Vintage Radio

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The Harbros 12/54B transceiver

Designed specifically for rural fire brigade networks in the early 1950s, the Harbros 12/54B transceiver was a 12-valve unit with some interesting design features. It superseded army-surplus transceivers that had been adapted for the job and was much easier to operate.

By the end of World War 2, the value of radio communications was apparent and returned servicemen from country areas quickly realised that 2-way radio could help coordinate fire-fighting activities. Not only would it make such activities more effective but it would ensure greater safety for firefighters as well.

At that time, here were many thousands of high-frequency (HF) portable transceivers available on the military surplus market at very moderate prices. As a result, transceivers such as the FS6 and the 122 (described in May 2003 and October 2003 respectively) were quickly pressed into service on rural fire-brigade services. In addition, many of these sets were used by the Flying Doctor Service and by fishing fleets.

The 122 required no modifications to make it suitable for use in these services, as it had both a variable-frequency oscillator (VFO) and a crystal-controlled transmitter. However, the FS6 and many other ex-service sets did require changes, as their transmitting frequencies were controlled only by a VFO. The Postmaster Generals Department required the transmitters to be crystal-controlled, which meant they had to be modified and submitted for approval.

Disadvantages

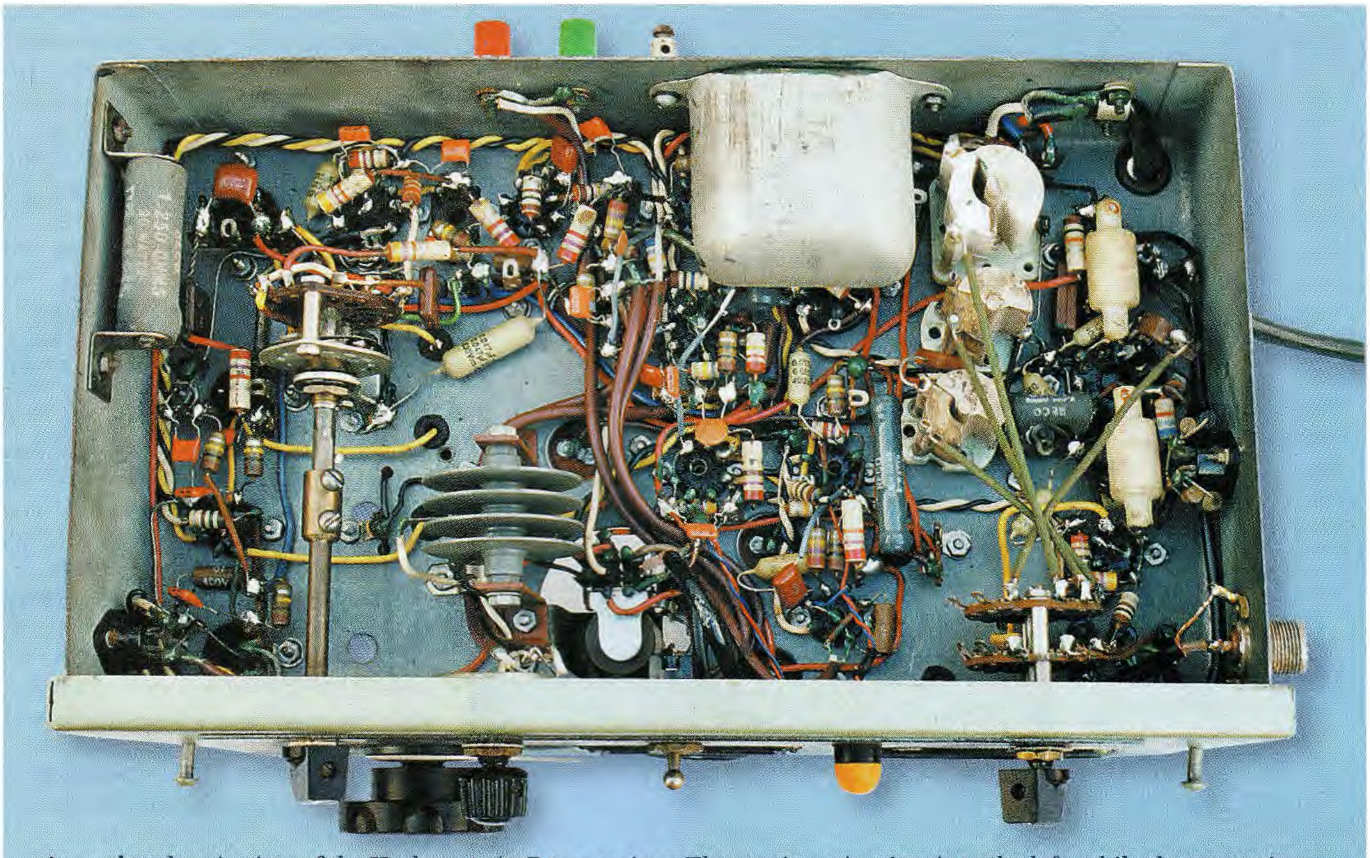
Although army-surplus transceivers worked well in these roles, they did have their disadvantages. Generally, they were quite bulky and heavy, were often difficult to service and could often only be operated effectively by someone with technical knowledge. They also usually had limited power outputs while at the same time drawing high currents when operated from a vehicle battery.

