the final set-up, and the circuit details are shown in **Fig. 106.**

A short note on the design philosophy behind this filter system may be of help at this point for the



S1 = Extra cw/ssb switch on front panel (see text)
XTAL = 455kHz HC6U etc. but preferably in metal can. (Earthed)
Note: Numbers adjacent to RLA, RLB on circuit diagram refer to pin numbers of RS DIL relay, do not reverse pins 2 and 6 as a diode is mounted across the coil in the DIL package.

FIG. 104.

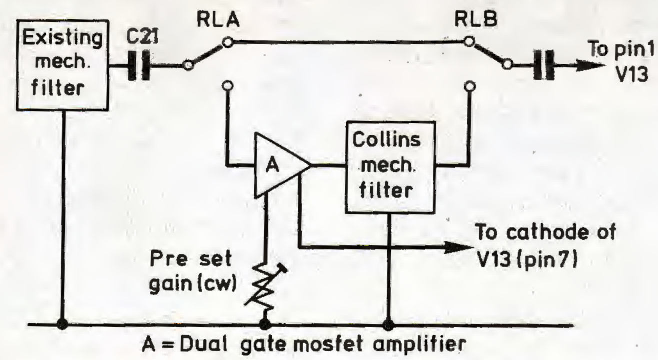


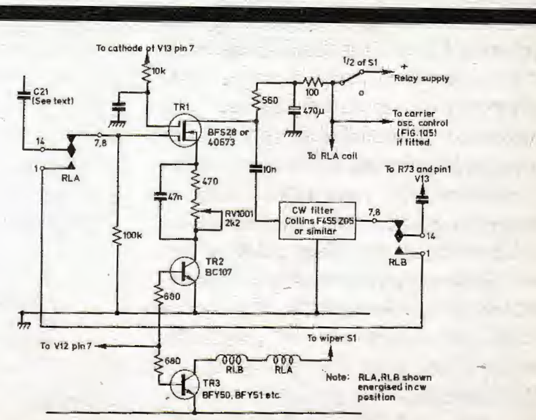
FIG.105. Block diagram of the improved cw filter

benefit of those who wish to modify the writers' system for their own requirements. It was considered that problems might arise if the original SSB filter was switched out of circuit on CW and replaced by a narrower filter, since out-of-passband signals might leak around the original SSB filter due to the extra wiring of the switching system. This would affect both transmit and receive operation. So it was decided to leave the SSB filter in the signal path on both SSB and CW, inserting the extra filter *as well* when required. At first the narrower filter was simply put in series with the receive final IF path, and although selectivity was much improved the receive gain was drastically reduced. So the amplifier of **Fig. 106** was constructed and inserted between the existing filter and the extra filter. This worked well, but it was found that the AGC behaved in a rather odd fashion on CW. This was found to be due to there being no AGC on the extra MOSFET stage. This problem was very simply cured by deriving the Gate 2 voltage for the MOSFET from the cathode of one of the existing AGC controlled IF stages in the *KW2000*. Because of the AGC action, this voltage varies with signal level, dropping as the increasing signal causes the AGC to move the valves towards cut-off and thus reduces the current through the cathode resistor. This is just what is needed, since reducing the Gate 2 voltage reduces the gain of the MOSFET. Most of the components for the amplifer can be mounted on a small piece of *Veroboard* positioned adjacent to the main filter. The new filter, which is rectangular in shape, can conveniently be mounted on the top of the existing filter on top of the chassis, using a large capacitor clamp and an aluminium strap to hold the old and new filters respectively, and making the connections to the new filter with miniature co-ax. The capacitance of this co-ax must be taken into account in determining the terminating capacitance required for the filter, which was found to be approximately 130pF in parallel with the input and output connections for this type of filter. If a different type of filter is used, the required value of terminating capacitance should be obtained from the manufacturer's data sheet. RLB was mounted adjacent to pin 1 of V13. The two transistors TR2 and TR3 in **Fig. 104** are used to remove the CW filter from circuit during transmit. These transistors obtain their base bias from the cathode of V12, one of the receive IF stages. During transmit V12 is biased off, which means that its cathode voltage is zero, so there is no forward bias on TR2 and TR3. On receive V12 is turned on, producing a voltage drop across its cathode resistor and thus supplying forward bias to TR2 and TR3. The values of the base resistors for these transistors are chosen to ensure that both devices are turned on hard despite the variation of V12's cathode voltage caused by the AGC action. Turning off S1 removes the supply from the amplifier and the relays, preventing the filter from being switched into circuit on receive, and this is the condition used for SSB operation.

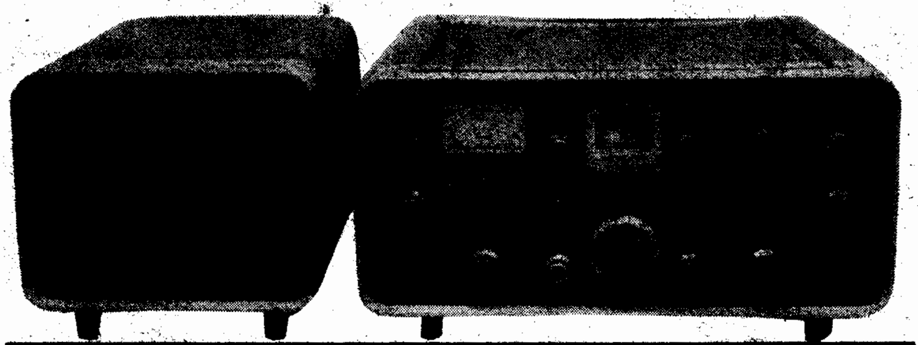
Setting up the filter system is very simple, merely involving the adjustment of the amplifier gain control RV1001, and the selection of the correct value of terminating capacitance for the filter. The procedure is to set RV1001 to minimum resistance, switch S1 to on and tune in a steady carrier of about S5. Now try various values of capacitor a little above and below the maker's specified value across the input terminals of the filter, using the value which is found to give the maximum S-meter reading. Then repeat the procedure for the output terminals. The exact value seems not to be all that critical and a few pF either way will make little or no difference. To set RV1001 the same S5 signal should be tuned in with the switch S1 set to ON, and S1 then switched off. Note the S-meter reading, switch S1 back on again, and adjust RV1001 to obtain the same reading.

