Vintage Radio

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The EILCO 6104 lunch-box RFDS radio

This view shows the set with the front cover removed, ready to be connected to a 12V battery, antenna and earth.

Radio transceivers designed for use with the Royal Flying Doctor Service (RFDS) are now scarce but well worth collecting. My EILCO RFDS radio transceiver is one recent acquisition that I've been able to fully restore.

THE AERIAL MEDICAL SERVICE (AMS) commenced operation in 1928 from Cloncurry in north-west Queensland, providing medical assistance to people in the outback. Before then, with no telephones or good roads in areas remote from Cloncurry, it was extremely difficult for people in those areas to access medical services – even though Cloncurry boasted a well-equipped hospital.

By contrast, the AMS had a doctor who could fly out to visit people in need of medical attention. Subsequently, the AMS became much more effective when, in 1929, the first radio link in what was to become the Royal Flying Doctor Service (RFDS) commenced at Cloncurry.

The radios in use at station homesteads at that time were extremely simple, consisting of a 1.5W single-valve Morse code transmitter (crystal controlled) and a 2-valve regenerative high-frequency (HF) TRF receiver. The base station was much more complex, as it transmitted voice with a power of 50W and used a high-performance receiver in order to receive the low-powered homestead transmissions (see "Outback Radio from Flynn to Satellites" by Rodney Champness for more details on the early days of the RFDS and the radios used in the outback).

The RFDS radios evolved over the years from sets made (initially) almost exclusively by Traeger Transceivers to those made by a number of other manufacturers. Traeger produced many fine transceivers over the years but their methods of construction and the designs used eventually became outdated.

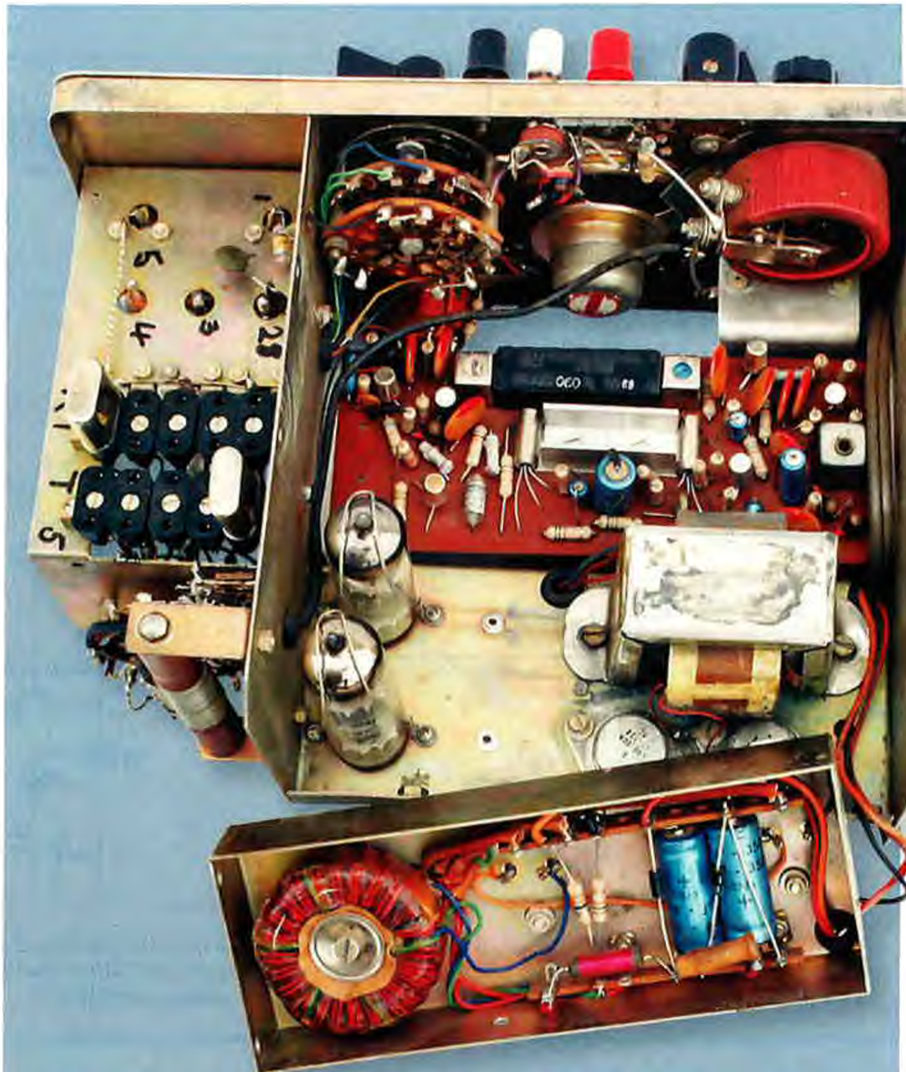
Traeger had pioneered the use of plug-in modules for the transmitters and receivers. This technique worked extremely well when only three channels were allocated for a particular flying doctor network. It meant that if people were transferred to another network or if a frequency change for a network was necessary, then all that had to be done was to send a plug-in module out to the affected stations. This module could be installed and correctly adjusted by relatively non-technical people.