That list of negatives didn't prevent the sets from being used for fire-brigade or fishing fleet communications though. When you have nothing else to use, you will work around any problems you encounter – which the various operators and networks did with considerable success. More suitable commercial transceivers were rare and costly at that time.

As the supply of cheap army-surplus equipment gradually dried up, manufacturers began releasing commercial HF transceivers to meet the increasing demand for equipment. Naturally, this new equipment was manufactured to meet specific requirements, rather than being adaptations of military equipment.

For example, some manufacturers concentrated on producing marine equipment, while others concentrated on land-based applications. One such company, Hardinge Brothers of Horsham, Victoria, specialised in HF transceivers for the rural fire-brigade networks

The view shows the author's fully restored unit. The cabinet was repainted a hammer-tone green colour, which closely matches the original finish.



An under-chassis view of the Harbros 12/54B transceiver. The receiver circuitry is to the left, while the transmitter circuit is to the right.

– mainly the Country Fire Authority networks in Victoria.

The Harbros 12/54B

Hardinge Brothers produced domestic radios before the war, although apparently only in limited quantities. The company subsequently tooled up for the production of HF transceivers in the early 1950s and the first unit produced (as far as I am aware) was the 11/53M – an 11-valve, single channel, HF transceiver with an output power of 5W. The "11" in the model number refers to the number of valves used, "53" to the year of initial production and the "M" to the fact that it was primarily a mobile transceiver.

The later 12/54B model is a 12-valve unit (not including power supply rectifiers), first manufactured in 1954. It was primarily intended as a base transceiver and is rather more versatile than the 11/53M, as it could transmit on three crystal-locked channels. The receiver could tune continuously from 2-6MHz and also boasted two crystal-locked channels.

The controls on this set are somewhat simpler to understand and use compared to the ex-service equipment, as the more critical transmitter tuning controls are preset within the case. In fact, there are only five controls in all: (1) receiver audio level; (2) receiver tuning (2-6MHz); (3) transmitter frequency selector; (4) receiver variable tune or crystal-locked tuning selection; and (5) noise limiter on/off. The power on/off switch has three positions: (1) 12 VDC; (2) off; and (3) 240 VAC mains.

The 12/54B transceiver was expected to operate on AC power most of the time, with 12V DC operation included as a back-up in case the base station location lost mains power.

Receiver circuit

The receiver circuit (see Fig.1) is similar to that used in many high-performance domestic receivers of the era. A 6BA6 (V1) acts as a tuned RF stage and this is followed by a 6AE8 (V2) as a frequency converter. Although a conventional oscillator circuit is used for the variable tuning, two frequency-controlling quartz crystals in a Pierce oscillator circuit are used for fixed-frequency reception.

Next comes a 455kHz IF amplifier based on a 6BA6 (V3) and this is then followed by a 6N8 (V4) as the second detector, AGC diode and first audio amplifier. The audio from the detector then goes to a noise limiter which uses a 6AL5 (V6) dual diode. This stage limits impulse interference, after which the audio is fed to the 6N8 pentode section.

