By RODNEY CHAMPNESS, VK3UG

Portable HF transceivers used by the Forests Commission of Victoria

The Forests Commission of Victoria (FCV) was in charge of Victoria's state forests from 1918 up until 1983. During that period, it used a range of interesting portable HF transceivers. We take a look at some of these sets here.

IN CASE YOU'RE wondering what happened to the Forests Commission of Victoria, it subsequently became part of the Department of Sustainability and the Environment (DSE). Today, the communications facilities available to the DSE are vastly superior to those that were available to the FCV, especially prior to WWII. The equipment now used by the DSE include a range of VHF and UHF 2-way radios (both analog and digital), plus the necessary hill and mountain-top repeater stations to maintain communications in difficult terrain.

In addition, some services use satellite phones, mobile phones and UHF CB radios as necessary in emergency situations.

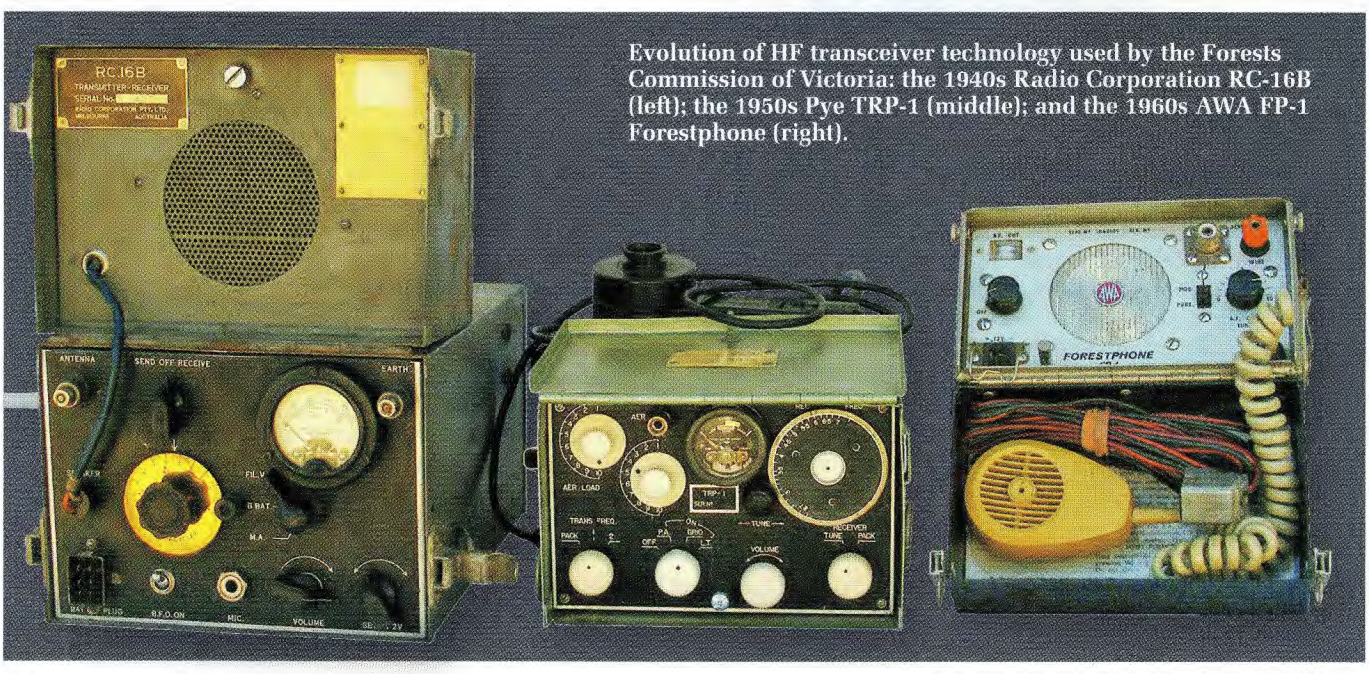
The era before WWII

In the years before WWII, telephones were uncommon in many of the remote and often mountainous areas administered by the FCV. This meant that radio transceivers were necessary to provide effective communication links during routine work. They also proved vital for coordinating efforts during bushfire emergencies.

Many of the radios used were sourced direct from the manufacturers but quite a few were actually built by employees of the FCV. Just how the FCV went about establishing their radio network in the 1930s and early 1940s has largely been lost with time, something that happens all too often when government departments reorganise themselves and historical documents are destroyed.

However, much is known about the equipment installed by the FCV and the transmitters and receivers used.

Over the years, the FCV installed base radio stations at locations where access to utilities such as mains power, telephone and postal facilities were generally available, eg, in country



Evolution of HF transceiver technology used by the Forests Commission of Victoria: the 1940s Radio Corporation RC-16B (left); the 1950s Pye TRP-1 (middle); and the 1960s AWA FP-1 Forestphone (right).

towns. The transmitters used were often made by the FCV and a number of them used the rather large 813 transmitting valve.