Unfortunately, this approach subsequently became cumbersome and expensive when more than five channels were needed.

The birth of EILCO

One of the companies that rose to the challenge of producing transceivers suitable for use in the outback was the Electronics, Instrument and Lighting Company Pty Ltd (EILCO), which is known these days as Codan. EILCO was started by three University of Adelaide graduates – Ian Wall, Alistair Wood and Jim Bettison – in 1959. As a sideline, before the establishment of EILCO and before graduating, they often repaired equipment for the university and in some cases built better replacement equipment.

In 1961, they were asked to complete the construction of some HF radio equipment for the Anglican Bush Church Aid Society at Ceduna. They looked at the design and the partly constructed transceivers and decided that a different approach to the job would be better for all concerned. The idea was accepted and the EILCO 6104 transceiver was born.



This above chassis view of the 6104 shows the unit with the power supply module (bottom) swung out of the way. It normally sits above the PC board.

The set itself is about the size of a lunch box. It has five crystal-locked transmit and receive frequencies and an 8W HF AM transmitter which covers a nominal frequency range from 2-7MHz.

The EILCO 6104 subsequently proved to be very popular as a portable transceiver with the RFDS networks, mineral exploration teams, government departments and many other groups that were just realising the value of communications in the outback. The set was easy to use – it was only necessary to pull up along the track, open the set up, put the battery clips onto the 12V vehicle battery, sling up a wire antenna into a tree (hopefully there was one nearby, even if stunted), attach an earth, adjust the tuning controls and call the base station.

In short, the design was a big success and Codan has since grown into a well-known and respected company in the field of HF radio communications equipment.

The 6104

As mentioned earlier, the 6104 was initially designed for use with the Anglican Bush Church Aid Society. However, it's a sure bet that the founders of EILCO saw that the set would also be suitable for use by other organisations with only slight modifications to the basic transceiver.

By the way, the set was the fourth unit that EILCO designed in 1961, hence the 6104 type number. However, while the first two digits indicate the year of the design, they do not necessarily indicate the year of manufacture.

The set itself is built into a metal "lunch box" case measuring 295mm long (including protrusions), 210mm high (including handle) and 105mm wide. As shown in the photo, removing the lid reveals a very neat and uncluttered transceiver control panel.

The far left controls are used to tune and load the transmitter to the antenna in use, on any particular frequency selected. As an additional aid to tuning "unusual" antennas, a control marked 1-2-3 is also fitted.

The two terminals along the top of the control panel with the torch globe between them are the antenna and earth terminals. The torch globe is used as an indicator to show when the transmitter is correctly tuned – ie, when the globe is at its brightest.