A 6AQ5 (V5) functions as the second audio amplifier which in turn drives the loudspeaker.

Transmitter circuit

The transmitter section uses six valves in all (V7-V12). A Pierce crystal oscillator based on a 6AQ5 (V11) and three switch-selectable crystals sets the carrier frequency, although only two crystals were usually fitted to the unit. For example, in the unit I have, the crystal frequencies are 2692kHz and 4510kHz. The third position was left vacant, as licences were usually only issued for two frequencies.

The output of the crystal oscillator is applied to the grid of the RF (radio frequency) power amplifier, which is based on a 6L6G (V10). V10's output

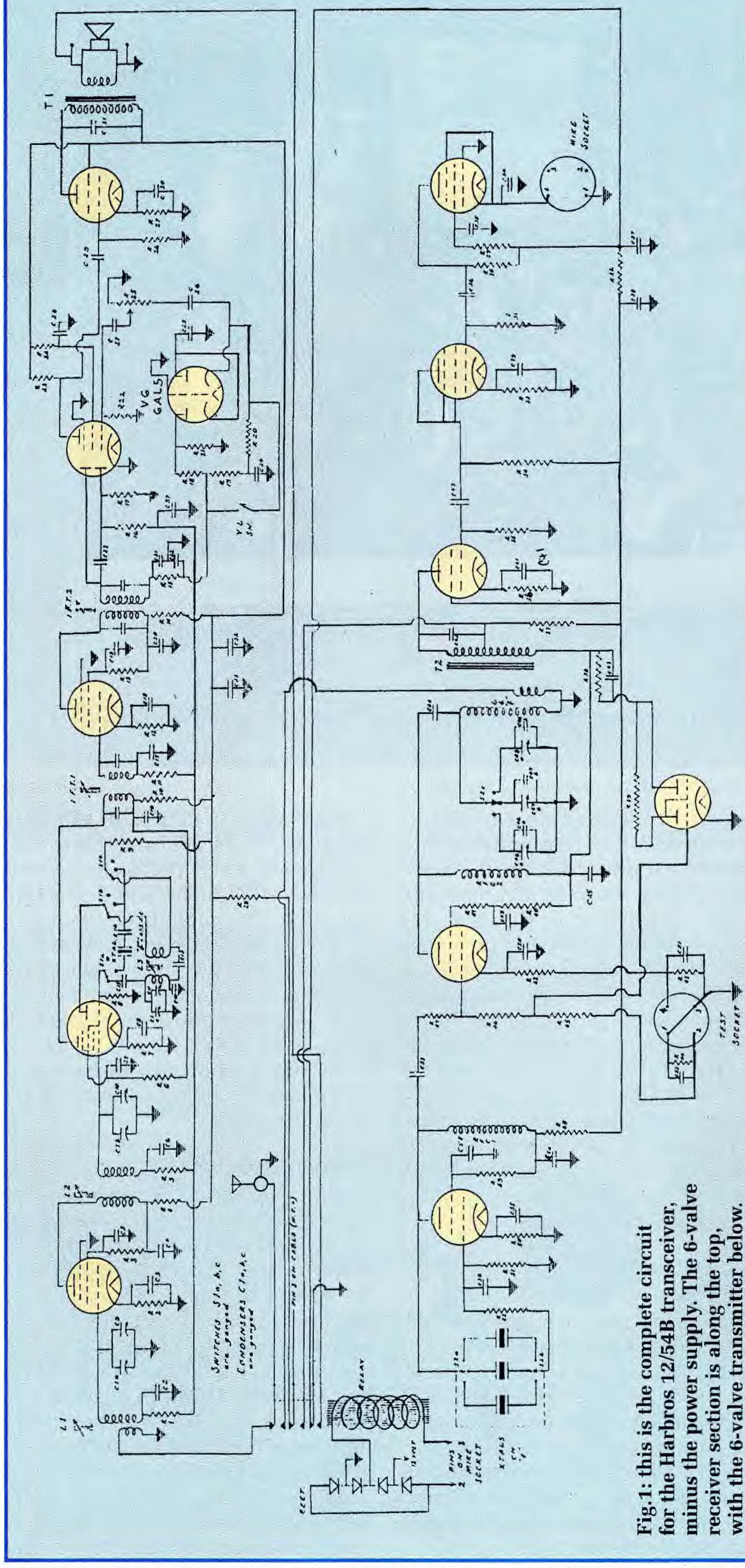


Fig.1: this is the complete circuit for the Harbros 12/54B transceiver, minus the power supply. The 6-valve receiver section is along the top, with the 6-valve transmitter below.

is then coupled via a tuned circuit to the antenna. This stage is tuned to suit the crystal frequency by switching different values of capacitance in parallel with the output coil.