These AM transmitters were grid modulated, with an output power of around 50W. These were quite large at around 1.5m high and about 50 x 50cm square.

A variety of receivers were used, many of which were ex-service items such as the Kingsley AR7. The antenna systems were usually horizontal dipoles strung between long thin wooden poles harvested from the forests that the FCV administered.

Frequencies in the higher MF and lower HF ranges were typically used for local communications. In earlier times, frequencies in the 3MHz and 4MHz range were used as the RC16B (for example) did not tune below 3MHz. By contrast, frequencies between 2600kHz and 2800kHz were used in the later days of the FCV's involvement with HF radio. However, the base stations used higher frequencies to communicate with other base stations during emergency situations.

Portable HF transceivers

Transceivers were expensive to produce in the immediate pre-war and post-war years. They were also bulky, heavy and nowhere near as effective as communications equipment is today.

Prior to WWII, the equipment was made as simple as possible to keep costs down. As can be imagined, by comparison with today's gear, it was quite primitive. Let's take a closer look at some of the early transceivers used by the FCV, beginning with the Radio Corporation RC16B.

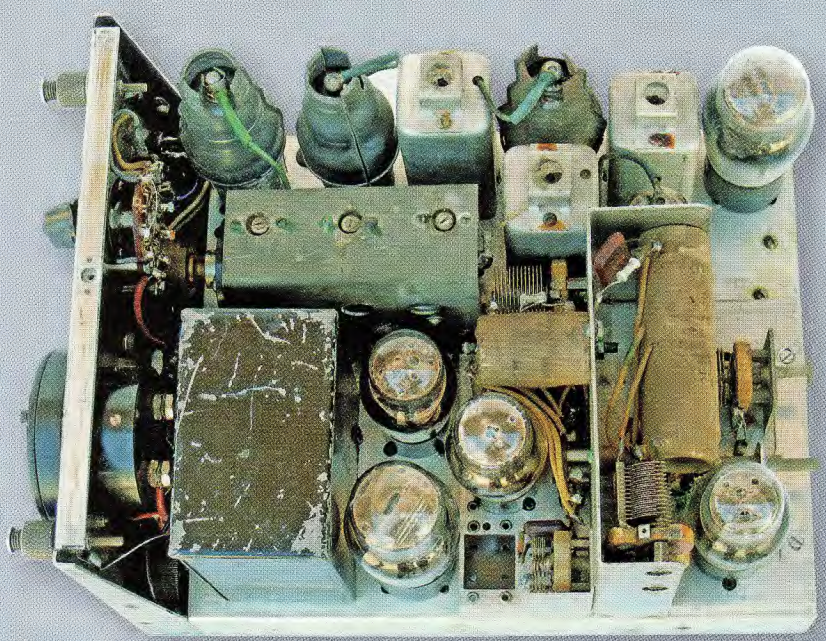
Radio Corporation RC16B

The RC16 high-frequency transceiver (and the military version the ATR4A/B) was designed and built by Radio Corporation in 1939, just before the outbreak of WWII. The receiver covered the 3-7MHz band and was a conventional superhet intended for AM reception. It also had provision for the reception of Morse code.

The transmitter section had an output of between 1.5W and 2W on either AM or CW (Morse code).

This transceiver was initially designed as a commercial portable unit and was designated the RC-16. A subsequent modified version intended for military use was designated the RC16B or ATR4A/B. The FCV adopted the RC16B for its work, as did a number of other forestry organisations throughout Australia.

The Radio Corporation RC16B covered the 3-7MHz band. It featured a 4-valve superhet receiver section, while the transmitter stage had an output of 1.5-2W and could transmit either AM or CW (Morse code).



This above-chassis view of the RC16B shows how tightly the parts were packed in, to minimise cabinet size.

Basically, the receiver used in the RC16B is a 4-valve superheterodyne unit which tuned from 3-7MHz in one band. To assist tuning, a 6:1 reduction vernier drive is used. The dial calibrations are rather sparse, so it was necessary to tune with care across that segment of the band where transmissions were expected.

Basically, it was necessary to hear the transmission before being sure that the receiver was tuned to the correct frequency. There was no provision for "netting" the receiver to the transmitter. However, the receiver does have one redeeming feature with its tuning, in that once a station has been tuned, it could be locked to that frequency.