Note that when the transmitter is correctly tuned to the antenna, the receiver is also tuned. That's because

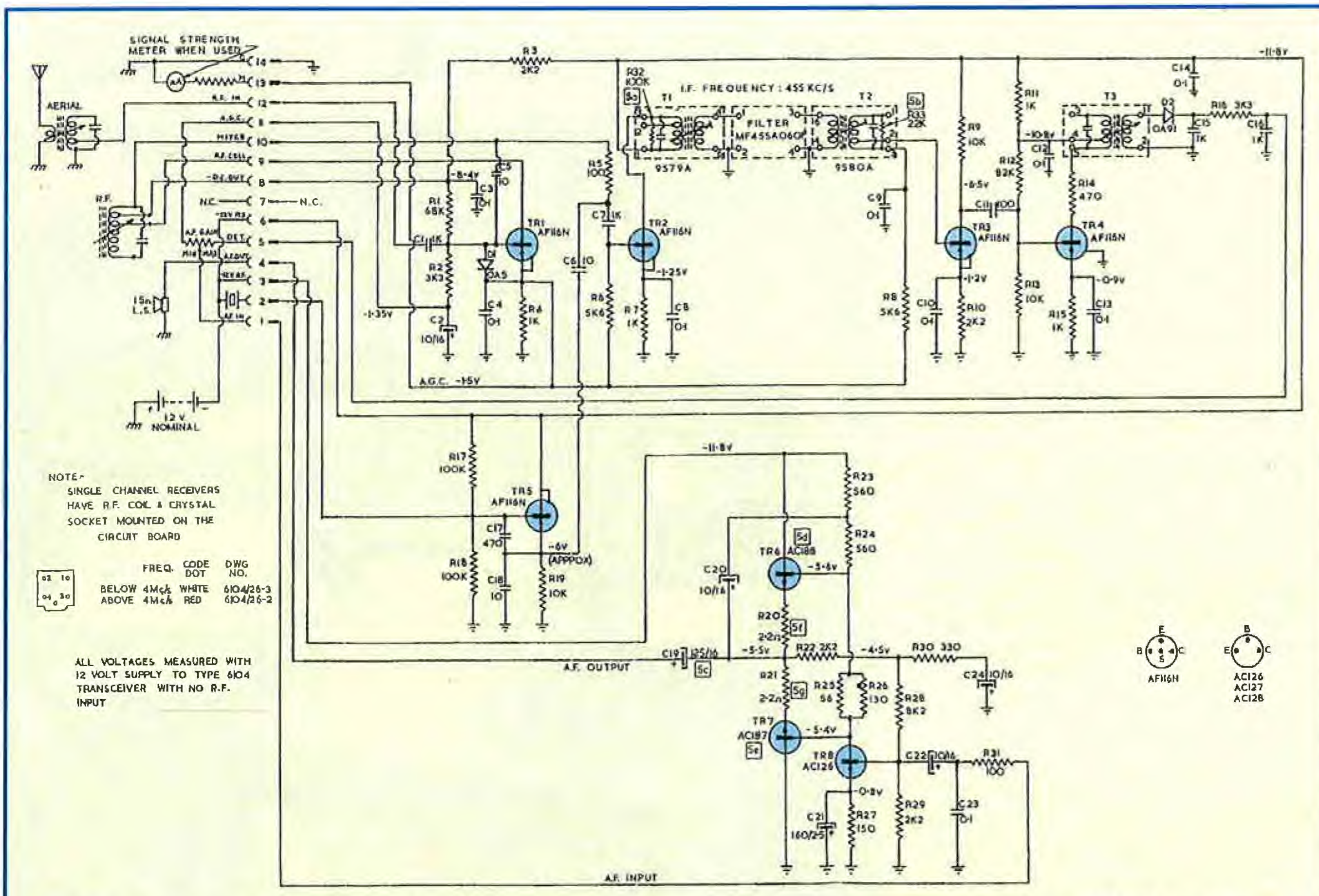


Fig.1: the receiver circuit uses eight germanium transistors and shares its antenna input stage with the transmitter. TR1 is the RF amplifier, TR2 functions as the converter stage and TR5 is the local oscillator. Transistors TR3 and TR4 are IF amplifier stages, while TR6-TR8 make up the audio amplifier.

the receiver uses both the loading/tuning circuitry and the transmitter output circuit as its input circuit. This is an advantage when the transmit and receive frequencies are the same or do not differ greatly. Conversely, if they do differ greatly, the receiver's sensitivity will be severely reduced.