In operation, the "loading" of the transmitter is adjusted to give optimum output. This is achieved by varying the position of a coupling coil which is wound onto a former and placed over the main tuned circuit winding – see photo.

The modulator is a 3-stage device based on valves V7-V9. V7 (a 6AU6) is wired as a grounded-grid audio amplifier, with a carbon microphone in the cathode circuit. Its output is fed to another 6AU6 (V8) connected as a triode and this in turn feeds a 6L6G (V9) modulator output valve.

The resulting audio signal from V9 modulates the RF signal via a centre-tapped audio choke. As shown, this is wired into the plate circuit of V9 and into the plate and screen circuits of the RF output stage (V10).

V12 (6U5/6G5) functioned as a magic-eye tuning indicator (to indicate modulation).

PTT switch

The changeover from receive to send is accomplished by pressing the PTT (press-to-talk) button on the unit's Zephyr carbon microphone. This actuates a 3-pole relay and one set of contacts transfers the HT (high-tension) voltage from the receiver to the transmitter. At the same time, a second set of contacts swaps the antenna from the receiver to the transmitter, while the third set removes a short circuit from the HT at V7 in the modulator and shorts the loudspeaker voice-coil to earth.

The last operation is necessary to prevent acoustic howl from occurring at the changeover from transmit to receive and vice-versa. It occurs because the transmitter and the receiver remain in operation for a fraction of a second after a changeover, as the filter capacitors in the supply rails take a finite time to discharge after the HT is removed.

Mechanical clean-up

The transceiver featured here had been in continuous service from 1961 until the early 1970s, when the Country Fire Authority changed to VHF radio communications. It then ended up in a garage at a coastal location, where the salt-laden air rusted the cabinets. When I used an angle-grinder to clean the rust off the lid, I found that it had penetrated some distance underneath the paint.

Fortunately, the transceiver and power supply cabinets were in much better condition. After removing the circuitry, they were rubbed down with fine sandpaper to remove any loose paint and rust. The cabinets were then cleaned down with turpentine and given a coat of Wattyl Killrust metal primer undercoat.

That done, I went looking for a spray paint that would roughly match the original green. Eventually, I came across a hammer-tone metal finish in Jade Green. This closely matches the original hammer-tone finish so I bought a can, even though it is rather expensive. It is labelled as Galmet metal protection and is easy to use.

Next, the knobs were removed and cleaned by scrubbing them with a nail brush dipped in soapy water. They were then polished with an automotive cut and polish compound and now look much brighter.

Next stop was the volume control. This was extremely stiff to rotate, so I sprayed Inox cleaner onto the shaft and rotated it back and forth until it operated freely. The valves were then cleaned with soapy water, with only gentle rubbing on the glass envelopes to ensure the labelling remained in place.

As a precaution, the octal valves were all held upside down while this work was being done, so that no water could seep into the valve bases. This isn't necessary with the miniature valves, since the valve pins emerge directly through the glass envelope.

After that, it was a matter of attending to a few sundry details. The front panel was cleaned with a kerosene-soaked rag, after which the dents were removed from the speaker grill. The grill was then resprayed with flat-black paint and came up looking like new.

A kerosene-soaked rag was also used to clean the top of the transceiver chassis. I also replaced the 240V power lead (it was starting to perish), cleaned the microphone and adjusted the PTT switch.

Servicing the power supply

A combined 240VAC and 12V vibrator power supply is used in these units. and this one wasn't without its problems. A quick inspection revealed that the 2nF buffer capacitor in the vibrator section had been overheating and had leaked wax onto the bottom cover of the power supply.

The major components are neatly laid out on the top of the chassis. Power comes from an external mains/vibrator supply.

