Upgrading the KW2000 series of HF transceivers

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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

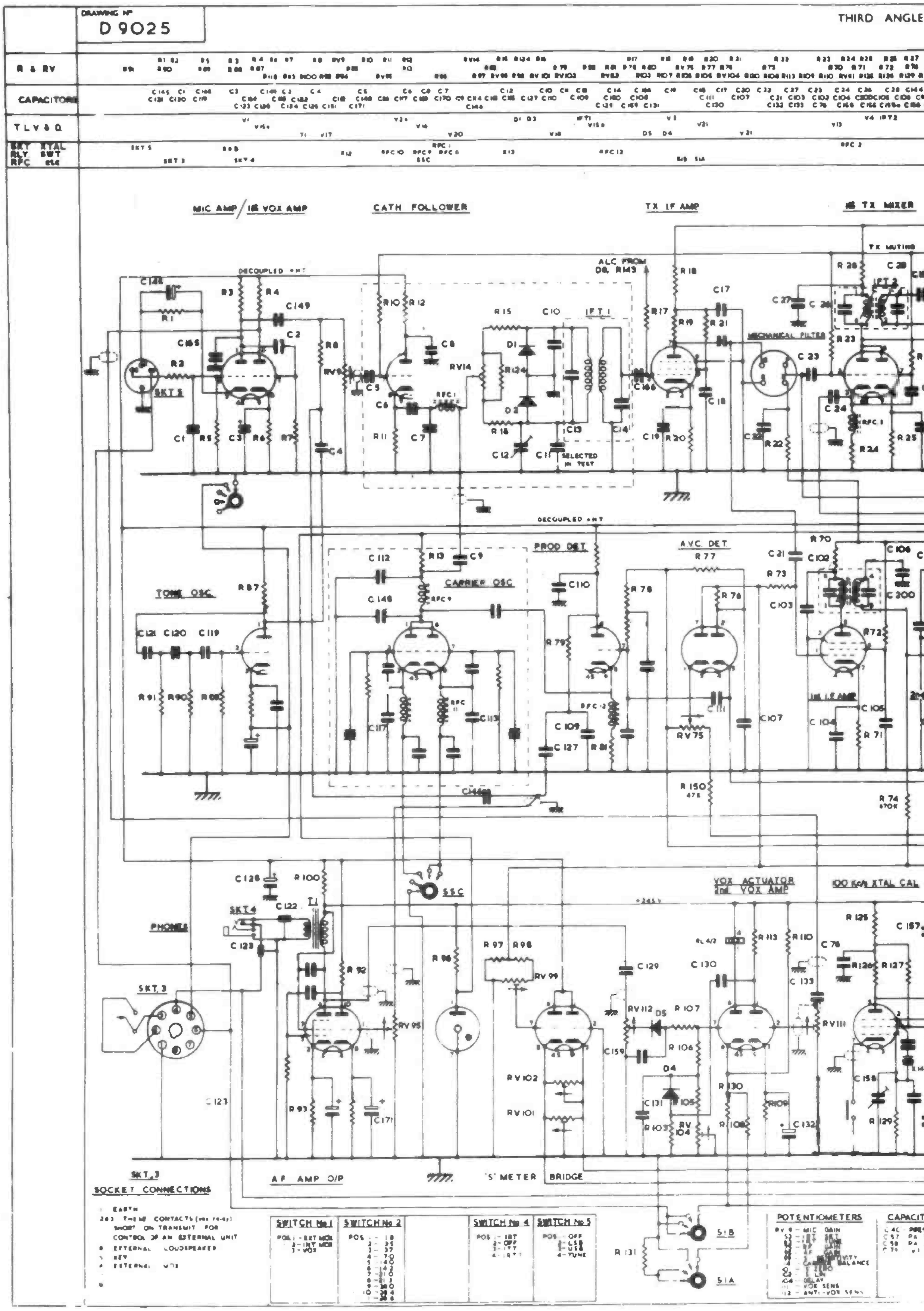
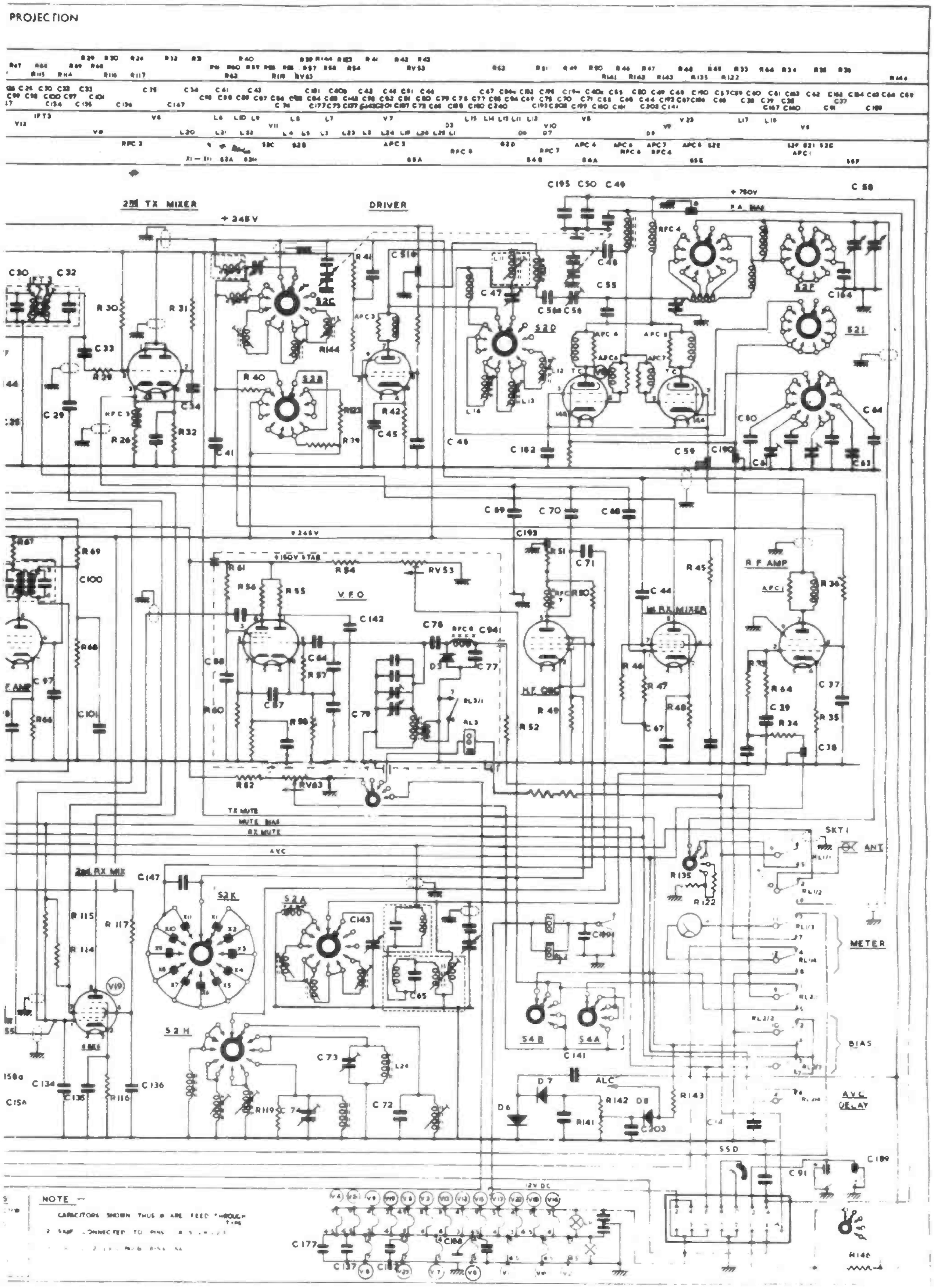