The remaining control at the top of the panel is used to switch between transmit and receive. In the receive position, only the fully-transistorised receiver is operating and this draws around 25mA with no signal input. The set can therefore be used for monitoring for long periods without flattening the 12V battery (after all, who wants to have a flat battery in their vehicle)!

In the standby position, the transmitter's valve heaters are turned on (so that it is ready to operate) and the current drain rises to around 0.8A. And finally, in the transmit position, the transmitter is operating and the current drain rises to around 3A.

The remaining controls on the front panel are an on/off volume control (lower centre) and the channel-change knob (bottom, far right).

Receiver circuit

The 6104 was built in several variants, the two main ones being the Mk.1 and the Mk.2. The main differences between these two variants are in the receiver.

The unit I have is the Mk.2 with the 6415 receiver. This receiver is a plug-in unit and can either be used in the 6104 or used as a separate local or remote monitoring receiver with one or more channels. However, when remotely controlled, only one channel was commonly fitted.

In particular, the RFDS and many other HF services used the 6415 and similar units as remote receivers, locating them well away from sources of electrical noise, such as towns.

Fig.1 shows the circuit details for the receiver. As shown, it is an 8-transistor unit based on second-generation germanium transistors.

As stated previously, the antenna input circuit is shared with the transmitter. Following this stage in an RF amplifier based on TR1 and its input is protected from high-level transmitter signals – either from its own transmitter or another nearby transmitter – using an OA5 diode connected between base and emitter.

Transistor TR2 functions as a converter stage, while TR5 functions as the local oscillator. Note that the local oscillator is crystal controlled.

The following IF stage is based on transformers T1 and T2, with a ceramic filter between the two transformers. It operates at 455kHz and the IF input circuitry establishes the shape of the IF amplifier response curve.

Transistors TR3 and TR4 function as RC-coupled IF amplifier stages. These in turn drive transformer T3 and the detector/AGC diode (D2). The resulting AGC voltage is applied to the base