I initially checked the capacitor with my 1000V tester and found it had a leakage resistance of about 30MΩ. I then decided to heat the capacitor with a hair drier and observe the change (if any) in its leakage resistance. When I did this, its resistance quickly dropped to just 1.5MΩ, so it was replaced immediately.

Unfortunately, I didn't have a suitable high-voltage (2000V) 2nF capacitor so I made one up using three 8.2nF 630V polyester capacitors in series across the secondary of the transformer. The higher resulting value (about 2.7nF) gives a lower standing current with no load, so the transformer is better tuned than it was with the original 2nF capacitor. The voltage rating of the three capacitors in series (about 1890V) is slightly lower than the rating of the original capacitor but this is unlikely to cause problems.

The circuit shows the vibrator to be a V6612 Oak unit. However, a V6606 is fitted with a 20Ω resistor in series with the reed drive to drop the voltage to around 6V. The drive voltage was 9V, so I changed the resistor to 56Ω and the voltage is now much nearer to what it should be.

The vibrator itself is not mounted in a resilient-mount socket, so the noise is quite noticeable when the unit is operating. It probably really doesn't matter, as this is a communications transceiver and the receiver is likely to be used in an area where interference and general background noise is present anyway.

The supply was also checked for any shorts or low-resistance readings from the high-tension (HT) line to chassis. There were no problems here, so the two 6X5GT rectifiers that had previously been removed were reinstalled. The supply was then switched on and the voltage across the filter capacitors carefully monitored. Then, after a few seconds, the supply was turned back off again, this cycle then being repeated several times to reform the electrolytic capacitors.

It really pays to be rather gentle with 6X5GT rectifiers, as they are prone to develop short circuits from cathode to filament if they are abused to any extent. When I had finished overhauling the transceiver, I took the same precautions with it, as it is on a separate chassis to the power supply.

Overhauling the receiver

As is my usual procedure, I commenced overhauling the receiver section by testing the paper capacitors. And I have to say that the units fitted to this set would have to be the worst batch I have come across.

Photo Gallery: Kingsley Kit Set KFT-1

First marketed in Australia in 1946, this Kingsley receiver used "ferrotuning" to tune in stations (as opposed to the more conventional variable-capacitance tuning). This new system used a grooved brass spindle to actuate sliding iron-dust cores inside the tuning coils, thus varying their inductance. The set came with a colourful dial and circuits for three, four and 5-valve models were available. The unit shown here is a 5-valve KFT-1 medium-wave model using 6J8G, 6U7G, 6G8G, 6V6G and 5Y3G valves. Ferrotuning never gained widespread popularity and such sets are now a rarity. (Restored by Maxwell Johnson; photo by Ross Johnson).

They consisted mostly of miniature AEE units (brown coloured) and their leakage resistances varied between 1-10MΩ (as measured on a high-voltage tester set to the 500V range). A couple of these capacitors were also buried under shielded audio cables and unless you went looking for them, they could have been easily missed.

I had no option but to replace the lot, the only exceptions being the cathode bypasses on several of the valves. In the end, some 26 capacitors in total were replaced in the receiver and transmitter circuits.

The resistors were mostly 20% tolerance types and most had gone high by about 20%, so I didn't need to replace any. I also checked the speaker transformer to make sure there was continuity across the primary winding and this proved to be intact.

Once these checks had been completed, it was time to apply power. I began by reforming the electrolytic capacitors as described previously, then let the receiver run. There wasn't so much as a peep out of it – it was dead quiet.

It was time for some troubleshooting and I started by checking the voltages around the 6AQ5 output stage (V5). This showed that the cathode voltage was zero, which meant that no current was being drawn by the valve.

I also measured the heater voltage and found that there was 12V across the valve socket instead of 6V. This indicated that the heater had probably gone open circuit.

I removed the valve and found that the heater was intact, so I replaced it again. It still wasn't drawing current, so I removed it again, re-tensioned the socket pins and gave the socket a spray with Inox lubricant. This time there was some action and the receiver came to life, although it was very noisy.