Again it may be found that it is necessary to use the IRT control when operating since the transmit frequency may not coincide with the centre frequency of the filter until the keying modification has been carried out. **Part 5 of this series in our July issue will describe this modification as well as others.**

Fig. 106. CW filter, amplifier control and AGC



Upgrading the KW2000 series of HF transceivers



Part 5 More Mods

by M.T. Healey, G3TNO and R. Charles

Improving the CW note

The note on most *KW2000s* leaves a little to be desired to the CW purists and the example at G3TNO was no exception. A number of critical reports on the note were obtained from local and more distant stations, including a most useful tape of the transmission from an SWL (needless to say, he received a QSL by return). It became obvious from the tape, various reports and local monitoring that the signal suffered from clicks on 'make', and thumps on 'break', and that the tone had a rather odd 'flutey' sound. Various experiments were tried with the usual key click/thump filter circuits, but none really cured the problem, so thoughts turned to an alternative method of generating the CW signal.

The *KW2000* was tuned up into a dummy load, and another receiver was used to monitor the signal produced. The balanced modulator was then temporarily unbalanced by shorting one side of the balance control RV14 to chassis, and the resultant carrier monitored on the outboard receiver; the note was perfect. So an external power supply was lashed up via a key to the junction of C6 and C7, a CR network being connected across the key contacts. The monitored note was now perfect with no trace of click or thump. This set up performed well on the lower bands, but on 21&28MHz a severe lack of drive was apparent, caused by the fact that the carrier in most SSB rigs is set to a frequency which is about 20dB down one side of the filter passband, as shown in **Fig. 105**. So a crystal in the centre of the passband was plugged into the socket normally occupied by the LSB carrier crystal, and again the note was monitored and the drive level checked; the note was still OK and there was now plenty of drive available on all bands. A few local contacts were made using this lash up, and everyone reported a great improvement in the transmission.

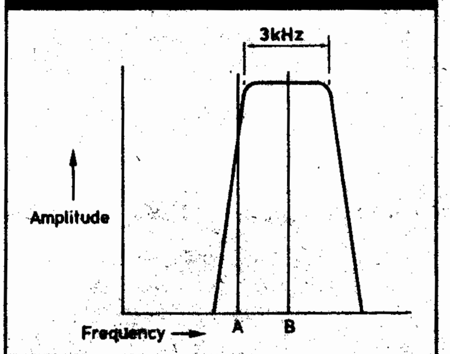


Fig. 105 The position of the carrier with respect to the filter passband. For SSB operation the carrier frequency is normally set to position A, some way down the skirts of the filter response, so that the filter passes the upper sideband and filters out the lower. For CW operation more drive will be obtained if the carrier is moved to position B, in the centre of the passband.

A list was now drawn up of the requirements for a permanent modification:

1) The ability to unbalance the balanced modulator with the key, without using an external power supply.

2) The automatic switching in, in the transmit mode only, of a carrier crystal in the centre of the SSB filter passband, reverting to the normal carrier crystal on receive.

After many trials and errors the circuit of **Fig. 106** was evolved. The advantage of this circuit, apart from an improved CW note, is that, at the flick of a switch (S1*), it is possible to revert to the unmodified state; thus the SSB performance is unchanged, and comparison between the modified and unmodified states is very easy.

The operation of the circuit is as follows. With S1 set to ON, and under key-up conditions, TR4 and TR5 are biased off, so no voltage will appear across R1003 or across the coil of relay C. The sidetone oscillator will be cut off, and with the rig set to VOX the contacts of the VOX relay RL4 will be open; thus the rig will be in receive with the CW filter switched into circuit. At the instant of closing the key contacts, TR5 is biased on, relay C is energised and a carrier crystal in the centre of the SSB filter passband is switched into circuit. The sidetone oscillator in the *KW2000* will at the same time activate the VOX circuit, putting the rig into transmit. This will close contacts RL4/2 and will keep TR5 biased on via D112. This latter feature is very important, as without it relay C will follow the keying, and the

* Note that the switch 'S1' referred to in this article is not the same switch as on the original KW circuit.