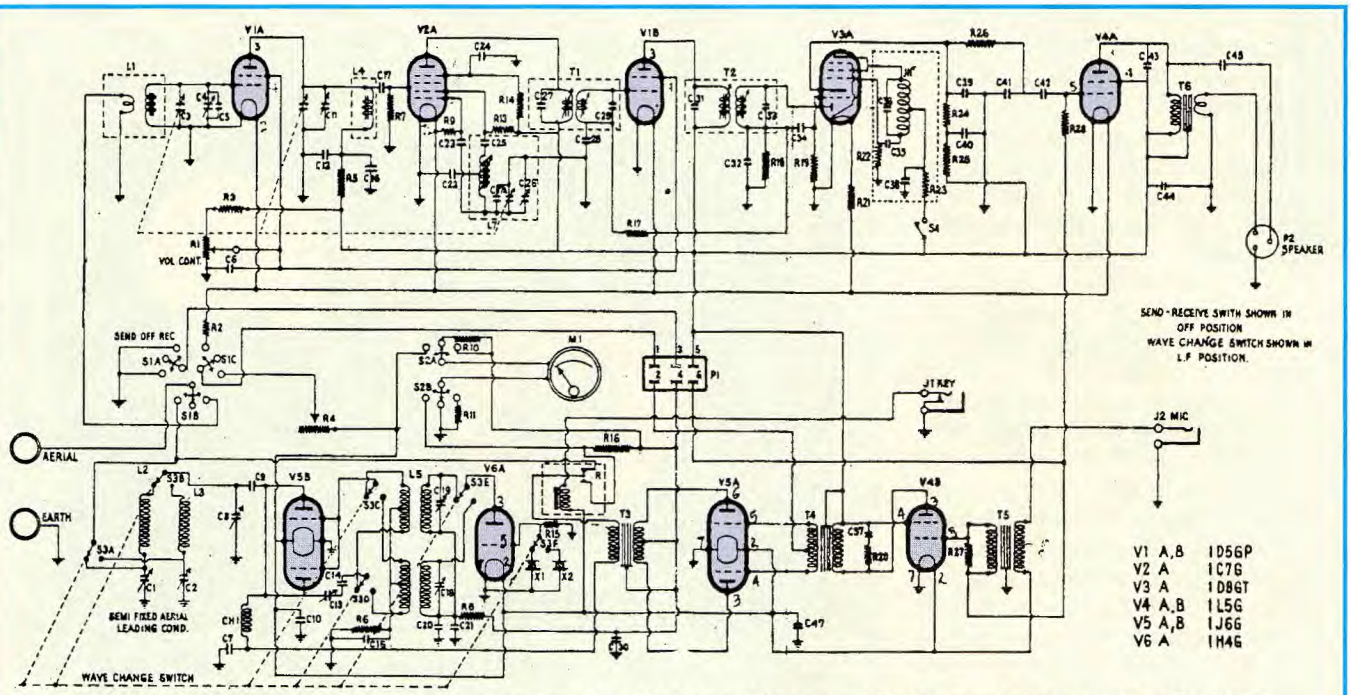


Fig.1: the circuit of the RC16B. The 4-valve receiver (V1-V4A) is at the top, while the 3-valve transmitter (V4B-V6) stage is along the bottom. V4B & V4A form the modulator, V6 is the RF oscillator and V5B is the power amplifier.

The parts under the chassis of the RC16B are neatly laid out, with short leads and laced cable looms to ensure reliability.

By the way, for those readers unfamiliar with the term "netting", it involves operating a low-level stage of the transmitter while tuning the receiver to the transmitter's frequency.

The first stage of the receiver is a tuned radio frequency (RF) amplifier using a 1D5GP pentode (V1A). This feeds a 1C7G frequency converter (V2A) and the 455kHz IF (intermediate frequency) on the plate of this stage is applied via the first IF transformer to another 1D5GP (V1B) which functions as an IF amplifier. The signal is then applied via the second IF transformer to the diode detector in V3a, a 1D8GT diode-triode-pentode valve.

The volume from the RC16B is controlled by varying the screen voltage on the RF and IF amplifier stages (V1A & V1B). This is effective although it's strange that automatic gain control (AGC) was not used, as the RF amplifying valves are variable cut-off types.

Following the detector, the audio is fed to the triode stage in V3A and the amplified signal then fed to a 1L5G output valve (V4A). This then drives the loudspeaker via transformer T6.

Morse reception

The pentode section of the 1D8GT (V3A) is used as a beat frequency oscillator (BFO) for Morse code reception. For those unfamiliar with the use of a BFO, it provides a low-level signal that's close to the frequency of the received Morse signal. These two signals then beat together to give an audio output which can then be read by a skilled Morse operator.

No provision was made for the use of headphones, despite the fact that these would have made copying of Morse code signals easier.

In use, the front lid hinged up to reveal the speaker grill (see photograph). The microphone and antenna lead were normally stored behind this panel when it was not being used.

All the valves in the receiver are 2V filament types, with the exception of the 1D8GT which is a 1.4V type. Perhaps the original RC16 had a 1H6G as the detector and first audio stage and the BFO was not included as it was not

required for normal AM communications. In fact, the Morse code function was probably an "add-on" for the military. The addition of Morse code (CW) to the transmitter stage also has the appearance of being an add-on but more on that later.

Transmitter circuit

The transmitter section uses four valves, all being 2V filament types. The RF oscillator uses a 1H4G (V6A) valve and has switching for two frequency bands – either 3-4.8MHz or 4.8-7MHz. The wave-change switch selects the various tuned circuits and switches in either crystal X1 (3-4.8MHz) or crystal X2 (4.8-7MHz) to control the oscillator frequency.