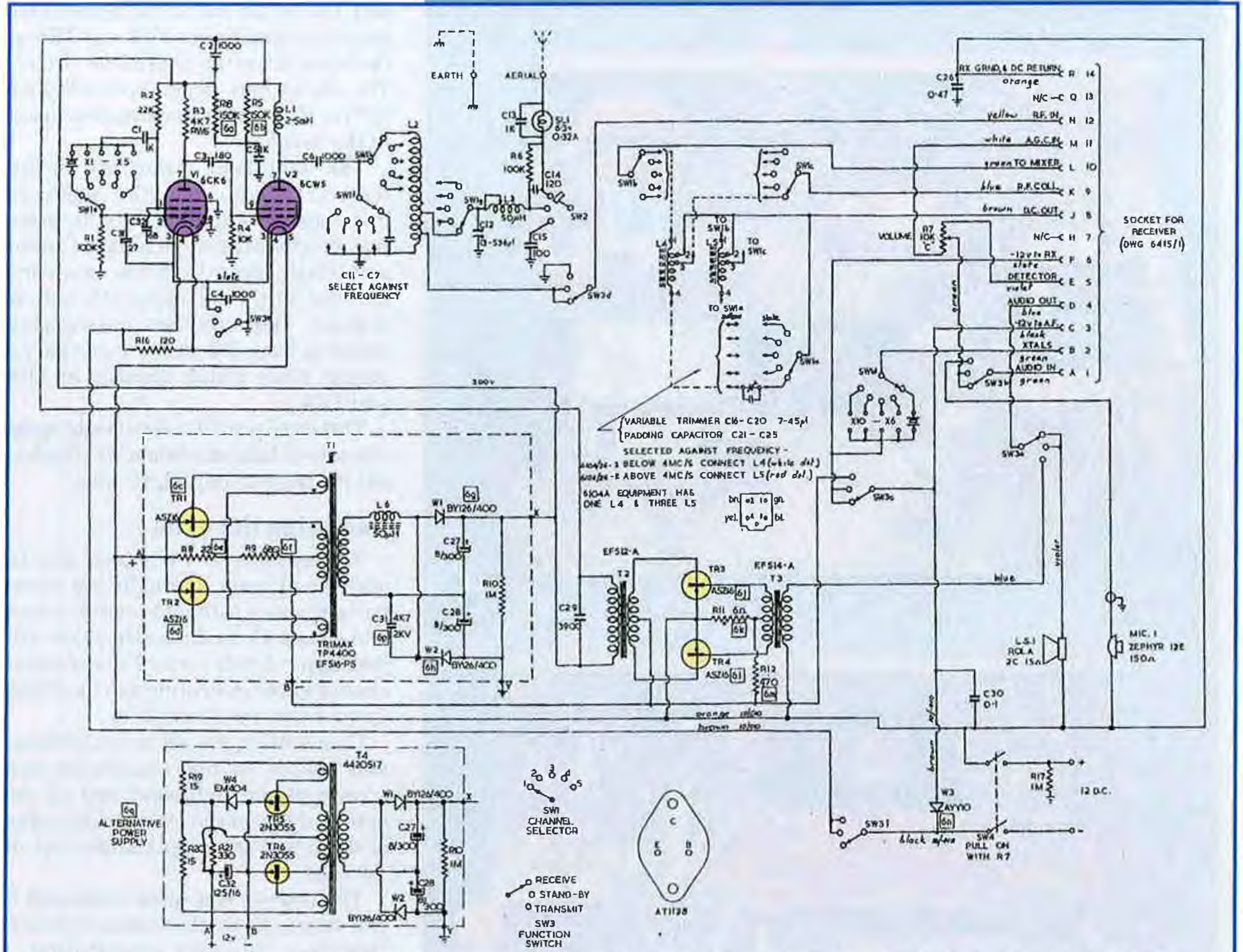


Fig.2: the transmitter circuit is a hybrid design, with valve V1 functioning as a Pierce oscillator and crystals X1-X5 setting the output frequency. V2 is the power amplifier output stage, while the modulator makes use of the receiver's audio amplifier stage to amplify the microphone signal. This signal is then fed to he modulator's output stage which is based on TR3 and TR4

of TR1 which in turn controls the gain of transistors TR2 and TR3 in the RF and IF amplifier stages.

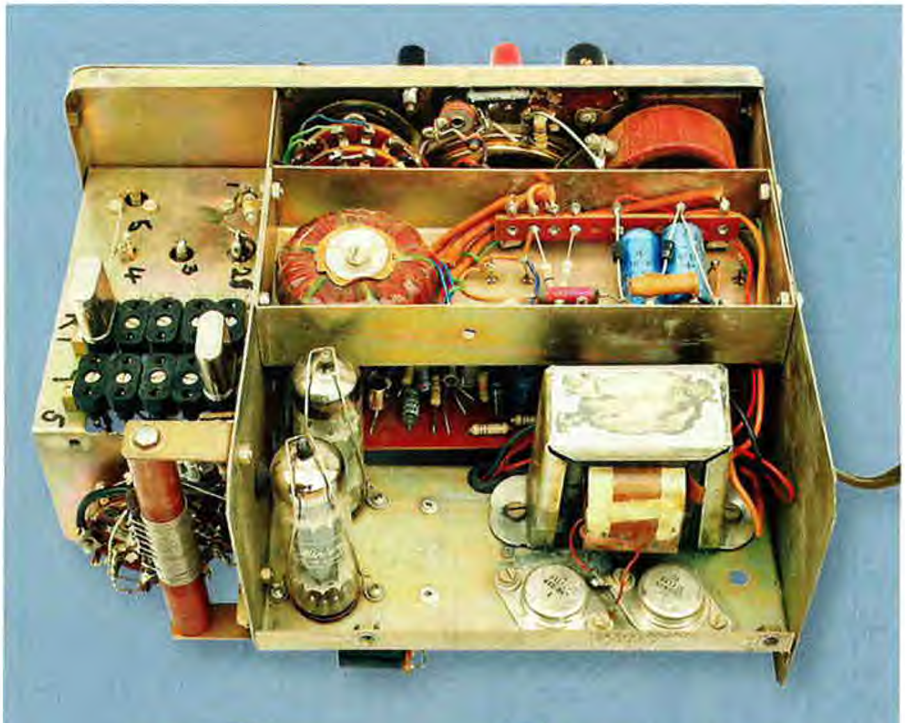
In addition, the audio signal from the detector is applied via a volume control to a 2-stage audio amplifier based on TR6-TR8. The output from this amplifier is fed to a 50mm loudspeaker on the front panel.