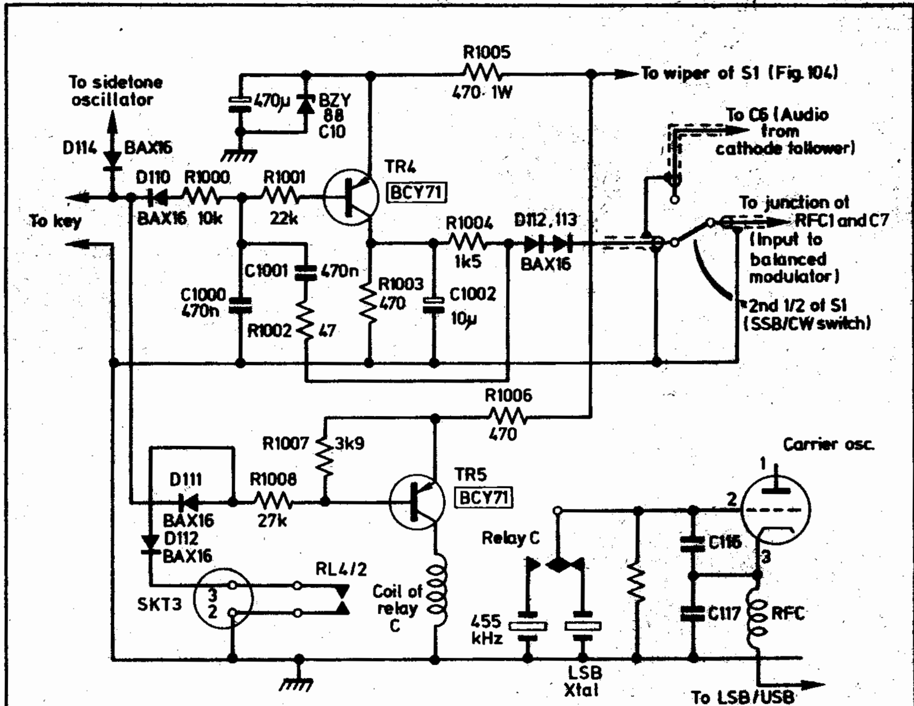


Fig. 106

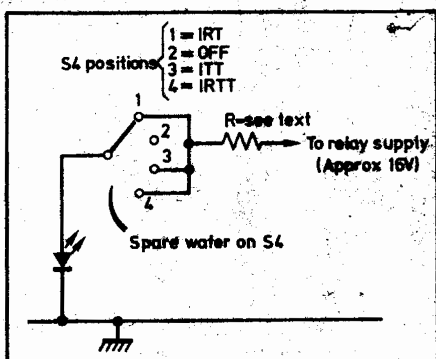


Fig. 121

outgoing transmission will sound like a cross between FSK and normal on/off CW! TR5 will stay biased on during the hold-in time of the VOX ciruict, or for as long as the rig is held in transmit by the INT MOX setting or by an external send/receive switch, provided that S1 is set to the CW position. Also under key down conditions TR4 is biased on via D110, R1000 and R1001, the turn-on and turn-off times being controlled by R1000, R1001, R1002, C1000, C1001 and C1002. These components are required to completely remove any thumps or clicks on the signal; there is therefore no need for further key click filters across the key or keyer contacts, and in fact they are positively harmful to the operation of this circuit.

When TR4 is biased on (key down), a voltage is developed across R1003 and C1002. This voltage is fed via R1004, D112, D113 and the second pole of S1 to the LF input of the balanced modulator, thus unbalancing it and producinga carrier at its output. This carrier will, of course, be fed on to the later stages of the transmitter. The two diodes D112 and D113 are used to prevent any slight leakage in TR4 unbalancing the modulator, which would, or course, produce a carrier under key-up conditions. D114 prevents this circuit being activated in the TUNE mode.

Variable transmitter output power

It has been found useful to be able to vary the output power of the *KW2000* when, for example, driving a transverter or linear amplifier. As the rig stands there is no way of doing this except by adjusting the MIC GAIN control, which is a very undesirable way of varying power output, particularly at low output levels. Although the ratio of *peak* output power to the suppressed carrier at normal mic gain settings may well exceed 40dB, as the mic gain is

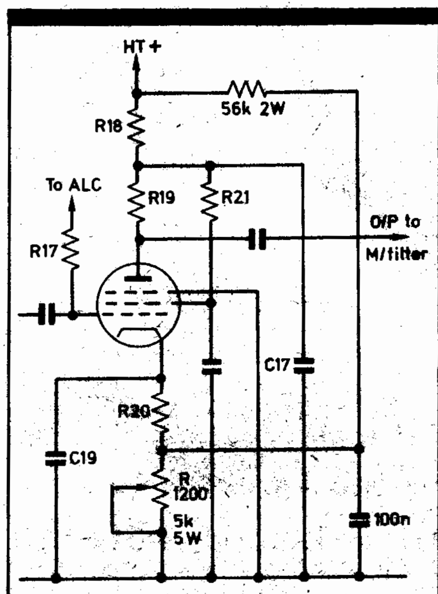


Fig. 120

reduced the carrier level due to leakage round the balanced modulator will remain the same while the peak output power will be reduced. Thus the effective carrier suppression will be reduced. The writers feel that it is best to vary the output power *after* the balanced modulator, and this can most easily be done by varying the gain of the transmit IF amplifier V3, which is in any case a variable-mu valve controlled by the ALC.

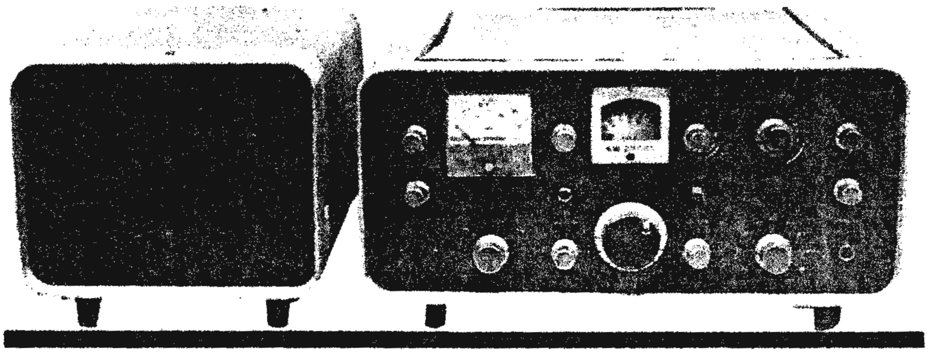
The simplest way of controlling V3 without upsetting the ALC action is to insert a variable resistor in the cathode circuit to vary the bias. A circuit for doing this, employing only three extra components, is shown in **Fig. 120**. At full gain the output level is the same as with an unmodified *KW2000*, while at minimum gain it is possible for the output to be reduced to below one watt. This method leaves the mic gain control set as for normal operation, giving the advantage that at low power output levels the carrier suppression is not degraded.