Fig. 1. Circuit of KW2000 A. KWZ000 is similar, but does not have V23 (2



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

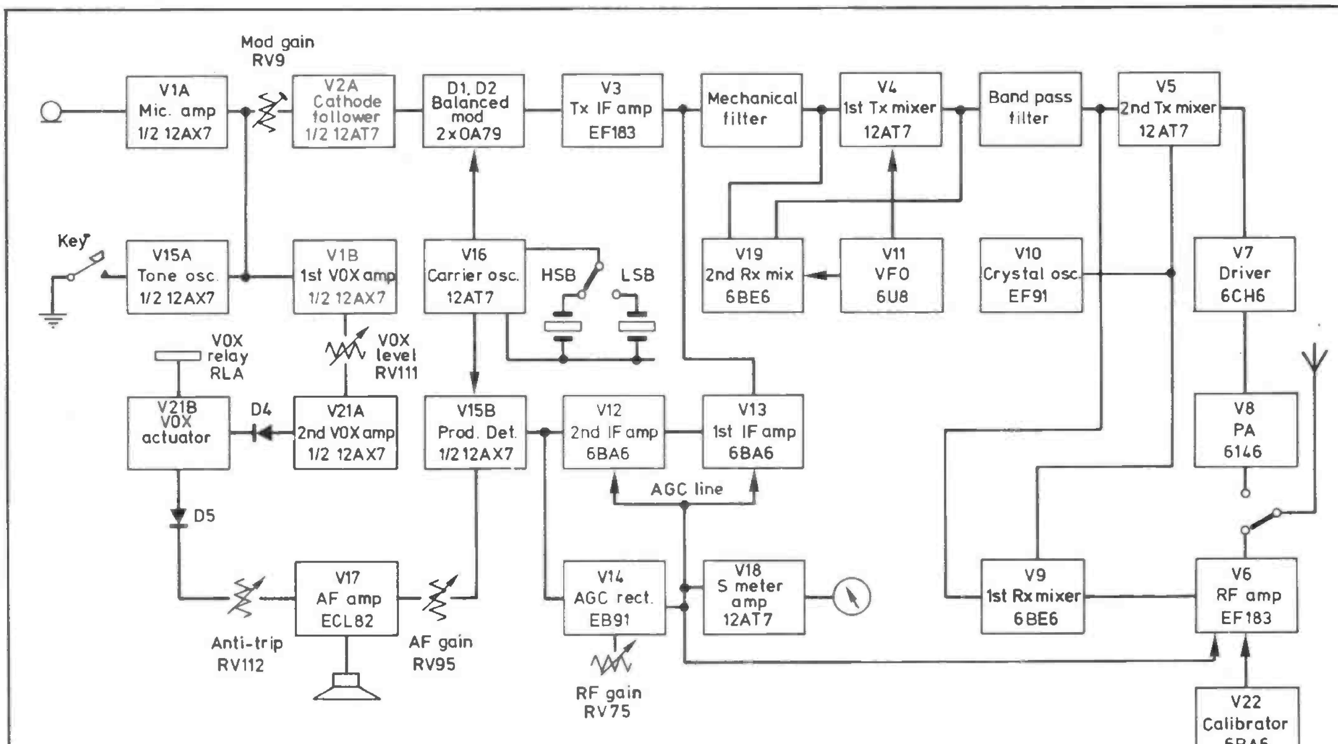


FIG. 2 Block diagram of KW2000

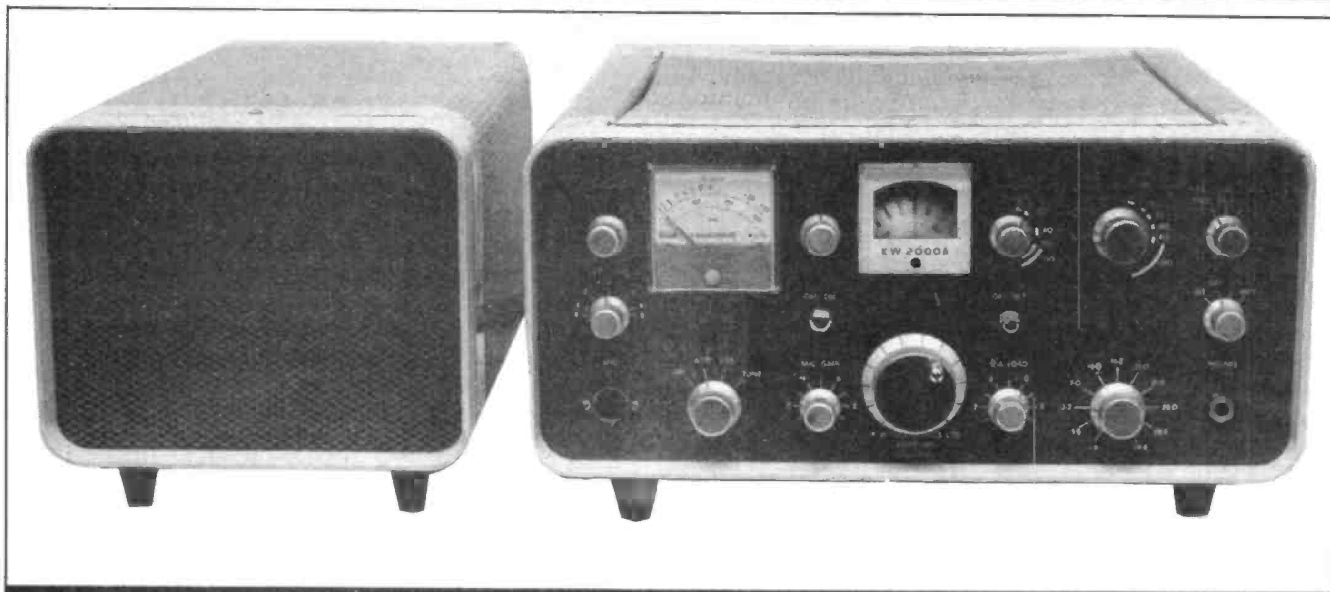
420MHz (yes, 70cms started at 420MHz in those days!), and the dominant mode was AM. It was the very end of the era when normal practice had been to buy an ex-forces communications receiver such as an AR88 or HRO, and to build a simple all valve transmitter to use with it. SSB was just beginning to appear 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.