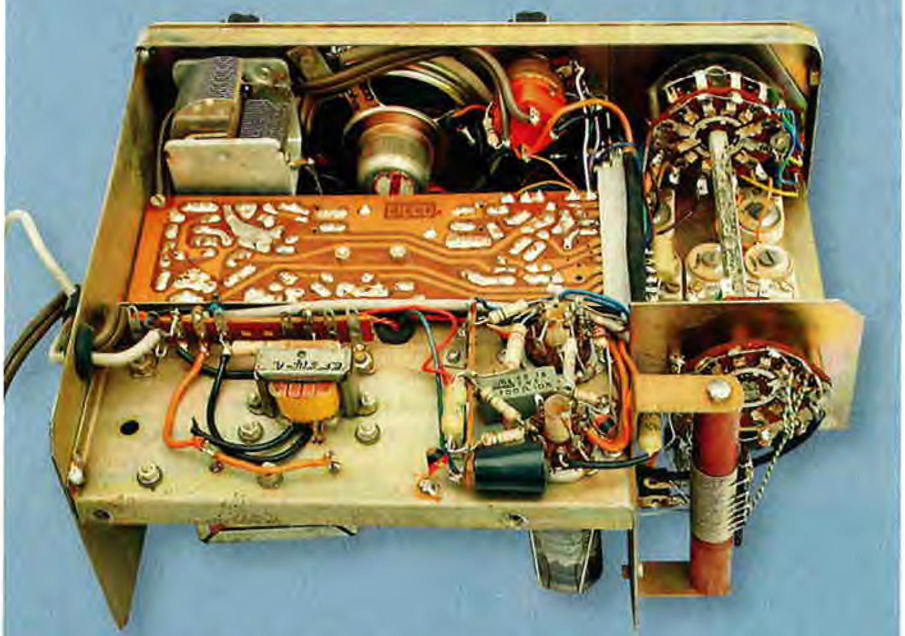
By the way, the symbol used for the transistors in Fig.1 may seem unusual, particularly for younger readers. In fact, it is one of the first symbols used for transistors and "Electronics Australia" magazine used it regularly in the 1960s.

Transmitter circuit

The RF section of the transmitter is

This is the fully restored Eilco 6104 transceiver in its "lunch box" metal case. The case was restored by powder coating it (cost $40) and it now looks like new.





These two photos show the top and bottom chassis views of the EILCO 6104 transceiver (taken from the rear). The two valves are used in the oscillator and power amplifier (PA) stages of the transmitter section (see Fig.2).

based on conventional valve circuitry. As shown, it uses a Pierce oscillator circuit based on a 6CK6, with crystals X1-X5 setting the frequency. This stage controls the grid of the power amplifier (PA) which is built around a 6CW5.

Coil L2 and its associated parallel capacitors are used to tune the transmitter output. Final output tuning and antenna matching is then performed by the tappings on the righthand side of coil L2 in conjunction with C12, L3 and the components connected to switch SW2.

A concise set of operating instructions is glued to the inside of the removable lid on the top of the carry case. Note that the valve stages in the transmitter require a high voltage supply of 300V DC. This is obtained from a transistor-based DC-DC inverter consisting either of transistors TR1 and TR2 at the left of the transmitter circuit or transistors TR5 and TR6 at the lower left of the transmitter circuit. The choice here depends on whether NPN or PNP power transistors are used in the inverter.