IRT IN USE indicator

A small but useful extra feature has been the addition of a warning LED to indicate that the IRT/ITT selector switch is on. The extra switching for this is already fitted, although left unused. There is a spare pole on S4, which can be wired as shown in **Fig. 121.** The LED is conveniently mounted approximately 1¼ " to the left of the switch. The value of the series resistor depends on the particular LED used and the brightness required.

The next article, in our September issue, will deal with the important question of modifying the *KW2000* to cover the 10, 18 and 24MHz bands, as well as the missing sections of the exisiting bands.

Upgrading the KW2000 series of HF transceivers



Part 6

Adding the new bands

by M.T. Healey, G3TNO and R. Charles

It may seem rather strange, but we start this month with a word of warning! The modifications required to fit the WARC bands require some dexterity and care as they involve a fair amount of 'digging around' in the front end and driver stages as well as the HF oscillator stage of the rig. However, with care it is possible to do the modifications needed in a few hours and this does give the advantage that, not only do the new bands become available, but extra portions of the existing bands can also be added. We have so far only tried the modifications on the *KW2000A*, but they should be equally possible with the other models in the series.

Modification procedure

First remove the PHONES socket from the front panel and link out the wiring from the socket so that the speaker is permanently connected. The socket can conveniently be re-fitted to the lower left hand side of the PSU front panel, making sure that the outer part of the socket is isolated from the panel in order to prevent hum being introduced into the headphone circuit by heater current flowing to earth via the headphone wiring. Next remove the links on the existing bandchange switch wafers, as shown in **Fig. 131**, not forgetting to remove the links on S2i wafer to disable one PA valve on 18 and 24MHz to comply with the current licence conditions! Next fit the coils L_A, L_B, and L_C listed in **Table 101** between the appropriate tags as in **Fig. 131**, remembering to keep the leads to the extra coils as short as possible, and also to position the coils so that access is possible to their ferrite cores during alignment. Now fit the new extra switch S1000 into the hole previously occupied by the headphone socket. Some care is required in this operation in order not to damage components in the HF oscillator compartment. You may well find, as the writers have, that it is easier to remove one or two components during the fitting of S1000, replacing them after the switch has been fitted. The wiring to the crystals is now modified as in **Fig. 132**, the extra sections of the existing bands may be fitted by adding extra wire ended miniature crystals to the contacts of S1000.

The wiring changes to the PA stage should be tackled next. First remove the links from S2E, and then

Table 101

Component	Details	KW2000 TUNING RANGE
L_A	3 off. 2 turns 22swg on 5mm dia with ferrite core. close wound.	
L_B	3 off. 3 turns 22swg on 5mm dia, with ferrite core. close wound.	
L_C	3 off. 11 turns 28swg on 5mm dia. with ferrite core. close wound.	
L_D	6 turns of 22swg Enam. Copper. Wound Directly on to ¼" dia. Iron Dust Core.	
L_E	10 turns of 22swg Enam. Copper. Wound Directly on to ¼" dia. Iron Dust Core.	
L_F	8 turns of 22swg Enam. Copper. Wound Directly on to 5/16" dia. Iron Dust Core.	
C_F	150 pF silvered mica.	
X19	Final o/p freq = 25.80MHz + 3.155MHZ = 27.95MHz ÷ 2 = 13.9775MHZ (XTAL FREQ) wire ended miniature crystal.	24.80-25.0MHz
X20	Final o/p freq = 18.0MHz + 3.155MHz = 21.155 MHz ÷ 2 = 10.5775MHz (XTAL FREQ). WIRE ENDED MIN.	18.0-18.2MHz
X30	Final o/p freq = 10.00MHz + 3.155MHz = 13.155MHz ÷ 2 = 6.5775MHz (XTAL FREQ) WIRE ENDED MIN.	10.0-10.2MHz
S1000	3 pole 6 way miniature switch. No particular make is specified but the writers made theirs up from RS components. *Maka — switch kits.* These just fit, but only just.	

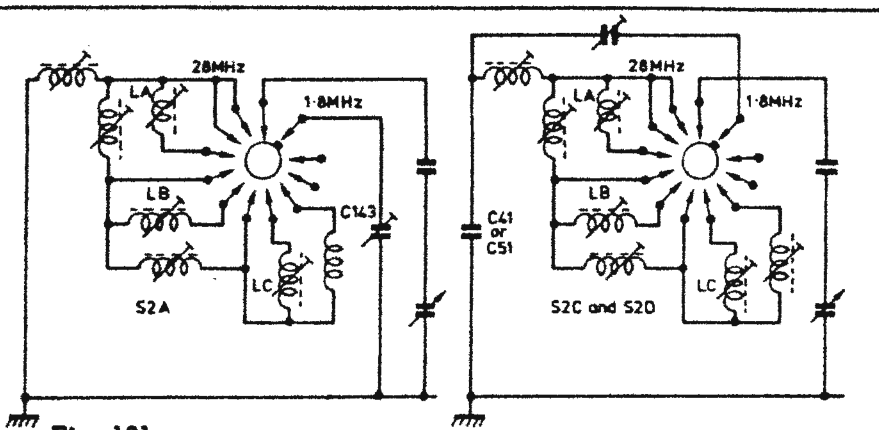


Fig. 131.

route additional leads to the pi-tank coil using PTFE covered copper wire as in **Fig. 133.** It is as well at this point to check the condition of the existing wiring to the PA coil, since we found that in some cases it had deteriorated to such an extent that the insulation actually fell from the wires when touched! At G3TNO it was found easier to carry out the above modification by first removing the sections of shaft coupling the band-switch wafers to the front panel indexing mechanism and then, with great care, to remove each wafer in turn from the transceiver, so that it could be modified on the bench instead of in situ. Care should be taken when re-installing the wafers to make sure that the wipers of all switch sections are correctly aligned before refitting the shaft.