The output from the 1H4G is passed via tuned circuits to a power amplifier (PA) stage based on V5B, a 1J6G (V5B) twin-triode with both sections wired in parallel. The amplified signal from the 1J6G is then fed through another tuned circuit to the antenna.

Either the supplied 15m-long wire antenna or a horizontal Windom-style antenna can be used. Note that the PA stage is operated with both its input and the output on the same frequency. As a result, this stage is neutralised to prevent it from becoming unstable and going into uncontrolled oscillation.

The modulator is quite conventional and is rather like the audio output stage of a battery-powered domestic radio of the late 1930s. Basically, the audio signal from the carbon microphone is amplified in a 1L5G (V4B). This in turn feeds an audio driver transformer which has a push-pull output winding. The resulting push-pull audio signal is then applied to the grids of V5A (1J6G).

Finally, V5A applies audio to the PA stage via modulation transformer T3. The 1J6G modulator can be run with little or no bias but Radio Corporation decided to use a reasonable amount of bias to ensure that the valve did not draw too much current.

Transmitter Morse code

As stated, the provision of Morse code in the transmitter appears to be something of an afterthought. For normal AM operation, the Morse key is not plugged in and as a result, the small relay shown just to the upper right of the transmitter oscillator is normally in the operated position.

The Pye TRP-1 superseded the RC-16B and was both smaller and lighter than its predecessor while offering superior performance. The transmitter output power was the same as the RC-16B at around 1.5-2W.

In this condition, all is normal for voice/AM operation of the transmitter. However, when the Morse key is inserted (but not pressed) the relay drops out, the antenna is shorted to chassis at RF (on transmit) and the HT (high-tension) voltage is removed from the PA stage.

When the Morse key is subsequently pressed, the antenna RF short is removed and HT is re-applied via the secondary of T3 to the PA. During this time, the modulator stages remain in operation, which is unnecessary and just uses some of the limited power. It is not good practice to key the transmitter via the HT lead that goes through the modulator transformer and good designs do not do this.

Filament power for the transmitter is supplied from a 3V battery, while a series rheostat allows the filament voltage to be adjusted to 2V. This voltage, the HT voltage and the PA current are all monitored via a switched meter on the front panel.

Although this transceiver was quite effective for its time, the battery drain was quite high. The unit consumed around 4W of power on receive and 12W on transmit. The weight of all the equipment packs was around 19kg.

As an aside, the RC16 was similar in many ways to many of the Traeger pedal radios of the late 1930s.

Pye TRP-1

Low-current miniature valves became widely available after the war. As a result, Pye-Electronic Pty Ltd (which had taken over Radio Corporation) decided to design a transceiver to replace the RC16B. Designated the TRP-1, it was considerably lighter and used less power than the RC16B while offering similar or better performance.

The TRP-1 had a tuning range of 2.7-7MHz, which is slightly wider than the tuning range of the RC16B. It was quickly taken up by the FCV and proved popular due to its lighter weight, slightly greater transmitter power and wider frequency range. It could also be used as a walkie-talkie and the ability to crystal lock the receiver to a frequency made it quite popular – even more so than its predecessor.