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

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.

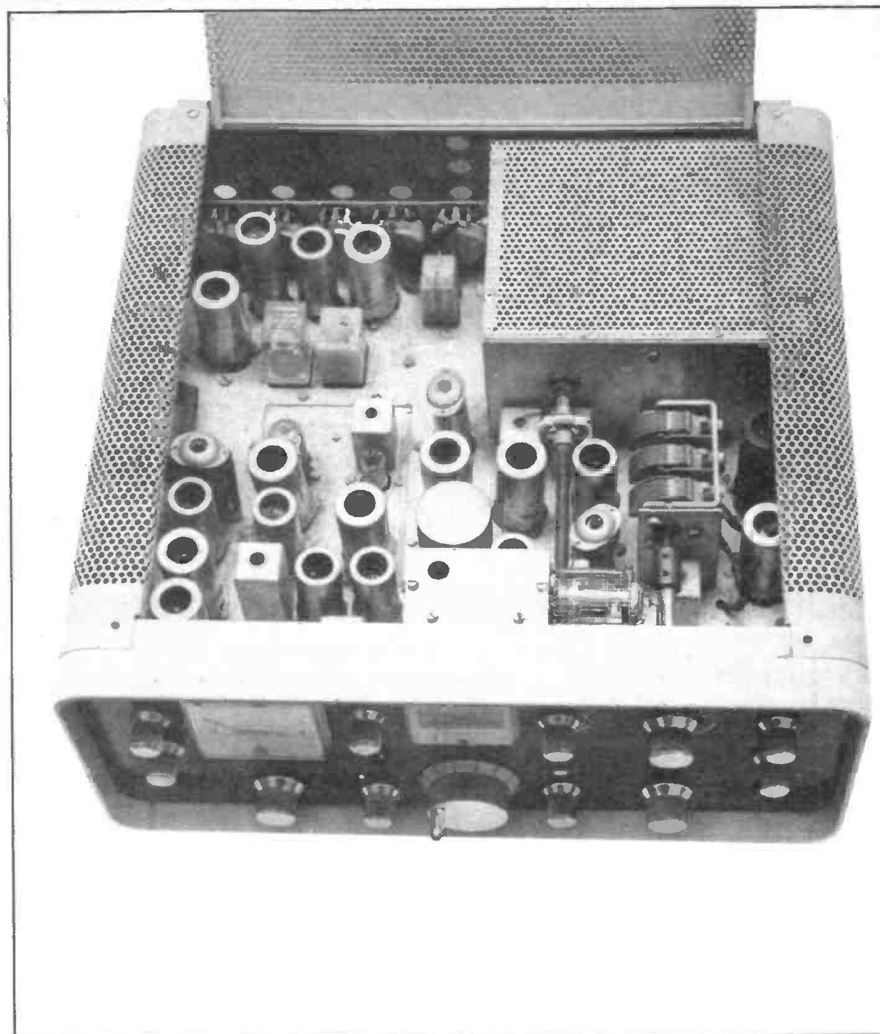
This valve, by the way, is ridiculously expensive, costing almost twice as much as the PA valve!

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.*