The modulator makes use of the receiver's audio amplifier stage, so this stage does double duty. In practice, this involves switching the audio amplifier's input from the receiver's detector to the microphone's output instead. The amplified microphone signal is then fed to the modulator's output stage which consists of TR3 and TR4.

This stage provides about eight watts of audio to fully modulate V2 which is the PA (power amplifier) valve.

Restoring the 6104

The transceiver I obtained was in quite good order internally but externally it was a different matter. It had had a hard life in the outback and still had Dymo labels around the channel change knob, indicating that the RFDS frequencies were installed.

Dismantling the set is not difficult and simply involves removing two screws at the righthand end of the case and two at the bottom. Once this is done, the set simply slides out of the case.

The chassis was quite clean and it was easy to access the various sections. Despite a thorough examination, I found no problems with the circuit and it's nice to have a restoration project once in a while that requires relatively little work.

I decided to tune the set up on 3565kHz, as I had crystals that suited that frequency which I had removed from another transceiver. Initially, I installed a 4020kHz crystal into the channel 1 position of the receiver (4000kHz - 455kHz gives a receive frequency of 3565kHz). That done, I was able to tune up the receiver by selecting various coil tappings and adjusting the trimmer capacitors for optimum performance.

The antenna coil can only be finally tuned when the transmitter is aligned. The IF was OK as the ceramic filter is a fixed-frequency device and won't shift frequency unless it is faulty. Transformers T1-T3 were also checked for alignment and were quite OK.

The transmitter was a little more difficult to tune up, mainly because I didn't have the alignment instructions.

However, after working on many fixed tuned transmitters and receivers over the years, a reasonable "guestimation" of suitable taps and capacitor values can be arrived at.

Of course, only people with an appropriate transmitting licence should have a working transmitter. I experimented with the tappings on L2 and the values of the parallel capacitor as selected by switches SW1f and SW1g. In this case, getting the right tapping and capacitor value is a bit like experimenting with the tappings on a crystal radio to get best performance.

Eventually, I got it operating as it should, which meant that the receiver's RF stage was now also aligned correctly.

Repairing the case

As indicated earlier, the metal case was rather the worse for wear. In the end, I figured that there were others far more capable than I when it came to fixing the scratches and abrasions.

As a result, I removed most of the handles and clips, although I couldn't remove the clips at the end of the case. That done, I took the case to a local powder coating firm and they did a first class job on it – so much so that it now looks like new. At $40, it was a job well done.

The control panel was in reasonable order but I did have to remove the old Dymo labels. Unfortunately, glue had been used around the labels and this proved to be so difficult to remove without damaging the front panel that I just cleaned it as best I could.

Photo Gallery: AWA R39 Battery Receiver

MANUFACTURED BY AWA in 1937, the R39 is a 4-valve battery-powered receiver requiring 120V HT, 2V for the valve filaments and bias voltages of -1.5V and -4.5V. The filament and bias voltages were all obtained from an internally fitted, tapped, battery.

The valve line-up was as follows: 1C6 frequency changer; 1C4 IF amplifier; 1K6 reflexed 2nd IF amplifier/1st audio amplifier/detector/AVC rectifier; and 1D4 audio output. Photo: Historical Radio Society of Australia, Inc.

Summary

The EILCO 6104 was one of the first truly "lunch box" size portable HF transceivers used in the outback. The outback of Australia has been a harsh testing ground for any equipment and the 6104 (and most other Australian-designed radio equipment) stood the test of time out there.

My unit works well but unfortunately it can not be used today on the amateur radio bands, as it is restricted to only five frequencies and to AM-only transmissions. By today's standards, it is well and truly obsolete.

That said, my 6104 is a worthwhile addition to my small collection of RFDS radios, dating from 1948 onwards. Early RFDS radios are scarce but some of the later ones are still available occasionally. They are well worth collecting, as they form part of our unique radio heritage. SC