The wiring changes to the bandswitch will, of course, alter what this switch does in practice, so **Table 100** lists the old and new (ie. modified) band positions.

After carrying out the modifications, or any part of them, a complete re-alignment of the front end is needed as per the instructions in **Part 3** of this series. In addition, the new bands will need to be aligned. Ideally, the equipment used for this should consist of:—

1. Signal generator with *accurate* frequency calibration.
2. RF millivoltmeter with high impedance input.
3. General coverage receiver.
4. RF wattmeter/dummy load.
5. Absorption wavemeter.

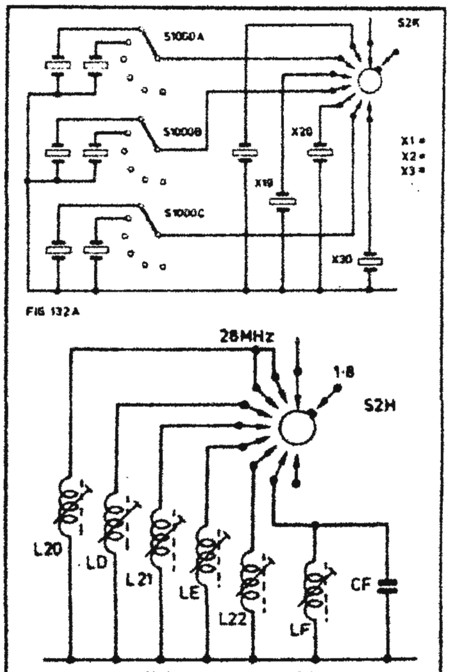
Alignment of the new bands

This should be carried out *after* the complete procedure for alignment given in Part 3 has been performed.

1. HF oscillator: Select the 24MHz band and remove the crystal for that band. Connect the RF millivoltmeter to pin 1 of V9 and the signal generator to pin 1 of V10 (HF osc). Set the signal generator to 27.955MHz and adjust the core of L_D (additional coil mounted on S2H) for maximum reading on the millivoltmeter, making sure that the core is not screwed fully in or fully out. Reduce the signal generator output so that the millivoltmeter reading does not exceed 500 MV. and re-check the setting of L_D, again adjusting for maximum reading.

Next select the 18 MHz band and repeat the above procedure, this time setting the signal generator to 21.155MHz and adjusting L_E for maximum millivoltmeter reading as before. Finally select 10 MHz, set the generator to 13.155MHz and adjust L_F for maximum reading.

If you do not have, and cannot borrow a high impedance RF millivoltmeter it is possible, with great care, to align the HF oscillator using a general coverage receiver tuned to the frequencies listed above. The receiver should be coupled lightly to the HF oscillator as in **Part 2** of this series, using a piece of wire wrapped around the glass envelope of V10, and L_D, L_E and L_F should be adjusted



Note:- Only switches requiring wiring changes shown for clarity

Fig. 132.

on the appropriate bands for maximum signal. If you do not have access to a decent signal generator (or worse still any at all!), it is possible to align L_D-L_F by using the

Table 100

Band select positions before modification	**Band select positions after modification**
28.6-28.8MHz	29.4-29.6 (OSCAR DOWNLINK)
28.4-28.6MHz	28-30MHz (Depends on settings of S1000 and XTALS CHOSEN)
28.0-28.2MHz	24MHz band
21.3-21.5MHz	21.0-21.5MHz (Depends on settings of S1000 and XTALS CHOSEN)
21.0-21.2MHz	18MHz band
14.2-14.4MHz	14-16MHz (Depends on settings of S1000) Note XTALLED FOR 14.0-14.6 and 15.6-16. For use with 144MHz transverter
14.0-14.2MHz	10.0-10.2MHz

All other switch positions remain unchanged

Table 103

Band	Position of new taps on PA tank coil
24MHz	Midway between existing 21 and 28MHz taps
18MHz	Midway between existing 14 and 21MHz taps
10MHz	Midway between existing 7.0 and 14MHz taps
	Note: The above taps will work satisfactorily but it is worth trying the position of the taps a turn or so either way, for optimum loading and output. We have modified for *KW2000* so far and the 10MHz tap is one case needed 3 more turns for optimum performance.

appropriate crystals as fitted in the modifications, but do make *sure* that you have tuned the coils to the correct harmonic of the crystals!

2. RF and driver stages: If you have fitted the crystals for the new bands during the previous stage of the modifications, first remove them again!

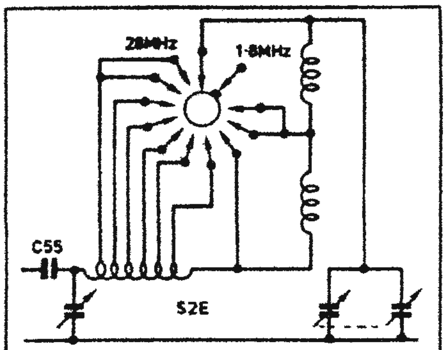


Fig. 133 Pi tank circuit. See table 103 for details of new taps required.