The TRP-1 is built on a conventional chassis and consumes around 2.6W

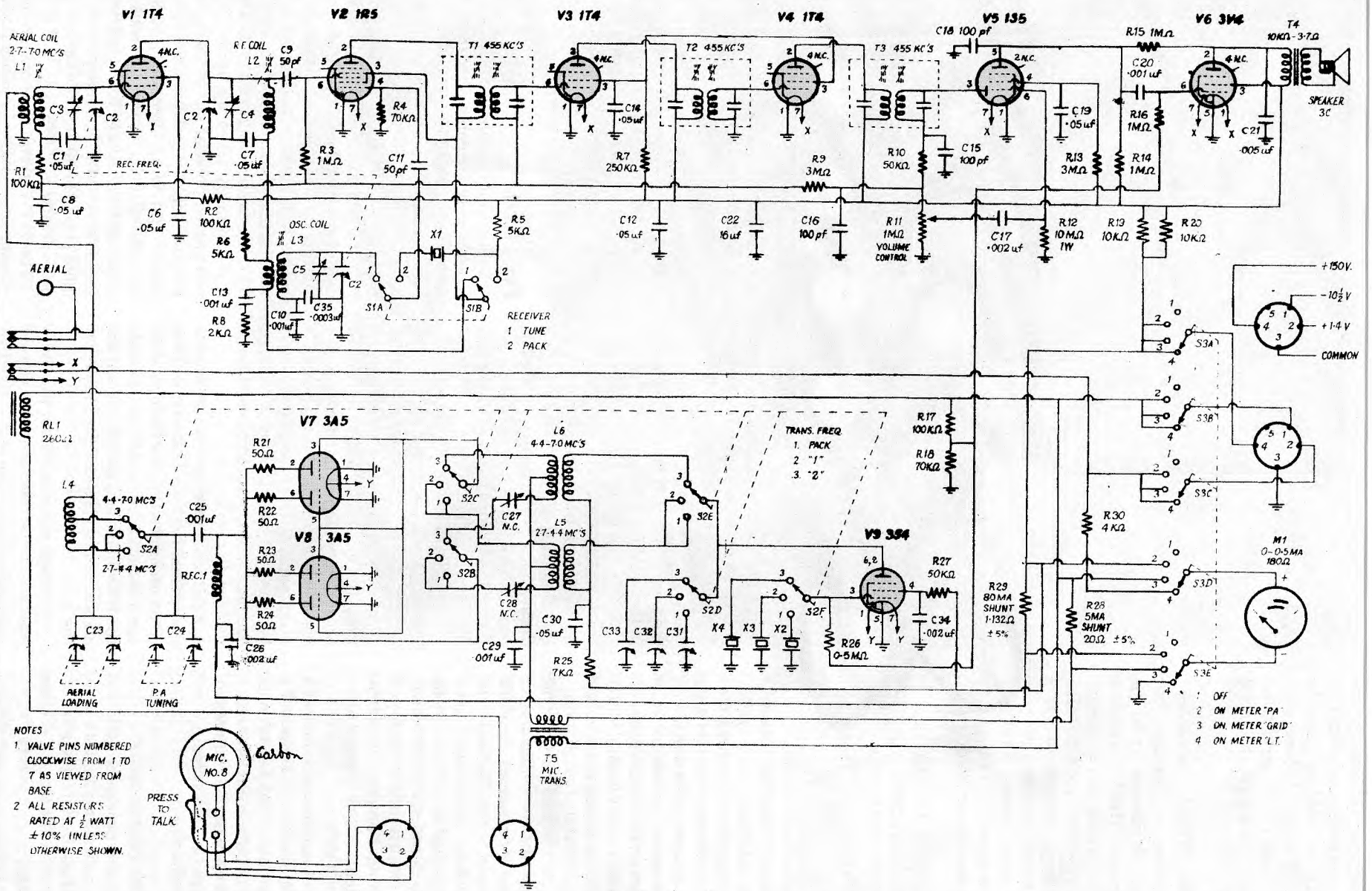


Fig.2: the TRP1 uses a 6-valve (V1-V6) superhet receiver stage. V1 (1T4) is the RF stage, V2 (1R5) is the converter, V3 & V4 (1T4) are the IF amplifiers, V5 (1S5) is the detector/AGC/audio amplifier and V6 (3V4) is the audio output stage. The transmitter stage uses V9 (3S4) as the crystal oscillator, while V7 & V8 (3A5) form the RF output stage.

on receive and 9W on transmit. It was designed to be used either as a semi-fixed portable or as a true portable transceiver. As a walkie-talkie station, it weighs 9.5kg. The portable battery weighs 3.6kg while the "camp" battery (for fixed station use) weighs in at a massive 16.7kg.

Fig.2 shows the circuit details of the set. The receiver (V1-V6) is a conventional superhet with a 1T4 RF stage, a 1R5 converter, a 2-stage IF amplifier using 1T4 valves, a 1S5 detector/AGC/audio amplifier and a 3V4 audio output stage. The -4V bias for the 3V4 is derived from a -10.5V bias battery within the battery pack.

A 150V battery provides the HT (high tension) for the receiver. This is supplied via resistors which drop the applied HT voltage to around 75V when the receiver is operating.

The RF, converter and first IF stages all have simple AGC applied to them. The converter can either be manually tuned across the 2.7-7MHz band or tuned to a spot frequency using its crystal oscillator.