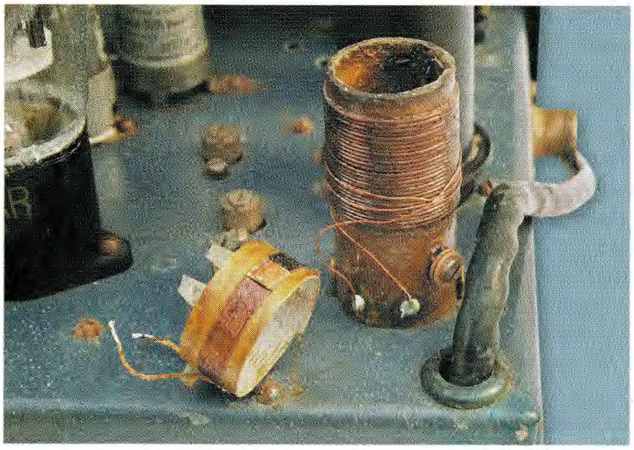
I tried wriggling the valve around in its socket and this produced loud crackles. After moving the valve around for a while (to clean the contacts), these crackles disappeared – or at least, they did for this stage. There were still problems elsewhere.

Next, I tried moving the 6BA6 RF stage (V1) around in its socket and the same crackling problem occurred. Its socket was also then sprayed with cleaner and the pins re-tensioned before replacing the valve. And again, the crackling problem disappeared.

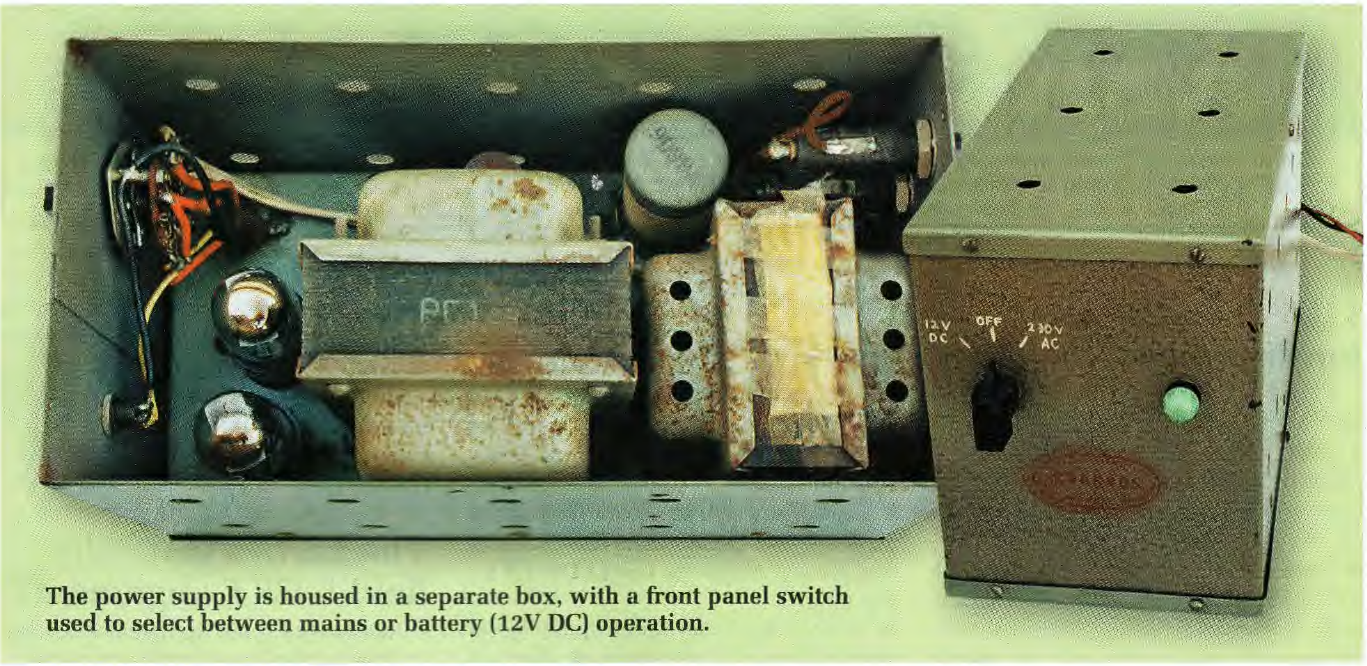
The set was now sounding much better, so I attached a signal generator to the receiver's antenna, tuned to one of the crystal-locked channels and adjusted the generator for an audible signal. The sensitivity was poor, so I checked around the 6AE8 converter stage (V2) and cleaned the frequency selector switch which was also noisy.