Select 24MHz, inject a signal at Pin 2 of V7, and set *KW2000* to INT MOX. Connect the output of the tranceiver to a dummy load. Adjust the PRE-SELECTOR so that the pointer lies midway between the 28 and 21MHz markings. Set the signal generator to a frequency in the middle of the 24 MHz band, and to an output of approximately one volt. Adjust L_A (S2d) for a rise in PA anode current. Tune and load the PA for a shallow dip into a dummy load/watt-meter, and then re-adjust the alignment of L_A, reducing the output from the signal generator if necessary to keep the PA current below 100mA on the *KW2000*, or 200mA for other versions.

Once the driver anode circuit has been aligned, remove the signal generator from V7 grid and connect it to Pin 2 of V5 (second transmit mixer). Proceeding as above, align L_A (S2c), which is in the anode circuit of V5.

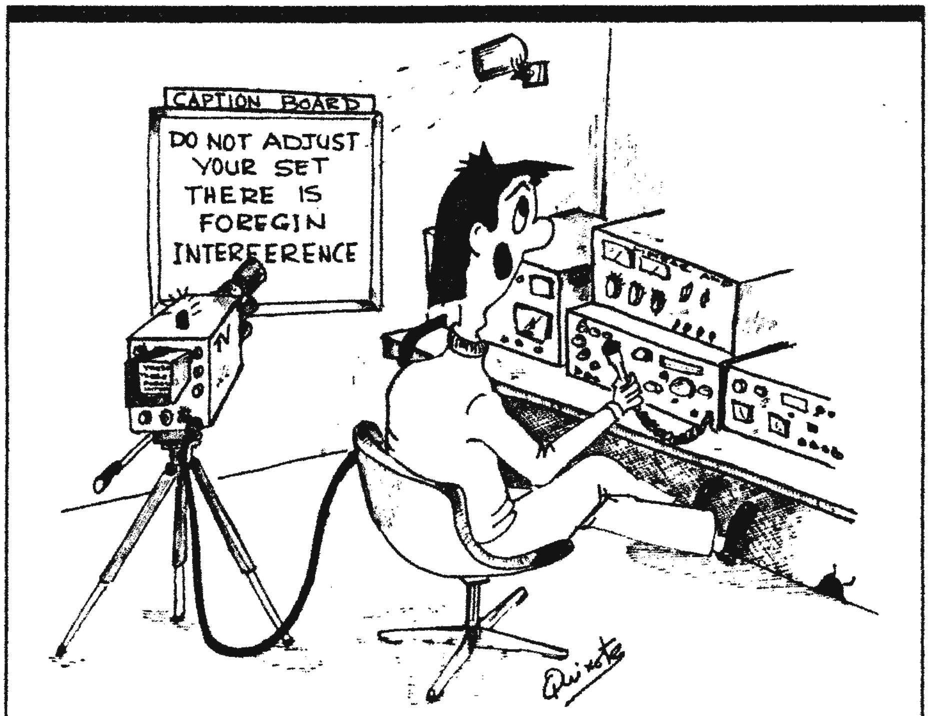
Now change bandswitch to 18MHz, set the pre-selector to midway between the 14 and 21MHz segments, and set the signal generator to the centre of the 18 MHz band. Remove the 18MHz band HF oscillator crystal, and then align L_B (S2d) and L_B (S2c) following the procedure given for the 24MHz band, not forgetting to tune the PA correctly into a dummy load. Finally repeat the procedure for 10MHz, setting the pre-selector midway between the 7 and 14MHz segments and adjusting L_C (S2d) and L_C (S2c).

Now refit all HF oscillator crystals. Set the bandswitch to 24MHz, switch to TUNE and adjust pre-selector and PA as in the instruction manual. *Without altering* the pre-selector setting, switch to receive and connect the signal generator to the aerial socket of the rig. Set the generator to about 24MHz and adjust its tuning until its output is heard on the *KW2000*. Ensure that the signal from the generator is centred in the receiver passband, and then adjust L_A (S2a) for maximum S meter reading, reducing the output level of the generator if necessary to keep the S meter reading below S5. Repeat the procedure on 18 and 10MHz in that order, adjusting L_B (S2a) on 18MHz and L_C (S2a) on 10MHz. The temptation to use off-air signals for this should be resisted, since your aerial may not present the correct 50 ohms impedance to the rig, which will affect the setting of the front end tuned circuit. For the same reason, do not re-adjust the setting of the front end coils after carrying out the adjustment with the signal generator as described above.

Modification for 10MHz only

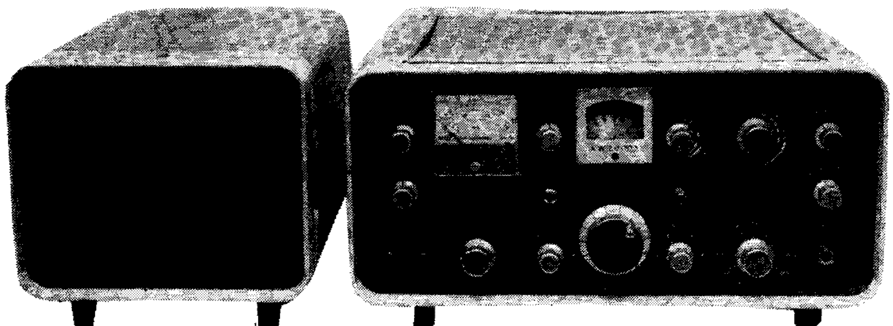
It is, of course, possible that, like one of the writers, you may only wish to fit the 10MHz band and not the other bands, at any event in the initial case. In this case, of course, a single pole two position switch can be used in the S1000 position, and of course only the extra coils appropriate to the 10MHz band need be fitted!