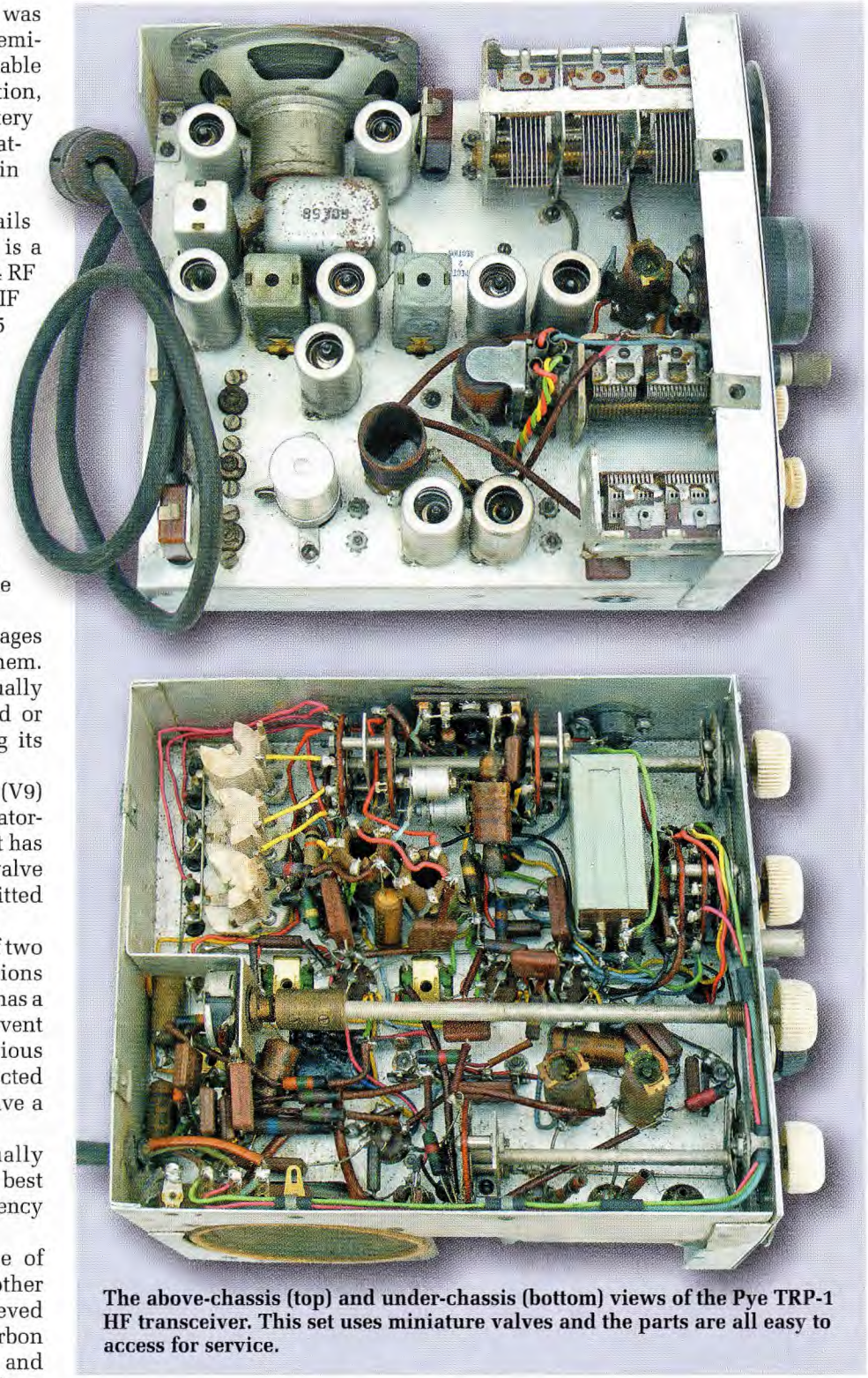
The transmitter stage uses a 3S4 (V9) which operates as a crystal oscillator-cum-driver for the output stage. It has -4V of bias applied to protect the valve in the event that crystals are not fitted in all three crystal positions.

The RF output stage consists of two 3A5 valves (V7 & V8) with all sections connected in parallel. Each plate has a 50Ω "parasitic stopper" in it to prevent the unit from transmitting spurious signals. With four triodes connected in parallel, it is mandatory to have a neutralising circuit.

The output circuit is manually tuned and the circuit loaded for best output on each transmission frequency selected.

The modulator is the essence of simplicity compared to most other modulators. Modulation is achieved by feeding the output from a carbon microphone to transformer T5 and then to the grids of the 3A5 valves, with -10.5V of bias.

The changeover from receive to transmit is accomplished by pressing the PTT (press-to-talk) button on the microphone. This grounds one side of the change-over relay which then swaps the antenna from the receiver to the transmitter, disconnects the receiver filaments and applies 1.5V to the transmitter filaments. The HT is left on at all times in both the transmitter and the receiver, so it is imperative that no work is done on either the transmitter or receiver with the set turned on.