This made no difference to the sensitivity so the 6AE8 was removed and its socket also given the "treatment". This did improve the performance but when I subsequently touched the 6BA6 IF valve (V3), the crackling became quite bad and the sensitivity varied widely.

This valve was also removed and its socket cleaned and tensioned, after which the sensitivity improved quite



This close-up view shows the power amplifier tank coil, together with the coupling coil which has too many turns. The roughly-wound 3-turn coil over the tuned winding gives better performance.



The power supply is housed in a separate box, with a front panel switch used to select between mains or battery (12V DC) operation.

noticeably. I then checked the remaining valves and found that their sockets all had bad contacts.

These were all given a good clean up and the receiver was now turning in a reasonable performance. All those years spent in a salt-laden atmosphere had certainly caused some problems.

Receiver alignment

At this stage, I decided that a quick realignment of the receiver's front-end was the way to go.

First, I set the tuning to the 2692kHz crystal-locked position and rotated the receiver's tuning dial until an increase in sensitivity was observed. That done, the signal generator was adjusted until the signal was audible. I then peaked the RF and aerial coils slugs for best performance, after which the receiver was switched to 4510kHz and the signal generator and receiver tuning again adjusted for best performance. The aerial and RF coil trimmers were then adjusted.

Unfortunately, the variable frequency oscillator adjustments did not line up with the settings for best reception on crystal-controlled operation. As a result, I set the receiver up for best performance on the 2692kHz crystal-locked position with the signal generator, then switched to the tunable position and adjusted the oscillator slug until the 2692kHz signal was heard. I then did the same on 4510kHz, this time adjusting the oscillator trimmer.

The set now tunes quite well and signals well below a microvolt are readily heard. It really is quite a "hot" receiver!

I didn't touch the IF alignment, as it appears to be perfectly OK. Note that care is needed in tuning the IF of a crystal-locked receiver, as just peaking the IF alignment may mean that the receiver is no longer tuning the frequency it is intended to tune.

For example, to tune to 2692kHz, the receiver's crystal oscillator must operate at 3147kHz. That's assuming an IF of 455kHz (ie, 3147 - 2692 = 455). However, if the IF was aligned to say 465kHz, the actual frequency that the receiver would now tune would be 2682kHz (ie, 3147 - 465 = 2682).

At this stage, there was just one remaining problem with the receiver – the hum level was quite noticeable. It became inaudible when the volume control was reduced to zero and I subsequently found that better shielding around the detector and noise limiter (6AL5) improved the situation.

When the set is on vibrator supply, there is noticeable vibrator hash and the use of the noise limiter is desirable. It's not the best noise limiter in the world but it does work.

Overhauling the transmitter

Like the receiver, the transmitter had many leaky AEE capacitors that had to be replaced. And like the receiver, the resistors were all OK but just within tolerance.

Having replaced the capacitors, it was time to test the transmitter into a dummy load/power meter. I pressed the button on the microphone and adjusted the tuning capacitor on each of the transmit frequencies but could only get 5W output on 2692kHz and 3W on 4510kHz with 15W input – pathetic!

My suspicion was that the link coupling coil to the antenna had too many turns on it (12). To test this, I temporarily converted the output circuit to a Pi coupler and the output increased to 7W on 2692kHz to 8W on 4510kHz. I then experimented with the link coupling coil and found that three turns (instead of 12) resulted in an output of 6W.

This was still rather pathetic, as with 15W input to the V10 plate circuit, the output should have been around 10W. The rated input to the transmitter is 20W but I wasn't pushing it that hard with my temporary link coupling system.

The transmitter output stage doesn't gain any accolades from me. The ratio of the inductance and capacitance in the tank circuit (PA output tuned circuit) is not correct across most of the band to which it tunes. Furthermore, the link coupling method used for extracting the RF energy from of the tank circuit doesn't work efficiently in these transmitters. In my opinion, a better-designed output circuit would achieve an efficiency of 60-65% in the PA circuit. **SC**