The next article in this series will cover the improvement of the front end performance on the lower frequency bands, and provision for a separate outboard receiver, and separate receive and transmit aerials.



"...*cured my TVI problem*..."

Upgrading the KW2000 series of transceivers–



Part 7

Simple RF attentuator design plus switching circuitry for an 'outboard' receiver and seperate 'transmit' and 'receive' aerials.

By Malcolm Healey, G3TNO, and R. Charles.

After the foregoing articles in this series, a number of small refinements remained on the list of desirable extras worth incorporating in our KW2000 series of transceivers update. These were (1) To be able to use a separate outboard receiver for split frequency operation; (2) To be able to use separate aerials on 'receive' and 'transmit'. For example, when operating on 160 metres it is useful to use a loop aerial on 'receive' in order to null out QRM, particularly when chasing DX; (3) To have the facility to switch in an RF attenuator on 'receive' when using large aerials. This is particularly useful on the lower frequency bands ie 7 and 3.5 MHz where the receiver front end on the KW 2000 has been found to be prone to RF overload on largish arrays such as Vee beams or very long wires.

The above modifications can be achieved very simply. All or part of the modification may be readily incorporated, depending on your own needs.

Fig. 5000 shows the circuit details. Switch 5000 is fitted inside the case of the KW 2000 an approximate 2¼ inches to the left of the IRT/ITT switch and in line with the existing cab/set control. Switch 5000 is the attenuator control switch. The user must select the value of the attenuator to be fitted as this largely depends upon the type and size of aerials in use. **Fig. 5000** gives resistor values and attenuation values up to −40dB which, unless you have stolen the aerial system at BBC Daventry, should more than cover most amateur uses!

The switching circuitry for alternative aerials and an outboard receiver has been fitted outside the KW 2000 itself, as this gives greater flexibility. At G3TNO this was incorporated in the station control and switching unit, which also controls the switching of the station aerials. Only the circuitry relevant to the modification is shown (see **Fig. 5001**).

After incorporation of the above modifications, in particular that of the RF attenuator, it is really amazing to hear the improvement in reception on, say, the extremely crowded 7MHz band after dark. Much DX that just

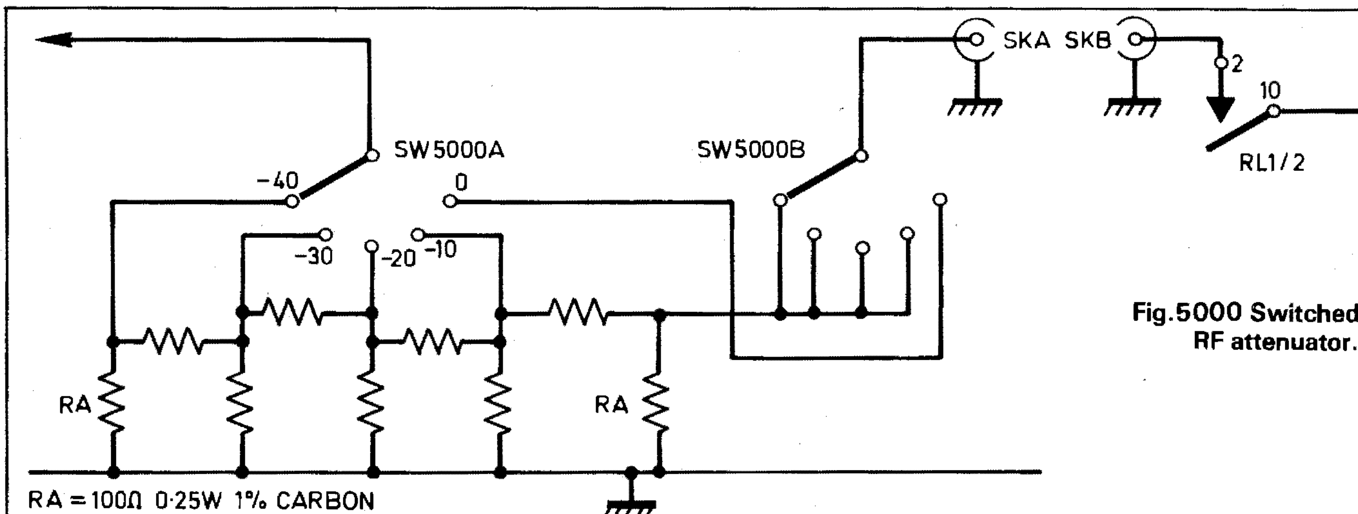


Fig.5000 Switched RF attenuator.

RA = 100Ω 0·25W 1% CARBON
ALL OTHER RESISTORS = 150Ω 0·25W 1% CARBON
NOTE:- DO NOT USE WIRE WOUND RESISTORS AS THESE WILL BE INDUCTIVE, AND MAY WELL GIVE SOME VERY ODD RESULTS.

could not have been resolved before the above modification was now easily readable, with much reduced interference, because of the reduction in RF 'cross-modulation' of the KW 2000.

Extra CW Selectivity

Extra selectivity has been added to the KW 2000 A in use at G3TNO and has been found worth while in *very* heavy QRM conditions. This was made up as a 'plug in' extra and generally used only during contests. A shorting link replaces the extra xtal (see **Fig. 5002**) for less heavily occupied band conditions.

A Few Conclusions

Since the start of this series of articles a number of people have contacted the writers and asked for practical help in getting their defunct KW 2000s going. So far, in most cases, the problems have been rapidly resolved. We have usually found that a step in the procedure of checking through the KW 2000 has been missed; sometimes a voltage has not been checked, or an alignment stage incorrectly carried out or even not done at all!