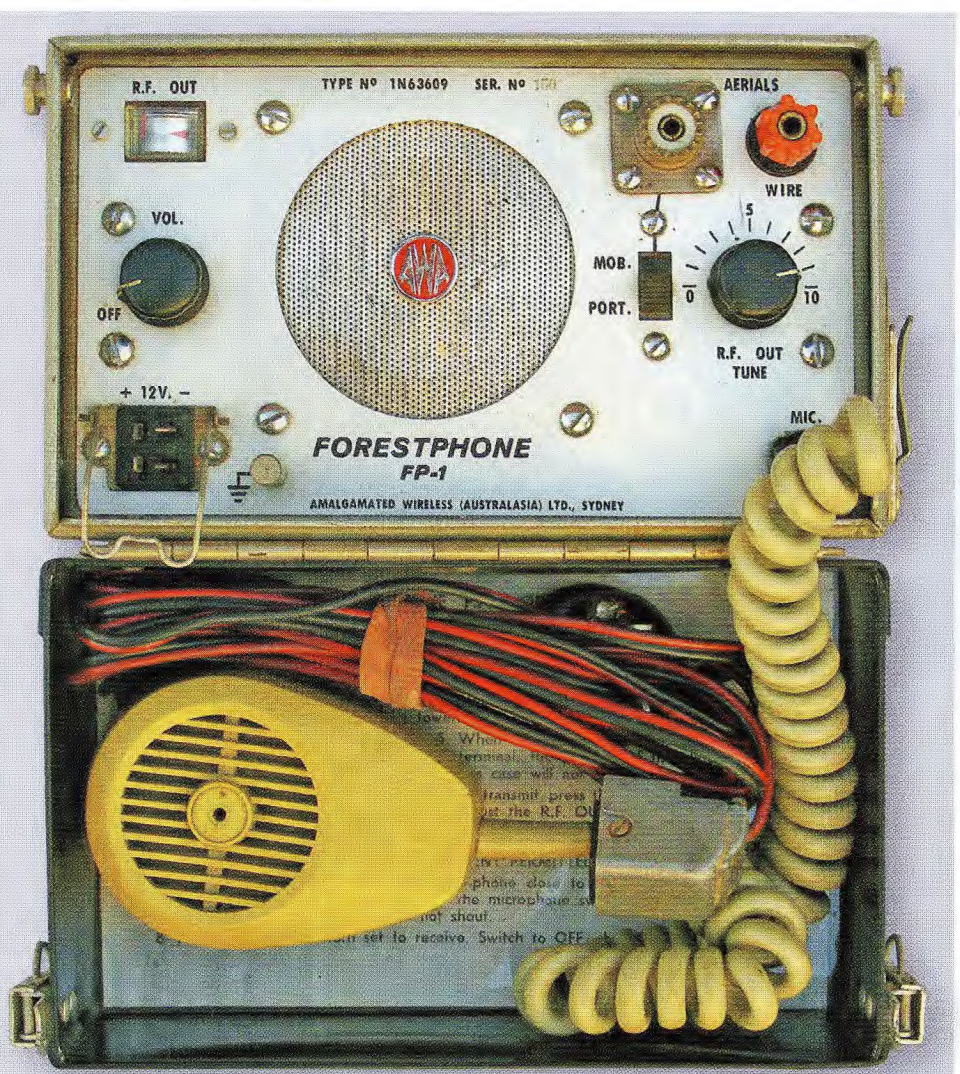


The above-chassis (top) and under-chassis (bottom) views of the Pye TRP-1 HF transceiver. This set uses miniature valves and the parts are all easy to access for service.

The AWA FP-1 (Forestphone)

In the mid 1960s, AWA was asked to design a solid-state replacement for the TRP-1 in collaboration with the FCV. The new transceiver was to be more powerful than the TRP-1, with an output power of about 10-12W (compared to 1.5-2W).

The set also had to be capable of being used as a walkie-talkie, as well as being suitable for use in a vehicle.



The solid-state AWA FP-1 Forestphone replaced the TRP-1. It was smaller and featured a more powerful transmitter, with an output power of 10-12W.

In addition, the FCV wanted to be able to remove it from a vehicle mount and convert it to walkie-talkie or base station operation in a matter of minutes.

Some of the features of the earlier transceivers were found to be redundant. It was unusual to need more than one frequency, so the receiver and transmitter were both crystal-controlled to work on a single frequency. However, a (rare) variant designated the FP-5 had outriggers on each side of the transceiver which enclosed switching for a total of five crystal-locked channels.

Having the tuning preset made the set easier to use for the average non-technical forestry worker.

Because it could be used in different configurations (a walkie-talkie, a portable, a mobile or a base station) at short notice, provision was made for several antennas with different characteristics. Over the years, the range of frequencies used became consolidated in the 2-5MHz range, where communication was found to most be most reliable.

The red-capped antenna terminal is connected to a 600Ω tap on the toroidal matching transformer in the output of the transmitter stage. The FCV used Windom-type antennas at many of their HF base stations and the nominal impedance of the single wire feed to this antenna is around 600Ω. The coaxial antenna connector is connected by a slide switch to two taps on the output transformer, giving an impedance of 50Ω which suits most mobile antennas and an impedance of 200Ω for much less efficient portable or walkie-talkie type antennas.

The receiver is a conventional short-wave unit for the late 1960s and uses one NPN and 10 PNP germanium transistors. This section is built on three PC boards, one for the RF amplifier and mixer, another for the IF amplifier, detector and noise limiter and the third for the low-level audio stages.

The front end of the receiver has an RF amplifier followed by the mixer and a separate crystal oscillator. The output of the mixer is then amplified by the 2-stage IF section and applied to the detector and a noise limiter diode. The noise limiter diode was necessary to prevent ignition noise when the transceiver was used in vehicles.

The DC voltage developed at the detector is applied to a transistor which acts as both an audio preamplifier and an AGC amplifier. The resulting AGC voltage is amplified by another two DC-coupled transistors and applied to the RF amplifier and the IF amplifier stages.