However, a few rather more obscure problems have arisen and are well worth a mention in these pages. Two cases of severe instability, on both 'transmit' and 'receive' were found to be due to the owners of the rigs concerned having used rather obscure (!) manufacturers equivalents to the valve types listed. In both cases although the correct type number was on the envelope of the valve, there was actually no manufacturers name. At a guess the valves probably came from eastern Europe. Replacement with the correct types from well known manufacturers (Brimar and Mullard) cured the problem. So, be careful of the pedigree of your replacement components! The second problem encountered was slight chirp on CW, even after the CW note modification, combined with FM on SSB at full drive levels on 80-10 meters. This was found to be due to a non-standard mains transformer being fitted in the PSU and in one case was with a 'home brew' PSU. In both cases the problem was essentially a lack of HT 'stiffness' and two actions have been taken to effect a 100 per cent cure. Firstly, the 250V HT decoupling in the PSU was increased in value to 250uF, and then a 32uF capacitor was fitted across the thermionic (valve) voltage stabiliser in the KW 2000 itself. These modifications completely cured the chirp and FM on SSB and I believe are worth fitting to apparently trouble free KW 2000s.

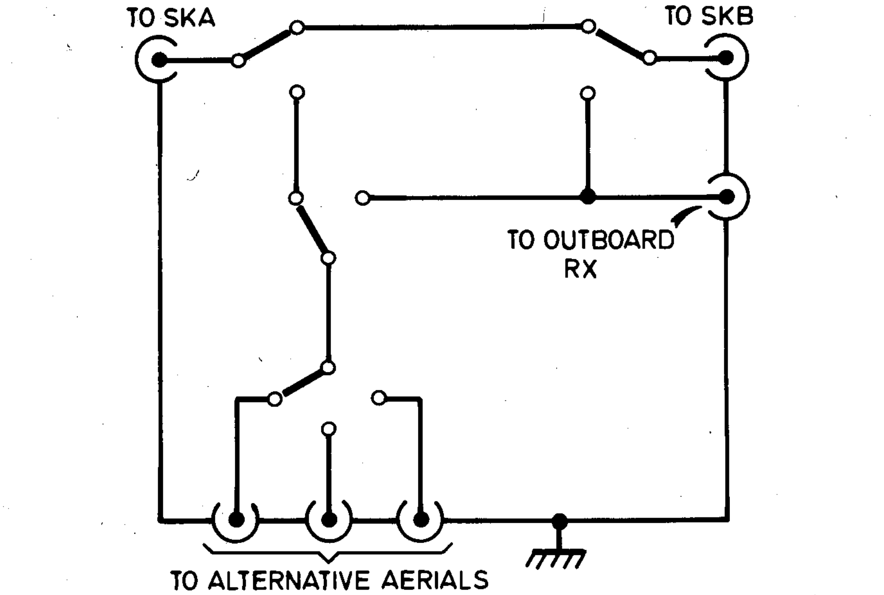


Fig.5001 The switching circuitry for alternative aerial systems.

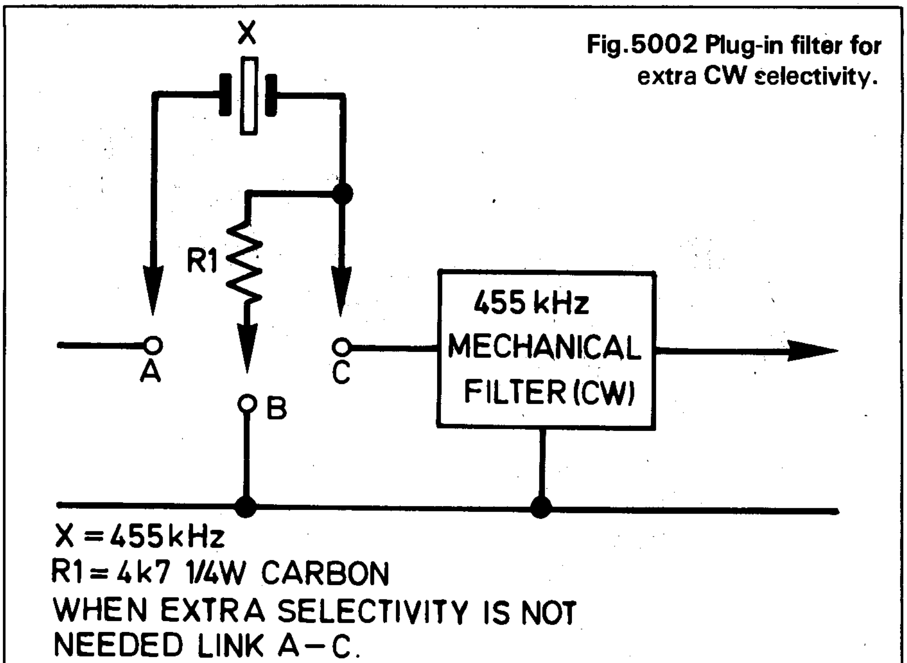


Fig.5002 Plug-in filter for extra CW selectivity.

Whilst the modifications described in this series are by no means the ultimate as to what can be done with an original KW 2000 it is hoped that the articles will encourage a few to be brought out of those dusty corners, re-vamped, and used on the bands instead of rotting away. I must say that judging from your letters this appears to have happened. As a final thought from the writers: how about making the VFO solid state? and also adding a digital read-out of frequency? Well, you write the articles and we will give them a try! (How about this?)

The writers would like to thank the countless number of people who have given reports on our signals both before and after our modifications.

Some correspondence has been received at HRT regarding various aspects of the KW 2000 update series. Malcolm has kindly written answers to these and they will be published along with the original correspondence in the 'Letters' section of the February dated issue.