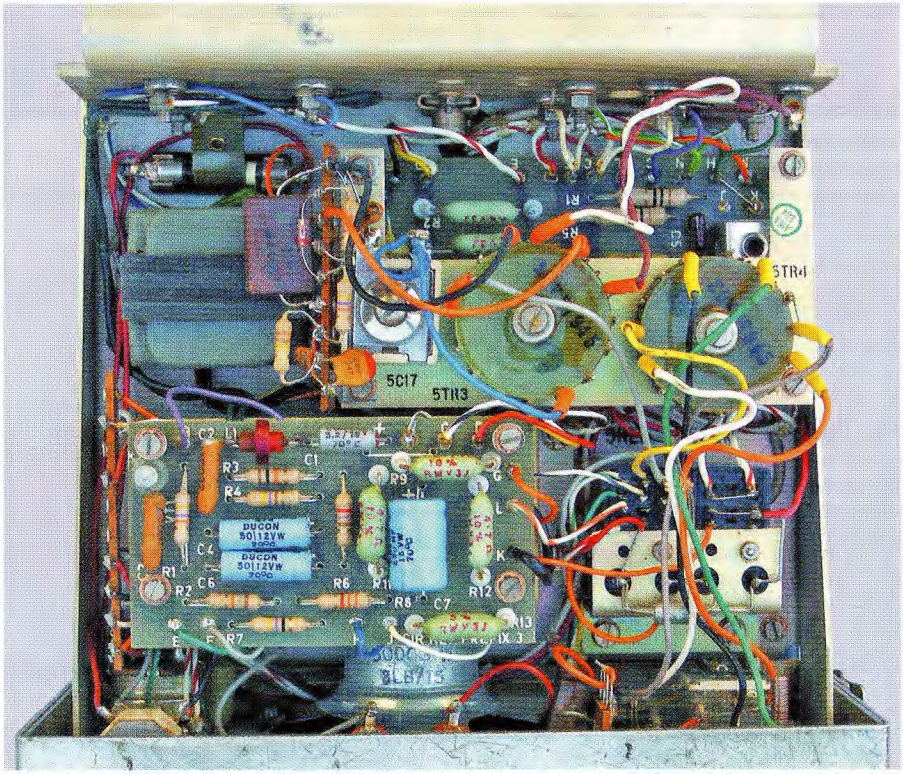
The audio is applied via a volume control to a 2-stage audio amplifier and finally to the loudspeaker. As a space (and cost) saving measure, this stage is also used as part of the transmitter modulator, by switching the input to a dynamic microphone instead of the audio preamplifier.

The audio output transformer has one centre-tapped primary winding and two secondaries. One secondary is switched to the loudspeaker, while the other secondary is centre-tapped and drives the bases of the two 2N301A modulator transistors.

The RF section of the transmitter is mainly built on two PC boards, with the larger electronic components mounted on the chassis or other sub assemblies. The crystal oscillator and its buffer amplifier use two transistors (VT1 & VT2). Its output is fed to an RF transformer which then drives two 2N3879 transistors arranged in push-pull configuration in the power amplifier (PA) stage. Each of these transistors is neutralised to ensure RF stability.

As mentioned earlier, the modulator shares most of the receiver's audio circuitry. This drives two 2N301A modulator transistors in push-pull. The output winding on the modulation transformer has several taps so that a small amount of modulation is applied to the RF driver stage and full modulation to the PA stage.

The output stage tuned circuit consists of a toroid with a centre-tapped primary and a secondary with 11 taps, so that the correct amount of induct-



The RF section of the FP-1 Forestphone's transmitter is built mainly on two PC boards, with the larger electronic components mounted on the chassis or other sub-assemblies. As a space-saving measure, the modulator shares most of the receiver's audio circuitry (not visible here).

ance can be selected for a particular frequency. This is then fine-tuned by adjustable trimmer capacitors. This stage is then coupled across to an antenna matching/tuning circuit that's identical to the PA tuned circuit.

Switching between receive and transmit is achieved by a PTT switch on the microphone. This actuates two relays to change from one function to the other.

An important feature of the set is that its DC supply rails are isolated from the chassis, so that it can cope with both negative-earth and positive earth vehicles (both types were produced at the time). In addition, the set features reverse polarity protection and is fused to provide protection if a fault develops.

The RF output from the Forestphone is about 10-12W with a 12V DC supply and this increases to around 15W with a 13.8V DC supply. Its current drain is 20mA on receive with no audio output, 2A with the transmitter operating but with no modulation and up to 3.8A with full modulation. The receiver's sensitivity is better than 2μV (using AWA's test procedure), which is noticeably better than the sensitivity of either the TRP-1 or the RC16B.

The FP-1 is lighter than either of the two previous units. It weighs 3.7kg complete with its front storage cover and vehicle mount rack but this does not include the weight of any antenna equipment. For portable or walkie-talkie use, it is necessary to add another 3-5kg for a sealed 12V battery.

Summary

The period of portable HF transceivers in the Forests Commission of Victoria extended from around 1939 through to the mid-1970s, when VHF radio communications took over. The evolution of the sets in size, receiver sensitivity, transmitter power and ease of operation demonstrate how HF transceivers developed in era before VHF radio systems came of age. SC